

Supporting Information for Ultra-Slow Discharges That Precede Lightning Initiation

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1. Figures S1 to S5

Introduction

The following TRI-D images display a few additional ultra-slowly propagating electrical discharge events. While each of these discharges have unique and interesting characteristics, they are still seen as supplemental to the main text and therefore reside here.

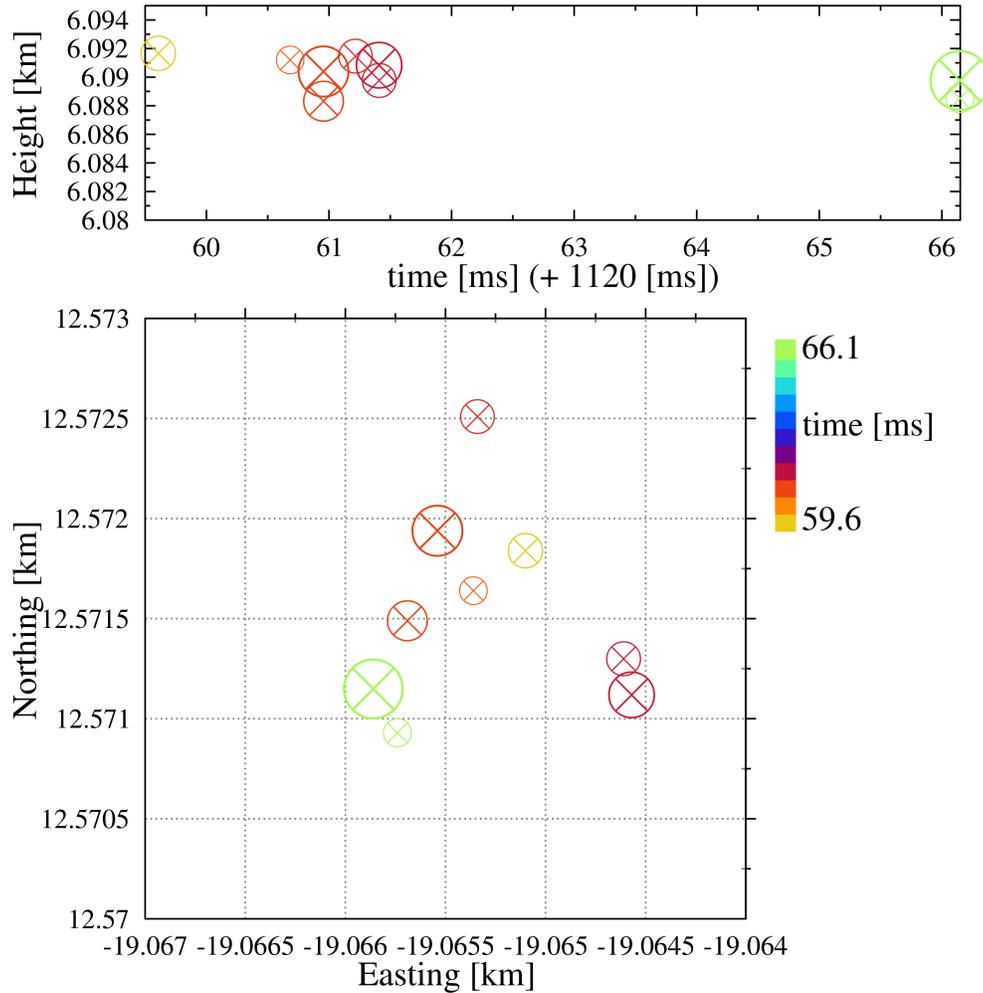


Figure S1. Zoom in of the first 6 ms of the slow propagation event displayed in figure 3 in the main text. Shown are the height versus time on the top panel and the ground projection on the bottom panel. As shown, the first source (yellow) and the second source (light orange) are separated by about 1 ms, and a distance of about 250 cm. The second source is separated by about 500 cm from the fourth source, which is in turn separated by the final source (green) by about 300 cm and 5 ms. This is consistent with a stationary source within the margin of error of LOFAR.

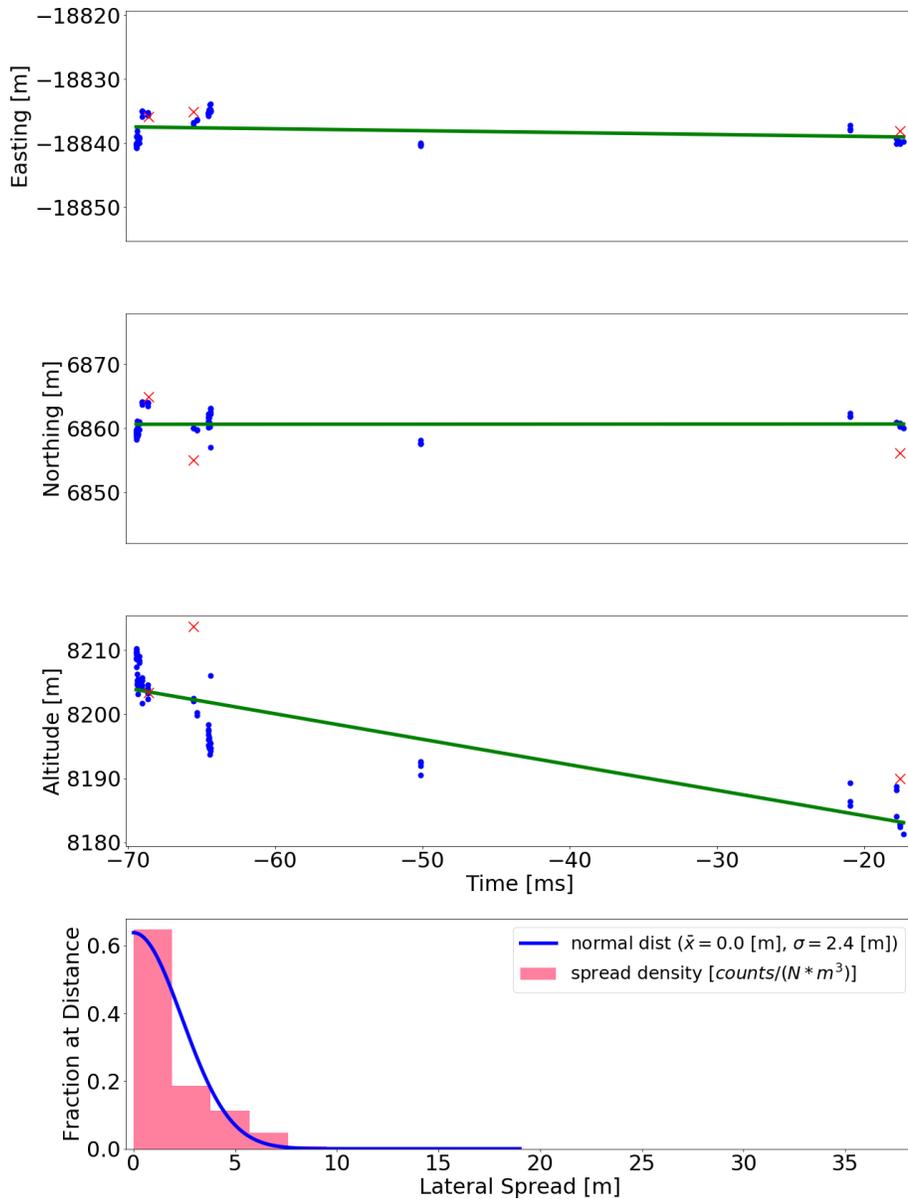


Figure S2. Displayed here is a TRI-D image of a slow discharge also contained within the 20B-10 flash dataset. The trajectory has a standard deviation of 2.4 m. This event follows a nearby lightning discharge by 400 ms after activity has ceased. The entire event is 55 ms long and is roughly 200 m from the associated flash. Two interesting features of this event are that between -50 ms and -20 ms there is a gap in activity and that overall motion of the discharge during this period is only about 3 m.

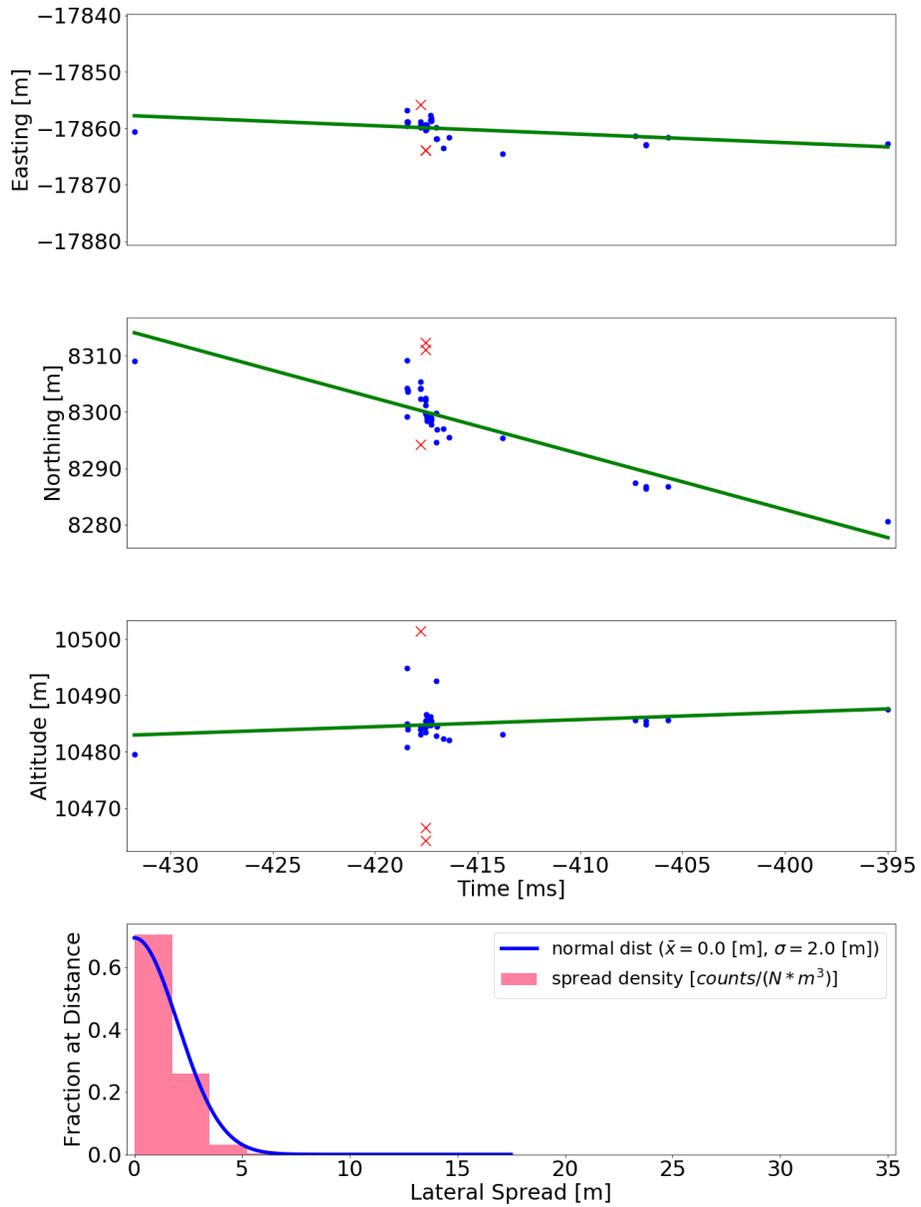


Figure S3. Isolated slow discharge event, with no observed flash within ± 700 ms from the propagation. The nearest lightning activity is about 2.5 km from the discharge. Velocity is about 1.0 km/s and the standard deviation is about 2.0 m. The most surprising feature of this particular event is that the trajectory is along the North-South axis, which is not the typical propagation direction of a negative leader within a thunderstorm.

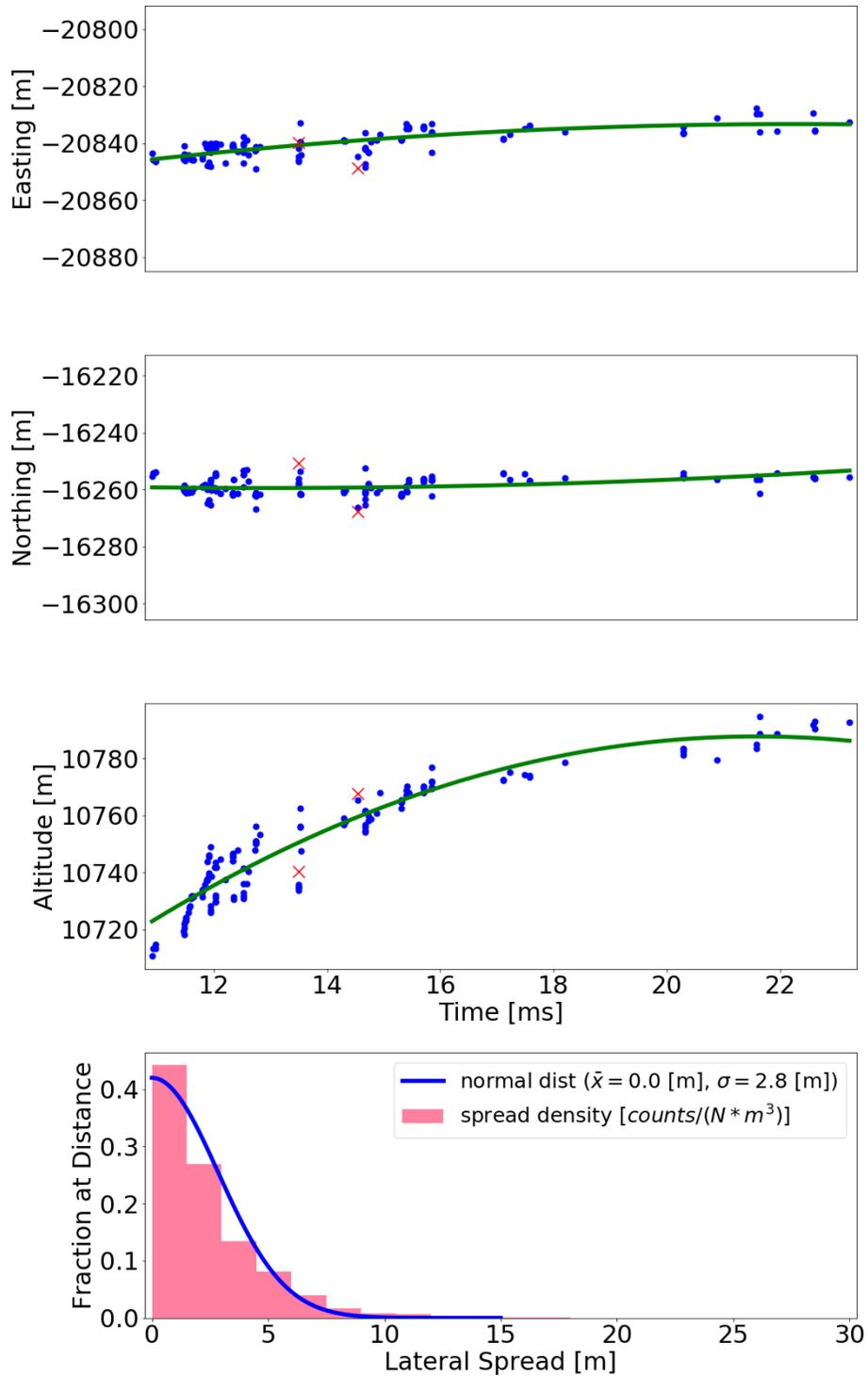


Figure S4. This slow discharge precedes a lightning initiation event by about 800 ms and is about 100 m from the location of the initiation event. It starts with a velocity of 12.5 km/s and decelerates to 1.7 km/s about 20 ms later. Lower quality fit with a standard deviation of 2.8 m is attributed to simultaneous remote flash about 100 km from this discharge.

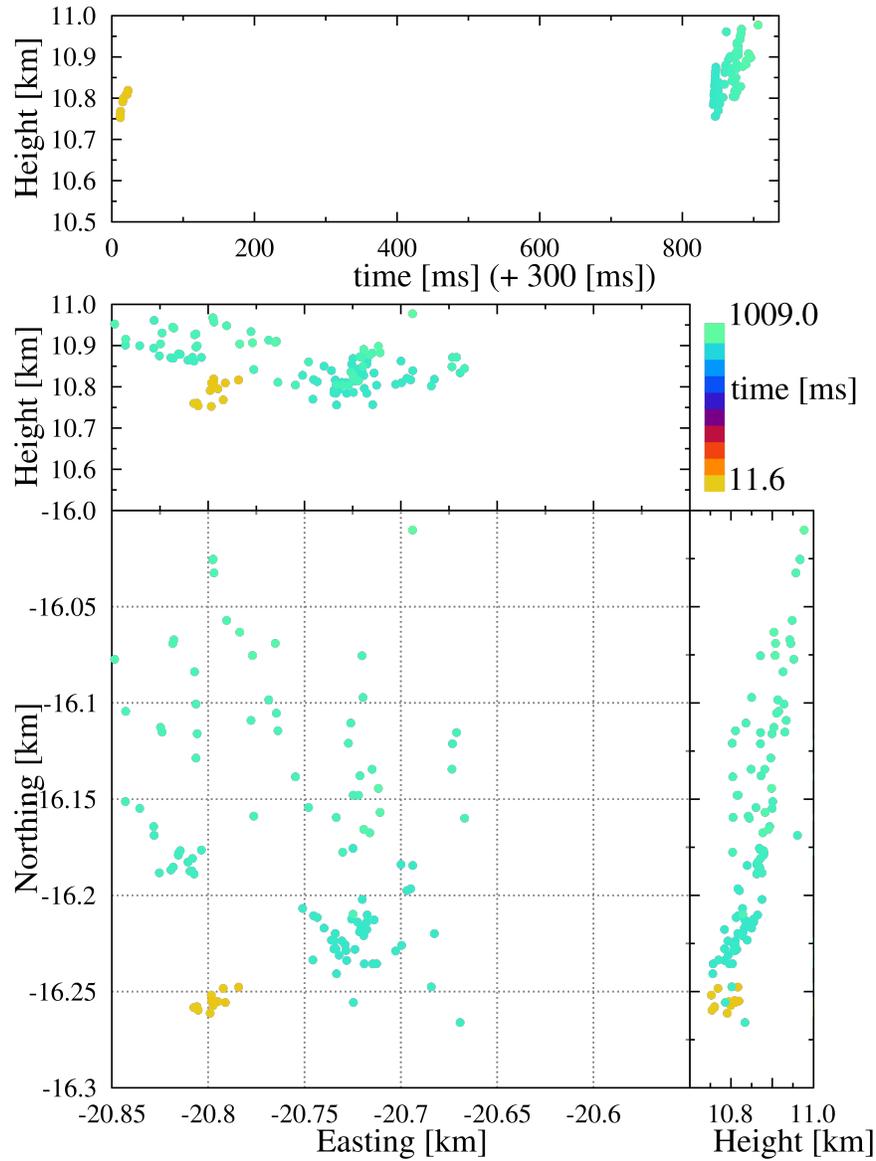


Figure S5. Shown here is an impulsive image of the slow propagation shown in figure S4 (yellow) and corresponding IRNL that forms 800 ms later (blue-green). The top plot indicates the altitude versus time in ms, the middle shows height versus easting, and the bottom details the northing versus easting or ground projection of the event. Note in the ground projection the discharges are within roughly separated by 100 m despite being 800 ms apart in time.