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Time-of-arrival and interferometric methods for imaging lightning with LOFAR

Brian Hare, Olaf Scholten, Gia Trinh, and the Cosmic Lightning Group
KVI-CART, University of Groningen, Groningen, Netherlands

We will present a inverted intra-cloud lightning flash mapped with the LOw Frequency ARray (LOFAR), which is a broadband radio telescope that consists of a large number of dual-polarized antennas, sensitive to 10-250 MHz, spread over the northern Netherlands and beyond. Since LOFAR covers a large frequency range, has antennas spread over a large area, and saves the raw trace data from the antennas, LOFAR for lightning imaging can combine the strongest aspects of both lightning mapping arrays and lightning interferometers. We will discuss the potential of of applying both interferometric and time-of-arrival techniques to LOFAR lightning data, and we will show that LOFAR can reach meter-scale accuracy, nanosecond resolution, and is sensitive to the distribution of current during individual leader steps.

Since LOFAR antennas are dual-polarized and cover a very wide area, they can extract all three components of the electric field at a large number of distances and angles relative to the lightning flash. This data should be able to provide the direction and radiation pattern of individual leader steps, which should lead to a measurement of the shape and size of the current distribution.