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On the Influence of Luminous-and-Grounded Channel on the Radiated Electric Fields at Close Distance in Rocket-Triggered Lightning

Quanxin Li[1,2], Jinliang He[1], Jianguo Wang[2], Marcos Rubinstein[3], and Farhad Rachidi[4]

1 State Key Laboratory of Power System, Department of Electrical Engineering, Tsinghua University, Beijing 100084, China

2 School of Electrical Engineering and Automation, Wuhan University, Wuhan 430072, China

3 University of Applied Sciences of Western Switzerland (HES-SO), 1400 Yverdon-les-Bains, Switzerland

4 Electromagnetic Compatibility Laboratory, Swiss Federal Institute of Technology (EPFL), 1015 Lausanne, Switzerland

Abstract— An analysis on the influence of the luminous-and-grounded channel on the radiated electric fields at close distance range in rocket-triggered lightning is presented. The presence of the luminous-and-grounded channel is found to play an important role in the fine structure of the electric fields associated with M-components.

Keywords: initial height; return-stroke; M-component model of charge transfer; electric fields

I. INTRODUCTION

The rocket-triggered lightning technique, usually performed by launching a rocket dragging a copper wire, is an effective way to better understand the lightning physics and effects (e.g., [1]-[2]). The trajectory of the copper wire is characterized by a noticeable luminous-and-grounded channel above the ground [3]. Considering e triggering wire as a grounded tall structure, the phenomenology of rocket-triggered lightning is to some extent similar to a natural upward lightning flash.

Following the procedure presented in [4], the classical guided-wave M-component model from [5] was extended to take into account the presence of a tall tower in [6]. Compared to return strokes, M-components exhibit noticeable differences in terms of their current peak, their rise-time and the associated E-field waveforms.

II. RESULTS AND ANALYSIS

As shown in Fig.1, the computed electric field waveshapes at 100 m considering various heights of the luminous and grounded channel are significantly different in their initial negative part. As shown in Fig.2, the fields are significantly affected by reflections in the channel and the effect of the first reflection seen to be dominant over rest of the multiple reflections. One reflection represents the scenario that reflected current wave from the ground will directly go ahead along the channel with any reflections at the top of the luminous channel.

III. CONCLUSIONS

The presence of the luminous-and-grounded channel plays an important role in the wave shapes of the M-component electric fields at close distance. In addition, the study shows that reflections in the luminous-and-grounded channel lead to a smaller amplitude of the initial negative peak and the first of the multiple reflection plays a dominant role in this effect.

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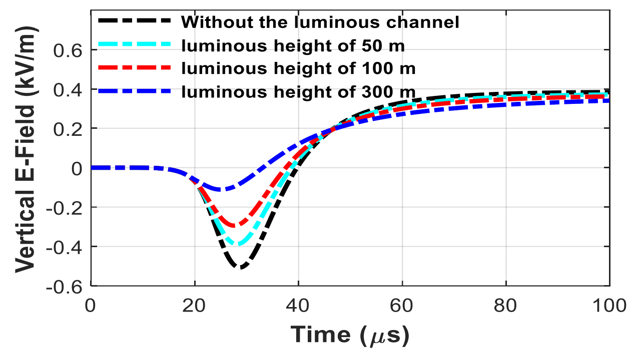

Figure 1. Electric fields of M-component mode of charge transfer at 100 m.

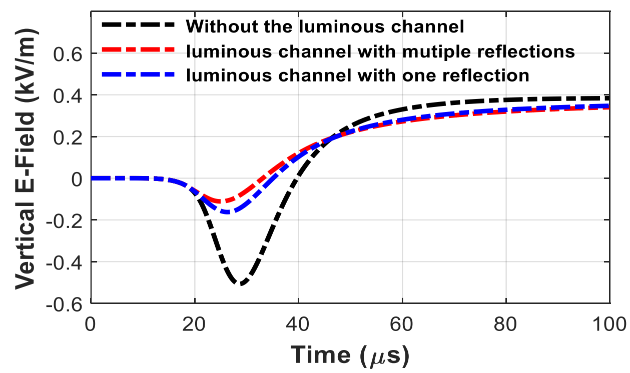

Figure 2. Influences of reflections inside the luminous-and-grounded channel on the electric fields of M-component mode of charge transfer (300 m distance).

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