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Akademik Vernadsky Station as a key point for studying the global lightning activity through Ukrainian ELF-VLF magnetometers network (review)

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Global thunderstorm activity (GTA) arising from worldwide lightning is strongly related to the earth's weather and can be used both as an indicator of climate changes and like a tool for studying the lower ionosphere. An efficient remote method of its analysis is monitoring of Extremely Low Frequency (ELF) and Very Low Frequency (VLF) electromagnetic radiation produced by lightning discharges. The most promising regions for ELF-VLF observations are the polar areas because of the absence of local thunderstorms and technological interference. We started the ELF measurements at the Ukrainian Antarctic Station (UAS) Akademik Vernadsky in 2002 to accomplish these benefits in investigations of the GTA. Later a network of ELF-VLF receiving facilities was built. It integrates three observatories including UAS. One of them is operated since 2007 at the Low Frequency Observatory (LFO, Ukraine) of the Institute of Radio Astronomy of the National Academy of Sciences of Ukraine. In 2013, another receiving ELF system was mounted in the Arctic (Svalbard, Norway). Two observatories – the UAS and LFO, are equipped with VLF sensors observing two horizontal magnetic and a vertical electric field component of atmospherics in the frequency range 750 Hz - 24 kHz in addition to the ELF ones which monitor two orthogonal magnetic components within 0.01 Hz - 80 Hz waveband. The combination of ELF and VLF technique has several advantages. Application of VLF atmospherics for the source bearing considerably improves accuracy owing to higher signal to noise ratio in comparison with the ELF records. The measurement of electric component of VLF atmospherics provides unambiguous source bearing and thus allowing for the single-site lightning location technique. In addition, the analysis of tweeks in the VLF waveband provides direct measurement of the effective height of the lower ionosphere.

The report reviews the long-term systematic studies of global thunderstorms using ELF–VLF network mentioned above, and this allows clarifying a series of academic and engineering issues. These include: (a) the impact of the 11-year cycle of solar activity on the state of the lower ionosphere, atmospheric weather and global thunderstorm activity; (b) reconstruction of daily and seasonal changes at three equatorial centers of global thunderstorms located at Asia, Africa, and America; (c) estimation of the annual and semi-annual variations of continental temperature based on the ELF monitoring of Schumann resonance parameters; (d) detection, calculating, global location, and finding the major parameters of powerful lightning discharges; (e) studying of the state of the lower ionosphere and an impact the space weather on the global Earth-ionosphere cavity; (f) monitoring of power supply harmonics radiated from industrial regions and studying the mechanisms of "electromagnetic smog" transportation to Antarctica.

Recently this year we have installed our VLF equipment on board of the new Ukrainian research vessel "Noosfera" and performed measurements during its voyage from Odessa (Ukraine) to UAS (Antarctic). Preliminary results of these observations also will be presented and discussed.