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The Electric Potential of a Giant Jet Determined From a Simultaneous Sprite

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Thunderstorm clouds may discharge directly to the ionosphere in spectacular luminous jets – the longest electric discharges on our planet. The electric properties of jets, such as their polarity, conductivity, and currents, have been predicted by models, but are poorly characterized by measurements. Here we present an analysis of the first gigantic jet that with certainty has a positive polarity. The jet region in the mesosphere was illuminated by an unusual sprite discharge generated by a positive cloud-to-ground lightning flash shortly after the onset of the jet. The sprite appeared to have elements in a ring at $\sim$40 km distance around the jet, the elements curving away from the jet. This suggests that the field close to the jet partially cancels the field driving the sprite. From a simple model of the event based on optical and electromagnetic measurements we conclude that a substantial portion of the positive cloud potential must be carried to $\sim$50 km altitude. The estimated electric current and potential is consistent with the observed channel expansion. It is further shown that blue jets are likely to substantially modify the free electron content in the lower ionosphere because of increased electron attachment driven by the jet electric field. The model further makes clear the relationship between jets, gigantic jets, and sprites. This is the first time that sprites are used for sounding the properties of the mesosphere. The observations presented here will allow evaluation of theories for jet and gigantic jet generation and of their influence on the atmosphere-ionosphere system.