Evidence of impact of earthquakes on geomagnetic and ionospheric activity during spotless Sun

Tamara Gulyaeva
IZMIRAN, Troitsk, 108840 Moscow, Russia
gulyaeva@izmiran.ru

We investigate the geomagnetic and ionospheric effects of seismic activity during 1810 Sun spotless days (SSL) from 1995 to 2020.

• Catalogue of earthquakes, EQ, is provided by Geophysical Survey, GS-RAS (Obninsk, Russia) at http://www.came.qras.ru/new/eng/ssd_news.htm
• Database of geomagnetic Hpo index [1] is provided by GFZ at https://kp.gfz-potsdam.de/en/hp30-hp60/
• Database of ionospheric GIM-W maps, WU, WL, WE, and Wp indices [2] is provided by IZMIRAN at https://www.izmiran.ru/ionosphere/weather/

The ionosphere Wq index is derived at the EQ epicenter from GIM-W map based on JPL GIM-TEC map [3].

• Superposed epoch analysis, SEA, is used with the zero time t₀ taken at EQ from t₀-24h (preEQ) to t₀+24h (postEQ).

Conclusions

• Superposed epoch analysis SEA is made with the zero epoch time t₀ ± 24h taken at daily peak earthquake EQ time for spotless Sun during SC23 and SC24.

• The decay of the planetary geomagnetic Hpo index at EQ time t₀ is observed for 91% of cases as compared to Hpo(preEQ) and Hpo(postEQ).

• These results testify on the planetary interplay between the Earth and space environment considering that the Hpo index is measured at sub-auroral latitudes while EQs occur at middle and equatorial latitudes [1, 3].

References


Fig. 1. (a) Monthly number of EQs provided by GS-RAS and smoothed sunspot number ESN[2]; (b) Daily number of EQs for 1810 spotless days used for the analysis; (c) Daily number of EQs at Japan area [30-47°N, 134-151°E] observed during 6270 days including 200+ events on 2011.03.11 at Tohoku EQ.

Fig. 2. (a) GS-RAS EQs data at Japan area, including frame of GIM cell (2.5° in latitude, 5° in longitude) around Tohoku EQ; (b) GIM-W(TEC) map at Tohoku EQ 2011.03.11 05:45 UT; (c) GIM cell around Tohoku EQ.

Fig. 3. (a) W index in latitude/time UT frame at 142.7°E during 10-12 March 2011 including Tohoku EQ M9.1 on 2011.03.11 at 05:45 UT; (b) geomagnetic Hpo index exceeding Hpo(t₀) during t₀(24h) for preEQ and postEQ time.

Fig. 4. The results of SEA analysis of Hpo index. (a) Hpo < 4.0 i.u.; (b) Hpo > 4.0 before and/or after EQ.

Fig. 5. The results of SEA analysis of Wq index. (a) positive WqEQ > 0 or negative WqEQ < 0; (b) absolute WqEQ index.

Fig. 6. Histogram of occurrence of relations between Hpo (1st panel), negative WL (2nd panel), positive WL (3rd panel), and absolute value |Wq| index (4th panel) prior earthquake (blue) and after earthquake (yellow) with the relevant index I at EQ. Sign > means I(preEQ) > I(t₀) and I(postEQ) > |I(t₀)|; '=' means the index is equal to I(t₀); '<' means that I(preEQ) < I(t₀) and I(postEQ) < I(t₀).

5th ISEE Symposium, 15-17 Nov 2022, Nagoya, Japan