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Distributions of the number of transient events derived from long-term Antarctic and Arctic ELF records

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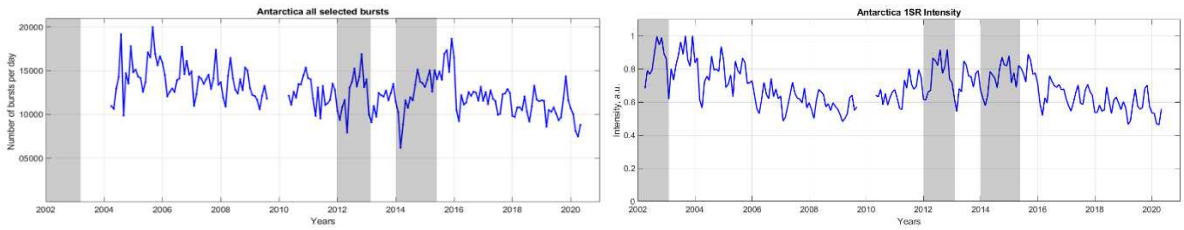
The paper presents and discusses the distributions of the number of transient events derived from long-term ELF records collected in the Antarctic and in the Arctic. In this study we use the data of round-the-clock observations of the horizontal magnetic field components within the ELF waveband carried out at the Ukrainian Antarctic station (UAS) "Akademik Vernadsky" situated in the Western Antarctic (65.25ºS and 64.25ºW) and at the SOUSY facility of the Tromsø Geophysical Observatory located at Spitsbergen island (78.17ºN, 16.00ºE). The longest dataset is collected at UAS where ELF monitoring has been performed since March 2002. In September 2013, the synchronous observations using an identical set of induction coils were started at the Arctic observatory. Location of observation points at high latitudes has significant advantages: minimal man-made interference and absence of local thunderstorms. In addition, the significant spatial separation between the facilities located in different hemispheres, provide a suitable spatial basis for synchronous data processing and analysis. The availability of long-term ELE record has already allowed analyses of different time-scale changes of the Shuman resonance field arise from both variations of the worldwide lightning activity and changes of the properties of the Earth-ionosphere cavity. In particular, the similarity of the intensity variations of the first Schumann resonance (SR) mode and the level of solar activity in the 11-year cycle was detected and discussed in [1]. The aim of this study is to analyze the long-term changes of the number of the ELF transient events associated with intense lightning discharges. A technique, which allows selection of transients and to rank events depending on their energy has been developed. A database that collected waveforms and characteristics of ~ $6.5 \cdot 10^7$ and ~$2.4 \cdot 10^7$ transients observed in the Antarctic and in the Arctic respectively was built. These data were used to calculate the interannual, seasonal and daily dependences of the number of transients discusses in the presentation. It worth noting that in the Antarctic the interannual variation of the number of transients (Fig. 1 a) demonstrates similarity with solar cycle and intensity of the first SR mode (Fig. 1 a). The presence of synchronous observations in both hemispheres increases the reliability of the analysis since 2013. The paper discusses the dependences of the number of transients obtained from synchronous data as well. Further improvement of the processing technique intends to implement geolocation of intense lightning discharges based on determination of azimuth to the source and the difference of the time of arrival to the observation points. Some results of geolocation based on the annual data of concurrent observations are discussed.



(a) (b)

Figure 1. Monthly averaged: (a) daily rate of the ELF transients; (b) total intensity of the first mode of SR signal. The horizontal axes show the time from 2002 to 2021. Gray bars correspond to solar cycle maximums.

References

[1] A. V. Koloskov, A. P. Nickolaenko, Y. M. Yampolski, Chris Hall, and O. V. Budanov, "Variations of global thunderstorm activity derived from the long-term Schumann resonance monitoring in the Antarctic and in the Arctic," *Journal of Atmospheric and Solar–Terrestrial Physics*, **201**, May 2020, doi: 10.1016/j.jastp.2020.105231.