ELECTROMAGNETIC FIELD IN THE UPPER IONOSPHERE FROM ELF GROUND-BASED TRANSMITTER WITH A FINITE LENGTH

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The feasibility of detection of electromagnetic response in the upper ionosphere to ground large-scale extremely-low-frequency (ELF) transmitters by low-orbiting satellites is considered. As an example of such mega-transmitters, we consider the ZEVS 82 Hz transmitter for submarine communication, FENICS experiments with decommissioned electric power line with 0.5-10 Hz generator, and industrial 50 Hz power transmission lines. We modeled the rate of the ELF wave energy leakage into the upper ionosphere from an oscillating grounded linear current with an finite length L suspended above a high-resistive ground. A realistic altitudinal profile of the plasma parameters has been reconstructed with the use of the IRI ionospheric model. For ZEVS (L=60 km) transmitter powered by 200 A current the modeled amplitudes of electromagnetic response can reach in the upper nightside ionosphere up to 60 muV/m and 6 pT. The assumption of an infinite scale overestimates the E-field response in the upper ionosphere by a factor of 5 as compared with realistic scale 60 km of the ZEVS transmitter. For typical current 100 A during FENICS experiments, the 10-150 Hz emissions can leak into the nightside upper ionosphere with amplitudes up to $\sim$ 60-70 muV/m. Unbalanced 50 Hz current of 10 A in power transmission lines can produce the electric response that can be detected by electric sensors at low-orbit satellite. Thus, nowadays our planet happened to be in the frequency band 50-150 Hz in an electromagnetic environment produced rather by industrial activity than by natural magnetospheric processes. This study is supported by the grant 21-77-30010 from the Russian Science Foundation.