Evidence of a link between thunderstorm activity derived from long-term observations of Schumann resonance and near-surface air temperature in Africa

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The paper demonstrates similarity of the yearly changes of thunderstorms activity in Africa derived from the Schumann resonance (SR) records and annual variation of air temperature above the African continent. We used the data of long-term monitoring of orthogonal horizontal components of magnetic field in ELF waveband (0.1-80 Hz) carried out at three widely separated observation sites located in Antarctica (Ukrainian Antarctic station, 65°14’ S, 64°15’ W), Arctic (Sousy, Svalbard, 78°10’ N, 16°00’ E) and mid-latitudes (Low frequency observatory, Ukraine, 49°56’ N, 36°56’ E). To separate the ELF radiation generated by African thunderstorms from other lightning centers we processed the signal of the magnetic component transverse to Africa bearing at every observation point. This selection technique is effective for African thunderstorms center because of moderate thunderstorm activity in the antipodal point. Additional selection was performed by choosing for data analysis the time period from 12:30 to 18:00 UT that corresponds to maximal number of lightning in Africa. To obtain the changes of the African thunderstorm activity through the year we calculated the average annual variations of the intensity of 1-st SR peak derived from power spectra at each observation site. The values of seasonal North to South drift of the African center estimated from the LIS satellite optical observations were used to correct the annual intensity curves taking into considerations the changes of the distances from source to observers. A point-source model and distance dependence of intensity described in [1] were used to make corrections. Finally, we estimated the average annual variation of African thunderstorms activity using corrected intensity curves calculated from all available SR data recorded at three observations sites from 2002 to 2018 year. The average air temperature of the African continent over the same period was estimated from the data collected by the global network of meteorological stations. These data presented by NOAA’s National Centers for Environmental Information are available from the ftp://ftp.ncdc.noaa.gov/pub/data/gsod. We split the globe into cells (10° in latitude and 10° in longitude) and calculated daily-averaged temperature for each one. Then we determined the set of cells corresponding to the shape of the area that cover the majority of African thunderstorms observed by the LIS satellite from space and calculated the mean monthly temperatures for this area. Figure 1 depicts annual variations of SR intensity and air temperature that demonstrate a similar behavior confirmed by significant value of cross correlation coefficient ~0.88. This evidence of a link between SR intensity and air temperature supports the approach that Schumann resonance might be a useful tool for studying changes of a global temperature.

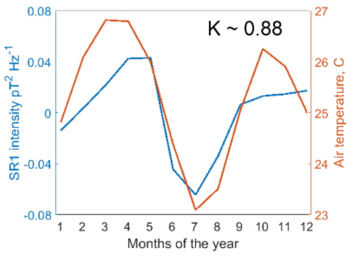

Figure 1. Averaged annual variations of the first Schuman resonance mode intensity corrected by the distances from the source to observers (blue curve) and near-surface air temperature above the African continent (red curve).

Our study demonstrates an efficiency of a simple point-source representation of the African thunderstorm for modeling the seasonal drift of lightning center. The developed technique may also be useful for analysis of thunderstorm activity and air temperature variations for different thunderstorm centers and time scales.

References

[1] A. P. Nickolaenko, A.V. Koloskov, M. Hayakawa, Yu. M. Yampolski, O. V. Budanov, V. E. Korepanov, “11-year solar cycle in Schumann resonance data as observed in Antarctica,” *Sun and Geosphere*, **15**, 1, January 2015, pp. 39–49.