Fractal Dimension of Cloud-to-Ground Lightning

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High speed images of lightning have significantly improved our understanding of lightning initiation and propagation. For example, they have helped understand the initiation of lightning leaders [Stolzenburg et al., JGR, 119, 12198, 2014; Montanyà et al, Sci. Rep., 5, 15180, 2015], the stepping of negative leaders [Hill et al., JGR, 116, D16117, 2011], the structure of streamer zones of leaders [Gamerota et al., GRL, 42, 1977, 2015], and transient rebrightening processes occurring during leader propagation [Stolzenburg et al., JGR, 120, 3408, 2015].

In this talk, we report the results from an observational campaign in the summer of 2016 to study lightning by using a Phantom high-speed camera on the campus of Florida Institute of Technology, Melbourne, FL. The high speed videos show that the propagation of the downward leaders of cloud-to-ground lightning discharges is very complex, particularly for high-peak current flashes. They tend to develop as multiple branches, and each of them splits repeatedly.

One of the effective approaches to characterize the structure and propagation of lightning leaders is the fractal description [Mansell et al., JGR, 107, 4075, 2002; Riousset et al., JGR, 112, D15203, 2007; Riousset et al., JGR, 115, A00E10, 2010]. We also present a detailed analysis of the high-speed images and report what we find about the fractal dimension of lightning. Finally, we compare the obtained results with fractal simulations conducted by using the model reported in [Riousset et al., 2007, 2010].