GC2024-STP001

Space weather and seismic activity: Possible triggering of earthquakes by strong solar flares of X-class

Victor A. Novikov[1,2] , Valery M. Sorokin[3]

[1] Объединенный институт высоких температур Российской академии наук
[2] Институт динамики геосфер Российской академии наук
[3] Институт земного магнетизма, ионосферы и распространения радиоволн имени Н. В. Пушкова

novikov@ihed.ras.ru

Previously performed numerical studies of the influence of solar flares of class X on seismic activity [1] showed that the absorption of X-ray radiation from a solar flare in the ionosphere can cause the geomagnetic field pulsations up to 100 nT and the corresponding generation of geomagnetic-induced currents in faults of the Earth's crust with a density of up to 10^{-6} A/m^2, comparable to the current density generated in the crust by artificial pulse power sources resulted in triggering of weak earthquakes in the Pamirs and Northern Tien Shan regions [2]. For verification of obtained numerical results the statistical analysis of impact of the top 50 solar flares of X-class (1997-2023) on the global seismic activity, as well as on the earthquake preparation zones located in illuminated part of the globe and in the area of 5000 km radius around the subsolar point was carried out. It is shown by a method of epoch superposition that for all cases the increase of seismicity is observed, especially in the region around the subsolar point (up to 38%) during 10 days after the solar flare in comparison with preceding 10 days. The case study of aftershock sequence of strong M=9.1 earthquake (Sumatra-Andaman Islands, 26.12.2004) after the solar flare of X7.2 class (20.01.2005) demonstrated that the number of aftershocks with magnitude M≥2.5 increases more than 20 times after the solar flare with a delay of 7 days. For the case of the Darfield earthquake (M=7.1, 03.09.2010, New Zealand) it was shown that strong solar flares of class X and M probably triggered two strong aftershocks (M>6) with the same delay of 6 days on the Port Hills fault, which is the most sensitive to external electromagnetic impact from point of view of the fault electrical conductivity and orientation. Based on the obtained results the possible application of natural electromagnetic triggering of earthquakes is discussed for a short-term earthquake prediction using confidently recorded strong external electromagnetic triggering impacts on the specific earthquake preparation zones.

Acknowledgments

The study was supported by the Ministry of Science and Higher Education of the Russian Federation (State Assignments of IZMIRAN No. 1021060808637-6-1.3.8, JIHT RAS No. 075-00270-24-00, and IDG RAS No. 122032900167-1).

References

[1] V. Sorokin, A. Yaschenko, G. Mushkarev, and V. Novikov, Atmosphere 14 (2023) 458.

[2] V. A. Zeigarnik, L. M. Bogomolov, and V. A. Novikov, Izv., Phys. Solid Earth, 58 (2022) 30.