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Schumann Resonance spectra decomposition method and studies of the locations of the African thunderstorm centres

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The idea, that the global atmospheric electric circuit is driven by global lightning activity was introduced at the beginning of the last century. Today, the different observational methods are used from satellites to the radio observations performed in the extremely low frequency (ELF) range to evaluate local as well as global lightning activity, its spatial and temporal variability and influence on our planet and Earth's climate. The ground-based thunderstorms observations, particularly ELF, also allow the measurements of the dipole moment of discharges.
Global lightning activity excites the Earth-ionosphere cavity and the produced electromagnetic radiation is responsible for generating the Schumann resonance (SR). The interaction of the standing and travelling waves leads to asymmetric shape of the observational SR power spectra picks, which was noticed by Kułak et al. (2006). They proposed a spectral decomposition method, what allows to separate the resonant field from the travelling wave contribution, which can be dominant at small distances from the sources. In such approach, one can apply the inverse problem solution for determining a distance of the dominant signal source. The distances to the thunderstorm centres are calculated using the numerical as well as the analytical models for the electromagnetic waves propagation in the Earth-ionosphere cavity. The ELF electromagnetic waves, recorded by Hylaty ELF station, located in South-East of Poland are used to derive the distances to the most powerful thunderstorm centres located in Africa and hence to obtain 1-D thunderstorm lightning activity maps. The observational data taken in January and August 2011 were binned in 10 minute intervals and SR power spectra were derived. Then a curve describing seven asymmetric SR maxima was fitted to the spectrum for each time interval. We use chi-squared test to compare the resulted decomposed power spectra with curves obtained within the considered numerical and analytical models and hence we inferred the distances to the dominant thunderstorm centres. The computed monthly lightning activity maps have the geographic spatial resolution of 1 degree and temporal resolution of 10 minutes. As a result we observe seasonal variations of the African thunderstorm centres distributions and intensities. Finally, the obtained lightning activity maps are positively cross-checked with optical satellite data recorded by the Lighting Imaging Sensor (LIS), supporting validity of the proposed approach for thunderstorm monitoring on Earth.

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