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山东人工引发雷电综合观测实验及回击电流特征

Shandong Artificially Triggering Lightning Experiment and Current Characterization of Return Stroke

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中文摘要:

山东人工引发雷电实验 (SHATLE) 自2005年开始, 六年来共成功引发负极性雷电22次, 包含大电流回击过程88次, 实验获取了包括雷电放电通道底部电流、近距离电磁场、高速摄像等在内的高质量同步观测资料。对36次实测回击电流的统计分析表明, 回击峰值电流的几何平均值为12.1 kA, 最大值为41.6 kA, 最小值为4.4 kA。回击电流波形的半峰值宽度范围在1~68 μ s之间, 电流10%~90%峰值的上升时间几何平均值为1.9 μ s, 中和电荷量为0.86 C, 作用积分 (action integral, 或称比能量) 为 $2.6 \times 10^3 \text{ A}^2 \cdot \text{s}$ 。人工触发闪电峰值电流约16.5 kA的回击在30 m处产生的电场变化可达56.0 kV/m, 60 m处的磁场几何平均值为52 μ T。一些强烈的M分量可以具有与回击相当的电流峰值和中和电荷量。人工引雷初始阶段上行正先导的发展速度约为 $0.96 \times 10^5 \text{ m/s}$ 。

Abstract:

Shandong Artificially Triggering Lightning Experiment (SHATLE) has been conducted continuously since the summer of 2005. During the six years from 2005 to 2010, twenty-two negative lightning flashes containing eighty-eight return strokes were successfully triggered. Channel base currents, close electromagnetic fields, and high-speed camera images were obtained simultaneously for some of the strokes. Based on directly measured currents for thirty-six return strokes, the geometric mean of return stroke peak current was about 12.1 kA with a maximum of 41.6 kA and a minimum of 4.4 kA, the half peak width of current varied from 1 to 68 μ s, and the geometric mean values of 10%–90% risetime, charge transfer, and action integral were about 1.9 μ s, 0.86 C, and $2.6 \times 10^3 \text{ A}^2 \cdot \text{s}$, respectively. The surface electric field at 30 m away from the discharge channel caused by a return stroke with peak current of 16.5 kA reached 111.9 kV/m. The geometric mean of magnetic field at 60 m away from the discharge channel was about 52 μ T. The peak current and charge transfer of some large M components were comparable with those of return stroke. The speed of upward positive leaders in the initial stage of triggered flashes was about $0.96 \times 10^5 \text{ m/s}$.

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