# Time domain fractal lightning modeling study of field change array data


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Even though lightning flashes and the associated phenomena have been well documented under many different environmental conditions, with various types of instruments, our understanding of the physical processes involved remains incomplete. This is partly due to the fact that the intrinsic complexity of lightning often makes it difficult to make detailed and quantitative connection between experimental data and theories about certain fundamental physical processes.

In this paper, through the study of Time Domain Fractal Lightning Modeling (TDFL) together with data from the Huntsville Alabama Marx Meter Array (HAMMA), we show that TDFL provides effective means for interpreting observational data in terms of theories of fundamental physical processes.

TDFL is capable of modeling lightning flashes starting with the initial breakdown and continuing until the flashes cease to be active. The flashes can be intra-cloud discharges or cloud-to-ground discharges. On its own, TDFL extends lightning channels using a stochastic model depending on various physical parameters. In other cases, as in the study to be presented, TDFL can accept constrains on the discharge geometry derived from data. In comparison with previous Fractal Lightning models, TDFL offers many advantages. For example, it works in the time domain and does not assume quasi-static lightning channel at any iteration by using the Method of Moments (MoM) to solve the Electrical Field Integral Equation (EFIE) with effectively unconstrained channel geometry. As a result, it provides information on the time evolution of both current and charge distribution along the channel and predicts the resulting electrostatic and electromagnetic signals for comparison to data. It also can be used to study other physical effects such as the corona sheath, space leader development, and time-evolving channel impedance.

HAMMA is a network of electric field change meters (Marx meters) with high time resolution capable of reconstructing the geometry and time development of the charge motions in a lightning discharge. The network provides lightning mapping capability and electric field records.

In this study, HAMMA network data are used to constrain the initial conditions and development of TDFL simulations, and the TDFL results are used to interpret the field change data from the network. The role of the evolution of the lightning channel electrical properties, the channel corona sheath, and the geometric development of the channel are examined, and the physical implications of the HAMMA data are studied.