

Supporting Information for The Spontaneous Nature of Lightning Initiation Revealed

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1. Figures S1 to S5

Introduction

The LOFAR antennas used in this work are inverted v-type dipoles with two separate antenna orientations. Figures 1-3 in the main text employed the NW-SE antenna orientation; Figures S1-S3 in this section corroborate measurements with the corresponding figures using the NE-SW orientation.

The final two images (Figures S4 and S5) indicate the structure of the flash as imaged through impulsive imaging methods. Note that as a result of the previous, neither Figure S4 nor Figure S5 show sources from the initiation event.

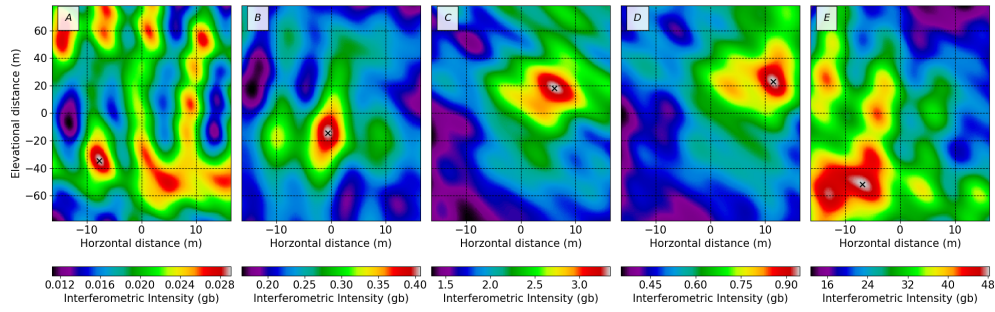


Figure S1. Similar to (Figure 1), the imaging origin is located at 6.1456 km West, 28.5129 km North, and 6.2542 km in altitude from the LOFAR core for all images. The time of each image is indicated by the corresponding section and matching labels in (Figure S2). The image in panel A is just above the background level and contains other features that may be mistaken for sources, however we confirmed the marked source as the true source due to consistency between both polarizations (see Figure 1).

References

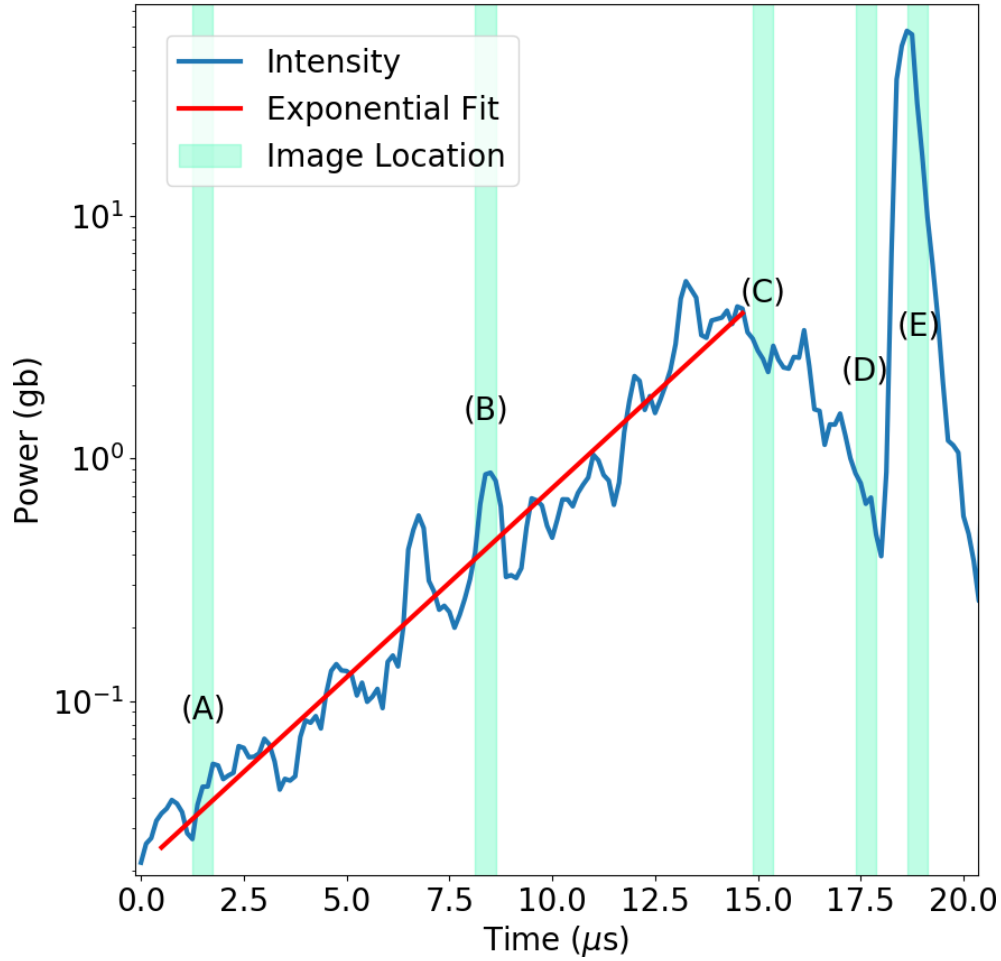


Figure S2. VHF power versus time calculated with data acquired from the NE-SW antenna orientation. In spite of a total power reduction by nearly a factor of two and the overall duration $0.5 \mu\text{s}$ shorter than in (Figure 2), an e-folding time of $2.7 \pm 0.4 \mu\text{s}$ is yielded by the ramp-up.

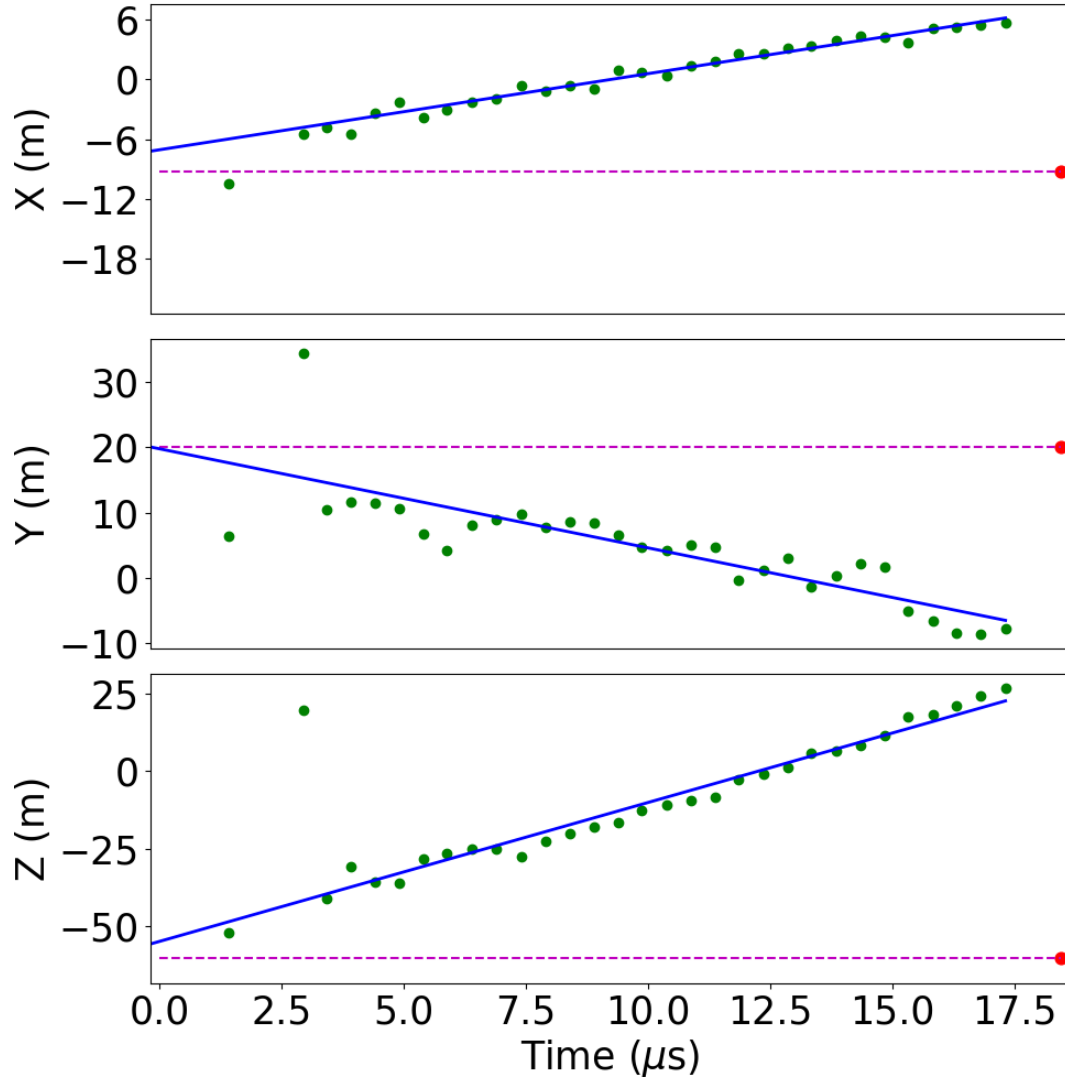


Figure S3. Corresponding fit for source location versus time for alternate antenna orientation.

While this data has higher scatter for the initial sources, a speed of $4.8 \pm 0.1 \text{ m/s} \times 10^6$ is still produced.

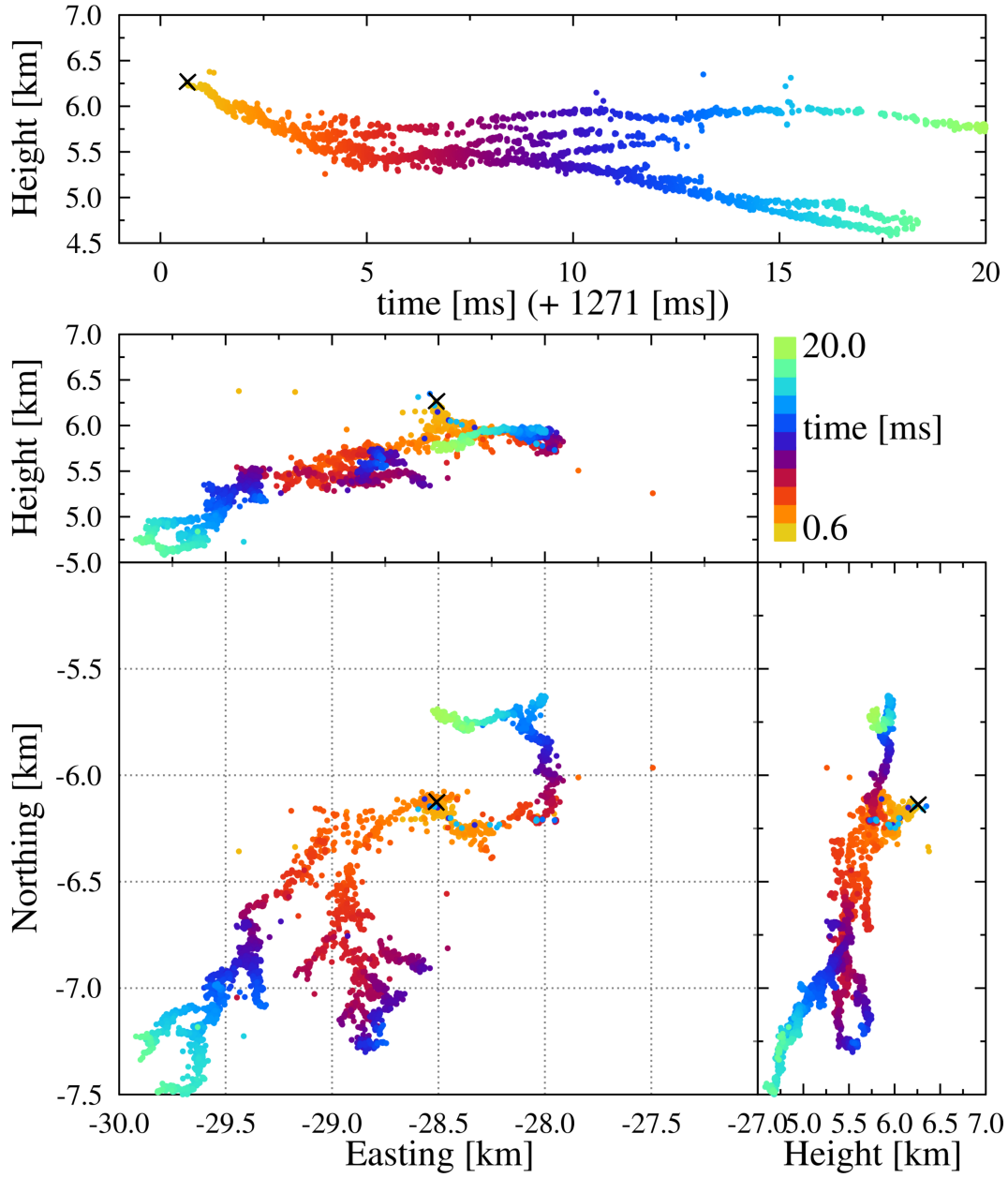


Figure S4. Figure highlighting the inception and development of the initial leader at approximately $t = 1271$ ms. The top plot indicates the height vs time in ms. The middle plot shows height vs Easting. The bottom left shows Easting vs Northing, and the bottom right shows height vs Northing. Note that the initial downward trajectory indicates that this is a negative leader and that the upward propagation of the streamer avalanche must result from positive streamers. For reference, the black "x" in each image indicates the location of the initiation event.

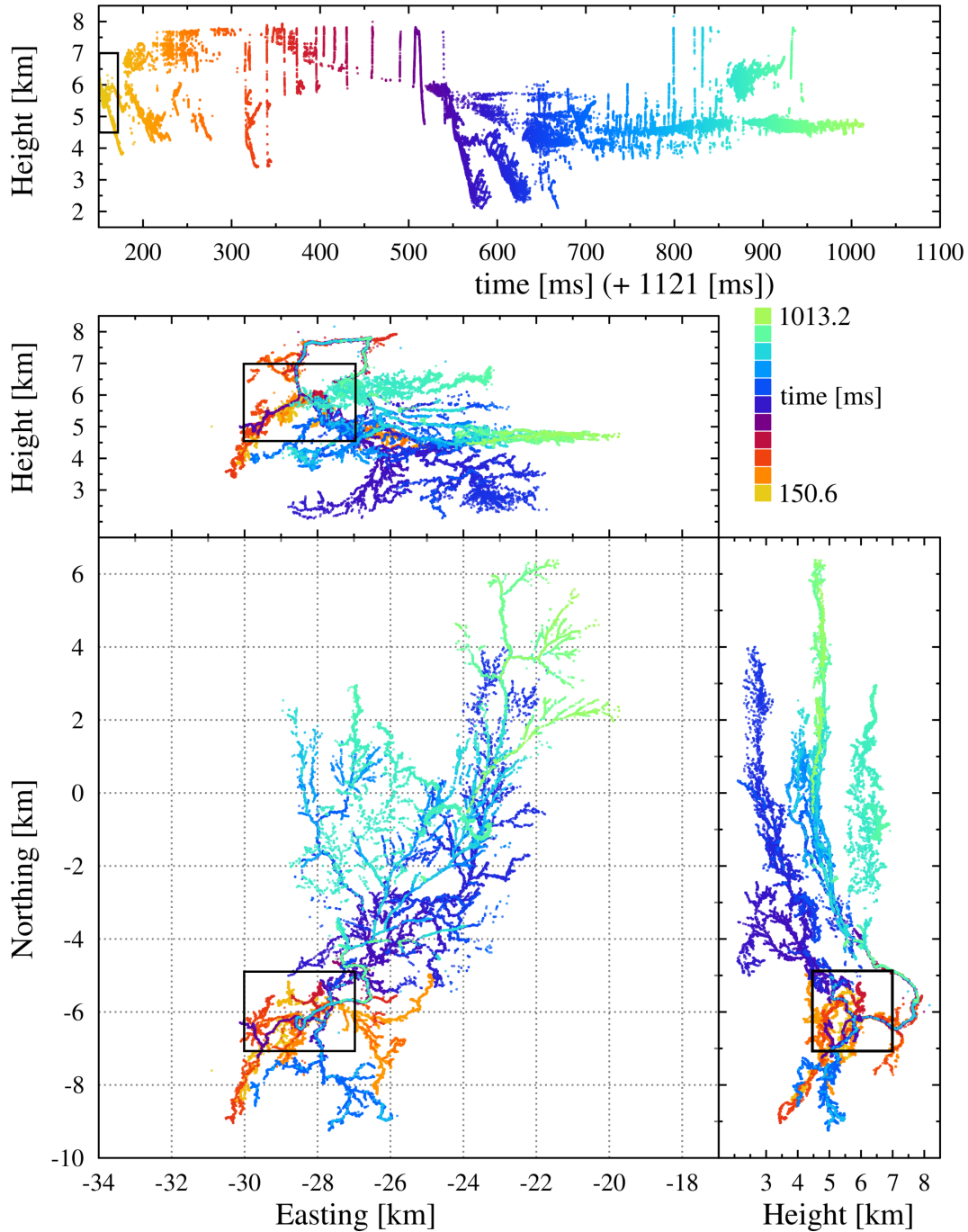


Figure S5. For reference, this figure indicates the overall structure of the entire flash. As with the previous figure the top plot indicates the height vs time in ms. The middle plot shows height vs Easting. The bottom left shows Easting vs Northing, and the bottom right shows height vs Northing. The black box indicates the location of the window used for Figure S4 above.