



Horizontal channel propagation in the initial stage of cloud-to-ground lightning

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We have compared propagation characteristics of lightning flashes from Lightning Mapping Array data to simultaneous electric field measurements at different altitudes in three thunderstorms. For normal cloud-to-ground flashes, detailed analysis has shown that when an electric potential maximum exists between the altitude of the flash initiation and ground, the first return stroke occurs only after a period of horizontal negative polarity branching below the initiation altitude, presumably because the potential maximum is a potential energy well for negative charge. This period of preliminary breakdown, or the time delay between the initiation and the first return stroke, lasted an average of 117 ms for 14 flashes that initiated when a low-level potential well was present. When no low-level potential well was present, the time between flash initiation and first return stroke averaged 15 ms. Existence of preliminary breakdown for more than about 40 ms before the first return stroke of a cloud-to-ground flash thus suggests that a low-level potential well for negative charge exists at that time in the thunderstorm. Overall, these data also give an indication of the rapid temporal evolution in the electrical structure of the storm and its impact on the lightning behavior.