Trigger generation of geomagnetic perturbation due to ionizing radiation of the solar flares

Sorokin V.M., Yaschenko A.K.

Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation of the Russian Academy of Sciences (IZMIRAN), Moscow, Russia

e-mail: sova@izmiran.ru

Model for generation of the geomagnetic field perturbation connected with absorption of the solar flare ionizing radiation has been developed. The analyses of magnetogram and their dynamic spectrum has shown that absorption of ionizing radiation of the solar flares X2.2 and X1.5 caused by magnetic field perturbation with period (5 – 10) min. The oscillatory mode of geomagnetic field perturbation is observed at various distances from a midday meridian on the Earth's surface. It is shown that the oscillatory mode is explicit for shorter flares based on the example of two events with various duration. We study the mechanism for generation of magnetic field oscillation. Solar flare radiation changes the conductivity and, accordingly, the electric current by ionosphere ionization. The appearing impulse of electric current caused by heating release and emergence of Ampere force. The calculations showed that the energy density of heat source and Ampere force action have the same value. Besides, the density of emitted energy considerably exceeds the density of absorbed energy of solar flare radiation. Thus, the radiation of solar flares is the trigger of release of the ionospheric current energy. It is shown that the appearance of impulse source of energy caused by generation of acoustic-gravity waves (AGW) in the lower ionosphere. The calculation of electron density, conductivity and also characteristics of sources of heating and Ampere force caused by electric current impulse were carried out. The model for magnetic field oscillation formed by AGW was derived. The calculations have shown that the propagation of AGW impulse in the ionosphere leads to magnetic field oscillation with periods (5 – 10) min. Observing geomagnetic field perturbation contains the quasistatic component which is similar the dependence of radiation on time, and the oscillatory component which is connected with generation of AGW in the lower ionosphere. The value of their period coincides with the period of atmosphere oscillation in gravitational field which are characterized by Brunt-Vaisala's frequency. Calculations have shown that amplitude of magnetic field fluctuation decreases with growth of duration of an impulse of radiation. The efficiency of their generation increases in the case when duration of source action is of the order of period of AGW oscillation. It should be noted that the pulse of ionosphere current can generate oscillations in the magnetospheric resonator, however their periods are much shorter than those which are considered in this work. Results of calculation based on the considered model are confirmed with observations of magnetic field perturbation during solar flares.

This work was carried out within the framework of State Assignment No 01201356396 and with the financial support of the Russian Foundation for Basic Research and the State Natural Science Foundation of China within the framework of scientific project No 21-55-53053.