

**ANALYSIS OF CHARGE TRANSFER IN INTRACLOUD LIGHTNING  
USING A TIME-DEPENDENT MULTI-DIPOLE MODEL**

by

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## ABSTRACT

A new model is developed to show in detail the charge transfer during intracloud (IC) lightning flashes with high time and space resolution. This model combines high-speed electric field measurements from a balloon-borne instrument (Esonde) and three-dimensional very high-frequency (VHF) lightning observations from the New Mexico Tech Lightning Mapping Array (LMA). At the time of each LMA source, the model places a charge at the source location. To conserve the charge, the same amount of charge with opposite polarity is placed at whichever earlier LMA source yields the best agreement with the electric field change since the previous LMA source. The two charges, which compose a dipole, are left in place while additional dipoles are placed when subsequent LMA sources appear. With this method we derive the time-varying charge distributions along the channels of two IC flashes with differing complexity. For the flash at 19:56:49 UT on 18 August 2004, the model estimates the negative charge transferred into two isolated positive cloud regions to be about  $-91$  C, which is  $\sim 50\%$  larger than that derived by *Hager et al.* [2007] using a different model. It is also found that the line charge density along the lightning channels varied significantly when the negative leader propagated into the lower positive cloud region, where most of the transferred charge was deposited. Using data of the lightning flash at 23:07:03 UT on 24 August 2007, the model is modified to include the measurements from a stationary electric field sensor on the ground. The modification gives better results for charges distant from the balloon-borne instrument and closer to the ground-based instrument.