EFFICIENCY OF THE RUSSIAN GROUND-BASED VLF NAVIGATIONAL SYSTEM UNDER IMPACT OF THE SPACE WEATHER DISTURBANCES

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Abstract:

The Russian ground-based VLF navigational system was designed to cover the whole territory of the country, which includes (10) ten hour belts in longitude. It consists of several transmitting stations operating at frequencies 11,9 kHz and 14,9 kHz. There are several control receiving stations, which record the transmitting signals constantly. In this report efficiency of the system under impact of the most disruptive events of the Space Weather-the solar proton events (SPE) and global geomagnetic storms-was analysed. We used the results of the VLF phase measurements made at the auroral, subauroral and purely middle-latitude radiopaths of different length (from several thousands km to several hundreds km). Two solar proton events were chosen for this study. The first one occurring on September 29, 1989 is attributed to the cases of so called \"Ground-Level-Effects\" (GLE) when energetic spectrum of precipitating solar proton fluxes is extraordinary hard. It means that the solar proton fluxes could penetrate to the lower levels of the Earth atmosphere. The second event- of October 19, 1989 had much more soft energetic spectra of proton fluxes but its intensity was unusually high.Impact of the global geomagnetic storms on the system is mainly determined by precipitating fluxes of relativistic electrons with energies above 1 MeV. Data of simultaneous riometer observations at different Arctic stations were used in this analysis for the purpose of calibration and comparison. The disruptive effects of the SPEs and geomagnetic storms on all VLF radiopaths including a middle-latitudinal one were evident. They are observed as the changes of the phase retardations, which are different at various stages of the Space Weather disturbances as well as at the radiopaths with different parts of their length located inside the polar regions. These measurements turned out to be very useful for experimental defining of the regions illuminated by the fluxes of energetic particles. It was found that the VLF phase anomalies produced by the Space Weather disturbances were recorded even at the mid-latitudinal radiopath Krasnodar-St.-Petersburg. Evaluations of sensitivity of the VLF navigational system to the energetic particles flux intensity are made. Comparison of this parameter with sensitivity of the standard riometer was made for both daytime and nighttime periods. Registration of the midday recovery of absorption effects during SPE on auroral VLF radiopaths could be mentioned as a rather unusual phenomenon when a VLF phase retardation came close to its undisturbed level concurrently with recovering of riometer absorption at geomagnetic noon hours.