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Mapping the African thunderstorm center in absolute units using Schumann resonance spectral decomposition method

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Monitoring of the global lightning activity provides a very useful tool to study the global warming phenomenon and the other longer-scale climate changes induced by humans. The lightning activity is measured using various observational methods form space (optical satellite observations) as well as from the ground mostly by VLF /LF lightning detection networks, i.e. World Wide Lightning Location Network (WWLLN) or lightning detection network (LINET) in Europe. However, the global lightning activity measurements are possible only in the ELF range. Here we examine the African thunderstorm activity center, which is the most violent and active one. In a spherical damped resonator, such as the Earth-ionosphere cavity, the electromagnetic field is described by the solution of an inhomogeneous wave equation. For such equation the general solution can be expressed by the superposition of the solutions of the homogeneous equation, describing the resonance field, and the component, which is quite strong close to the source and weakens with source-observer separation. Thus, the superposition of the standing wave field with the field of traveling waves, which supply the energy from the lighting discharges to the global resonator, is a main reason for an asymmetric shape of the observational Schumann resonance (SR) power spectra, which highly deviate from the Lorentz curves. It is possible to separate this component from the signal using the spectrum decomposition method proposed by *Kułak et al.* [2006]. In our approach, we apply the inverse problem solution for determining the distance of the dominant lightning source. The distances to the thunderstorm centers are calculated using the analytical models for the electromagnetic waves propagation in the Earth-ionosphere cavity. Such forms of analytic solutions of the resonant field in the spherical cavity is the zonal harmonic series representation, described by *Mushtak and Williams* [2002] and we calculated the sets of such curves for different source-observer separations, starting at 1 Mm up to 20 Mm with a step of 0.1 Mm. We selected two observational data sets, collected during different seasons of the year, from our Hylaty station, located in Poland. The data were binned in 10-minute files for which the SR power spectra were derived. In the next step a decomposition curve describing 7 asymmetric SR modes was fitted to the observational data. To compare the resulted decomposed power spectra with analytic model we use chi-squared test and hence we obtained the distances to the dominant thunderstorm center, located in Africa. We computed the monthly lighting activity maps and possible locations on the African continent with the spatial resolution of 1 degree and temporal resolution of 10 minute. Moreover we calculated the thunderstorm intensities in physical units, which are of the order of 2×10^{11} [C^2 m^2 s^{-1}]. We also notice the seasonal variations of the African thunderstorm centers distributions and as well as intensities. Finally, we compared our results with satellite data recorded by the Lighting Imaging Sensor (LIS) and we obtained very high correlation.

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