Physical Characteristics of Compact Intracloud Discharges (CIDs)

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Compact Intracloud Discharges (CIDs) are distinct, isolated electrical discharges that occur within intense regions of thunderstorms. Unlike other intracloud and cloud-to-ground lightning events that occur as sequential breakdown processes and often last for a large fraction of a second, CIDs are singular impulsive events that last for only a few tens of microseconds or less.

In recent years, CIDs and the thunderstorms in which the events have occurred have been studied using a variety of resources including ground-based electric field change and broadband HF arrays, satellite instrumentation including the Blackbeard receiver and FORTÉ satellite, NEXRAD weather surveillance radars, and the National Lightning Detection Network. Based on the data from these resources, CIDs have the following physical characteristics:

CIDs begin with an initial breakdown stage as indicated by RF radiation that lasts for a few microseconds. Ionization proceeds at a velocity on the order of one third of the speed of light and forms a channel that is between a couple hundred and many hundred meters in spatial extent. The channel is predominately vertically oriented. Subsequent charge movement along the channel occurs as a pulse of current that lasts between 10 and 20 microseconds and produces a dipole moment change on the order of 0.5 C-km. The polarities of 24 events that were observed during the summer of 1996 (and occurred between 8 and 11 km MSL) indicated that charge was transferred between upper positive and lower negative charge regions. The inferred average current during a CID is on the order of 100 kA.

A model of charge configuration prior to a CID indicates that the source region has a charge density on the order of many tens of nC/m^3 and an electric field strength on the order of one MV/m. Such charge densities and field strengths are higher than those that have previously been recorded by or inferred from in situ measurements. This apparent discrepancy may result from the fact that CID source regions have not yet been probed by in situ instrumentation. This possibility is supported by the sporadic spatial and temporal occurrence of CIDs in thunderstorms. In addition to occurring in regions of high apparent electric field strengths and charge densities, CIDs have been observed to occur in the cores of thunderstorms where radar reflectivities are in excess of 40 dBZ. The conditions that exist in regions of high reflectivity appear to be necessary conditions for the initiation of CIDs.