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Practical considerations when inferring lightning current from electric field recordings with a high noise-floor

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Abstract

During a cloud to ground lightning event a charge centre within the storm cloud is discharged. The discharge of a charge centre within the cloud leads to a change in the electric field radiated by the charge centre. It is theoretically possible to infer the lightning current from the derivative of the electric field. It is only possible to infer the lightning current from the electric field data where the noise is comparatively much smaller than the electric field data. The changing electric fields for a lightning event that occurred on the 3^{rd} January 2015 13:15:13 were recorded by a flat plate electric field sensor with a passive integrator. The oscilloscope used to capture the electric field data has a relatively large measurement noise and a low resolution. A low pass digital filter was applied to the recorded electric field data to reduce the effects from the high frequency noise. The lightning strokes were recorded by the South African Lightning Detection Network. The Lightning Detection Network data is used to obtain the distance of the lightning event from the sensor, to scale the inferred lightning current. The Lightning Detection Network also provides a lightning peak current measurement to compare to the peak current inferred from the electric field data. The lightning stroke current was inferred from the electric field recording for various bandwidths of the low pass filter. Inconsistent changes to the inferred lightning stroke current as the filter bandwidth is changed shows that the frequency components for each stroke differs. The peak stroke current was not constant for any filter bandwidth range implying that the measurement noise is relatively too large. The case study presented demonstrates that with a relatively large noise magnitude (3 to 4 discrete steps of the digital recording) compared to the electric field signal (21 discrete steps) it is difficult to accurately infer the lightning current from the electric fields recorded.