Bidirectional propagation of dart leaders in a negative cloud-to-ground lightning initiated by upward leaders

Lightning Physics

Zhijun Wu[1, 2], Rubin Jiang[1], Gaopeng Lu[1], Xiushu Qie[1]

1. Key Laboratory of Middle Atmosphere and Global Environment Observation (LAGEO), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China
2. University of Chinese Academy of Sciences, Beijing 100049, China

Correspondence:

Dr. Xiushu Qie, Key Laboratory of Middle Atmosphere and Global Environment Observation, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, 100029, China, Email: qiex@mail.iap.ac.cn Tel: +86-010-82995091 Fax: +86-010-82995073

Abstract: A negative cloud-to-ground lightning flash initiated by upward leaders from a high structure was captured by a high-speed video camera with a time resolution of 10,000 fps. The bidirectional propagation of the dart leader was observed for the first time. Initially, a decaying negative leader propagated downward and became cut-off. Subsequently, a bidirectional leader emerged from the cut-off point of the initial leader with the upward leader toward cloud at a speed of 1.2-4.2×10^6 m/s with an average speed of 2.4×10^6 m/s and the downward leader toward ground at a speed of 0.4-4.1×10^6 m/s with an average speed of 1.8×10^6 m/s. Eventually, the downward leader of the bidirectional system reached ground and induced a subsequent return stroke. The bidirectional propagation of the dart leader could be caused by guided electromagnetic waves which deliver negative charge stored on upper channel onto the lower channel.