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A new method for determining the distance to the major thunderstorm centers in the world using the Schumann resonance measurements

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Our group developed a method for determining the location, distance and intensity of the sources, in the spherical resonator, which is based on the comparison of homogeneous model solutions with observational Lorentzian spectra obtained with the spectral decomposition method (Decomp) [*Dyrda et al.*, 2014]. The algorithm presented below is based on the analysis of the wave impedance function of the strip line in the spherical Earth-Ionosphere cavity.

Kemp and Jones [1971] showed that the oscillation period of a wave impedance function of cavity Z(f) = E(f)/H(f) can be used as the distance indicator. It depends monotonically on a distance between the source of the signal and the observer. The use of the wave impedance method requires measurements of magnetic field component as well as the vertical electric field component E_z(f). This method was applied to measure the distances to the ELF transients generated by strong atmospheric discharges [*Nickolaenko and Kudintseva*, 1994; *Price et al.*, 2002]

Here, we present a new method that allows us to measure the impedance function without electric field measurements, measuring only its derivative. The difficulties of electric field measurement are well known and in the new method we use only the measurements of ELF magnetic field component, done by two stations located within a short distance from each other. In such a case, the derivative may be determined from the observation of the difference spectra of magnetic fields measured by the two stations. In contrast to the full function of the impedance of the resonant cavity, the new function will be denoted as δ(f, ρ) (delta function), where ρ is the average distance to the source. This method was tested on a realistic numerical model describing the propagation of ELF waves in the Earth-ionosphere cavity. Our calculations shown that the function δ(f, ρ) is an oscillating curve and the frequencies of maxima are closely related with the source-observer separation. Here, we will present the delta function waveforms obtained with the realistic numerical model and we will discus the properties of the delta function, which allowed us to infer the distance to the storm centers on the globe.

In the summer of 2013 and 2014, we tested a system of two to three ELF station, located in different positions in Poland. The data obtained from these measurements were used to determine the delta function δ(f, ρ). Using the properties of the delta function we infer the distances to the thunderstorm center located on the African continent. Our results were compared with the Decomp approach and we obtained a very good agreement between these two methods.

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