

## Optical progression characteristics of a positive cloud-to-ground lightning flash

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Using high speed optical imaging systems and a capacitive electric field change antenna, we have recorded a positive cloud-to-ground lightning flash that occurred about 800 m from our observation site. After examining the observed data in detail, we have obtained the following results.

- (1) The downward positive leader propagated at a speed of  $0.8 \times 10^6$  m/s over the height from 300 m to 60 m and then accelerated to a speed of  $2.3 \times 10^6$  m/s at the height of about 25 m.
- (2) More than 20 optical pulses occurred during the downward leader progression over the height from 300 m to 25 m above the ground. These pulses are more or less similar to the optical pulses radiated from negative leader steps but on average with a three-time longer rise time than their counterparts. The optical pulses attenuate on average to about 1/10 of their original peaks after 150 m of upward propagation.
- (3) The positive return stroke waveforms are quite similar to that of a typical negative return stroke. The return stroke propagated upward at a speed of  $6 \times 10^7$  m/s, considerably smaller than the average speed of negative return strokes if considering that the speed was measured at the lightning channel bottom.

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