VHF INTERFEROMETRIC IMAGING OF THE INITIATION AND PROPAGATION OF IN-CLOUD LIGHTNING LEADERS

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Radio emissions continue to provide the best view into many of the most interesting and scientifically important lightning processes. These include terrestrial gamma-ray flashes, most of which are produced during the upward development of new in-cloud lightning leaders, and lightning initiation itself, which may involve a newly discovered but largely unknown process termed fast positive breakdown [Rison et al., Nat. Comms., 2016; Stock et al., JGR, 2017]. Here we will present new measurements from a very high frequency (VHF) interferometric lightning imaging system that we have developed and operated near Duke University this year. This system is based on three flat plate electric field sensors on two 50 meter orthogonal baselines, a sampling frequency of 125 MHz, and an overall bandwidth of roughly 0.1 to 55 MHz. This system began operation in May 2017 and has since recorded radio emissions from lightning flashes in dozens of individual storms. The wide bandwidth enables us to process and image different frequency ranges separately to gain insight into the spatial and temporal relationship of lightning processes that radiate at different frequencies. Our primary focus in this presentation will be on two related topics. The first is our observations of fast positive breakdown during lightning initiation. In some cases it is clearly seen with the same features as those events that have been previously reported [Rison et al., Nat. Comms., 2016]. But in many cases there is no signature of fast positive breakdown, indicating that it is either very weakly radiating or not present. The second topic is the development of upward in-cloud lightning leaders as viewed simultaneously through VHF and 1-300 kHz low frequency emissions.