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Re-discharges on preexisting negative leader channels of a positive cloud-to-ground lightning flash

Zhuling Sun¹, Xiushu Qie¹, Mingyuan Liu¹, and Fengquan Li²

¹Institute of Atmospheric Physics, Chinese Academy of Sciences

²Wuhan NARI Limited Liability Company of State Grid Electric Power Research Institute, Wuhan, China

Using the lightning VHF interferometer, three types of discharges on the preexisting negative leader channels of a positive cloud-to-ground lightning flash were observed. The first type involved small-scale cluster discharges during the simultaneous development of the upper horizontally negative leader and downward positive leader before the return stroke. These discharges exhibited similar characteristics and radiation features as the needle-like discharges on the positive leader. Over time, their occurrence positions progressed toward the head of the negative leader, and some cluster discharges had the potential to develop into new negative branches. The other two types of re-discharges occurred after the return stroke. Immediately after the return stroke, rapid discharges initiated near the head of the negative leader, developed along the preexisting negative leader channel, and caused the decayed negative leaders to progress forward again. Subsequently, numerous lateral discharges breaking down the air occurred, distributed widely throughout the negative leader channel. These discharges developed rapidly, gradually slowing down over time until the long continuous current ended. In comparison to the positive leader discharges before the return stroke, which showed no obvious recoil leader discharges, the negative leader channel was more prone to extinguish. These re-discharges on the preexisting negative leader channel were influenced by both radial and longitudinal electric fields of flash channels, and they could also generate a backward surging current wave to sustain the discharge process on the positive leader or grounded channel.