2016 International Lightning Detection Conference &
International Lightning Meteorology Conference
18 - 21 April | San Diego, California, USA

NBEs and Lightning Initiation

P. Krehbiel(1), W. Rison(1), M. Stock(2), H. Edens(1), X-M Shao(3), R. Thomas(1), M. Stanley(1), and Yang Zhang(4),
(1) New Mexico Tech, Socorro, NM, (2) Osaka University, Osaka, Japan;
(3) LANL, Los Alamos, NM; (4) Chinese Academy Meteorological Science, Beijing
krehbiel@ibis.nmt.edu

ABSTRACT

Narrrow bipolar events (NBEs) have been found to be initiated by a relatively unknown type of discharge, called fast positive breakdown. Observations of three close (< 5 km) high-power +NBEs at Langmuir Laboratory with a broadband interferometer (INTF), coupled with detailed Lightning Mapping Array (LMA) and fast electric field change (FA) measurements, have shown the VHF radiation of the NBEs progressed vertically downward into the main negative charge region of the normal-polarity parent storm, and thus was produced by positive breakdown. In each case the NBE initiated an otherwise normal intracloud (IC) discharge.

Simulations of the NBE sferics show the breakdown propagated at speeds of 3-5 x 10^7 m/s, with estimated peak currents of 50 to 60 kA, and died out within 10-20 microseconds after traveling ~500-600 m vertical distance. The simulations also show the breakdown did not produce a conducting channel, as evidenced by the lack of a reflection upon reaching its bottom end, and by the discharge not continuing or intensifying. Instead, it appeared to be produced by a succession of fast, downward-cascading positive streamer events in a locally intense electric field region. The breakdown appeared to be of a purely dielectric nature, with no evidence of large-scale relativisitic electron avalanching prior to or during its occurrence. Following the NBE, negative breakdown commenced at the top o f the NBE that developed upward to form the negative leader of the ensuing IC flash.

Instead of being limited to high-power events, fast positive breakdown has been found to occur with a wide range of strengths and to be the initiating event of numerous other discharges, both ICs and cloud-to-ground (CG) flashes. This has been seen both in the NBE- and non-NBE producing storms, and also to occur for isolated, short-duration `precursor' discharges and high-altitude screening events. Based on the overall results, we tentatively conclude that all lightning discharges are initiated by NBE-type fast positive breakdown.

For an open access publication, visit http://www.nature.com/ncomms/2016/160215/ncomms10721/full/ncomms10721.html.