



The Radio Emissions from Streamers

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Streamers are a key component of both lightning and high-altitude discharges such as jets and sprites. With their timescales as short as nanoseconds at thunderstorm altitudes, they can produce high frequency (HF) and very high frequency (VHF) radio emissions. The radio signals in the HF and VHF bands are being used to map and image lightning development, so understanding the radio emissions from streamers is important to interpret lightning radio observations. The recent discovery of lightning-initiating narrow bipolar events being caused by fast breakdown (Rison et al., *Nat. Commun.*, 7, 10721, 2016; Tilles et al., AE12A-03, AGU Fall Meeting, 2016) further calls for a better understanding of the radio emissions from streamers, because fast breakdown has been suggested to be a system of streamers (Rison et al., 2016).

In this talk, we review recent modeling studies on the radio emissions from single propagating streamers and streamer collision, a process that can generate even faster current transients and so radio emissions at higher frequencies. We propose parameterization of the radio emission from single streamers and formulate a statistical approach to model the radio emissions from a streamer ensemble given the knowledge of single streamer radio emissions. The modeling results of the radio emissions from a streamer ensemble indicate that tens of million streamers can explain the measured current moment, charge moment change, and spectrum of NBEs. Finally, we give suggestions on future streamer simulation work and lightning radio measurements in order to advance our understanding of lightning initiation and propagation.