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A comparison of different source location methods for ELF transients with known positions

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Different kinds of direction finding methods (azimuth and range determinations) have been proposed so far in order to locate ELF transients. As for the azimuth determination, we have used the Lissajous method and goniometer and Poynting vector methods, which are found to be not so much different. The biggest problem is the range (or source-to-observer distance) estimation, which is principally based on the use of wave impedance. By using the known positions of parent lightning discharges during the European sprite campaign, we have compared different methods ((1)cross-correlation over a wide frequency range between the measured and theoretical wave impedances, (2) the use of peak frequency in the observed wave impedance, (3) Jones and Kemp method (the use of maxima and minima in the frequency spectrum of wave impedance), (4) the use of oscillation frequency in the wave impedance variation), and it is found that the best one is the use of Jones and Kemp method with an error of 0.33Mm for the nine events with sufficient S/N ratio from the analyzed 11 events. This has been based on the FFT analysis. However, for the remaining two events with small time separation, we have tried the use of wavelet analysis, which improved the range determination significantly. Finally, we recommend a combined use of Jones and Kemp method and wavelet analysis for locating ELF transients.

Keywords: Lightning, Electromagnetic noise, ELF transient, Position estimation