EVIDENCE OF IMPACT OF EARTHQUAKES ON GEOMAGNETIC AND IONOSPHERIC ACTIVITY DURING SPOTLESS SUN

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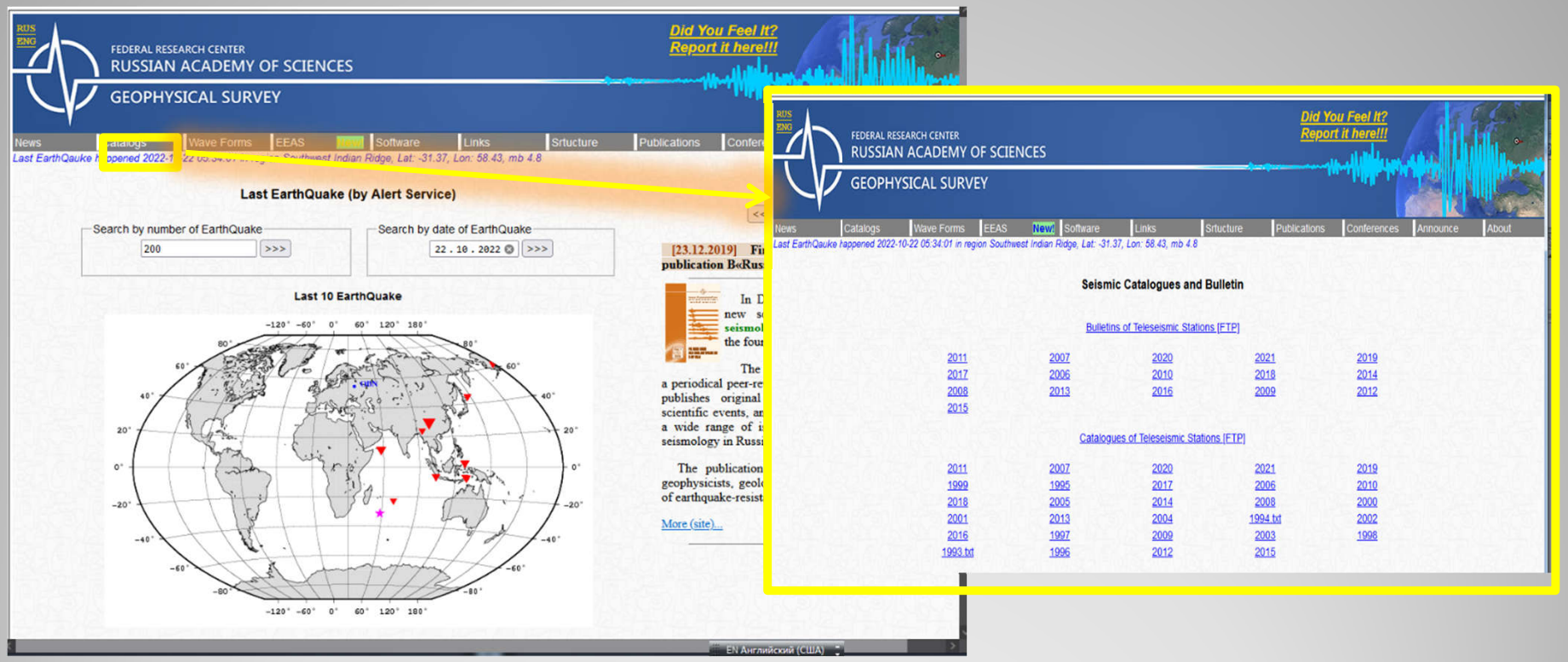
UN/Azerbaijan ISWI Workshop, Baku, 31 Oct-4 Nov, 2022

Outline

- **GS-RAS Database of earthquakes**
- **Database of geomagnetic indices**
- **Database of ionospheric indices**
- **W_{EQ} index of TEC variability at EQ epicenter**
- **Decline of geomagnetic Hpo index and W_{EQ} index at earthquake**
- **Summary and conclusions**

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

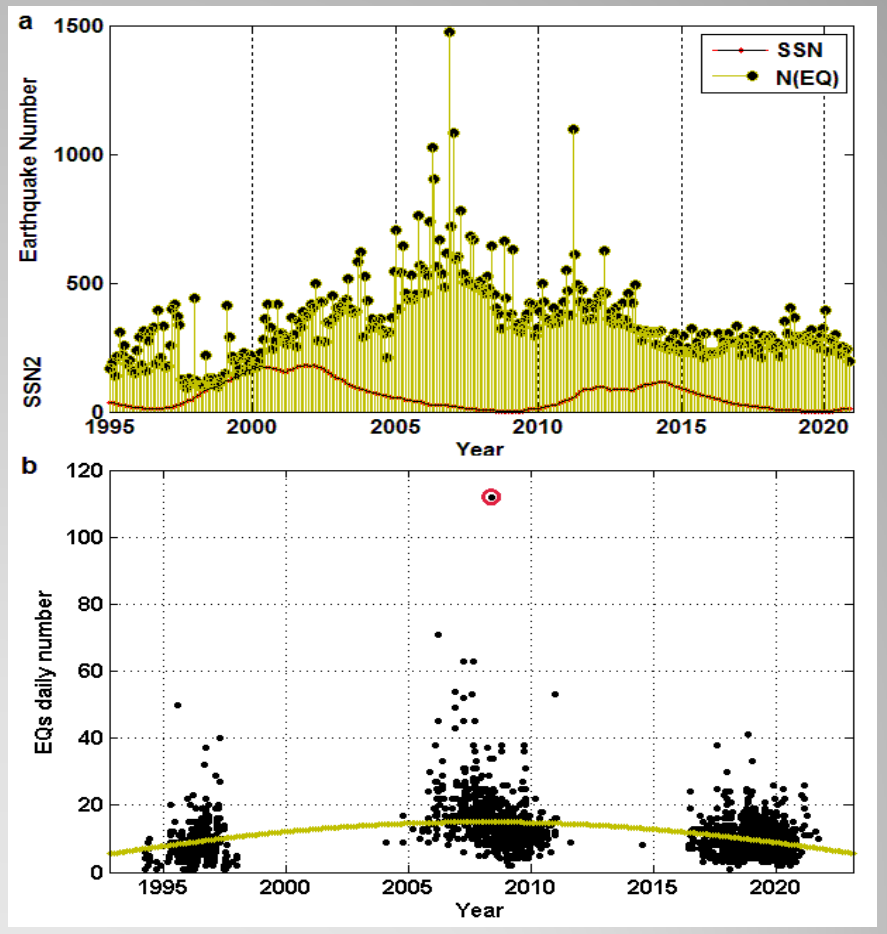
- **Catalogue of earthquakes, EQ, is provided by Geophysical Survey, GS-RAS (Obninsk, Russia) at http://www.ceme.gsras.ru/new/eng/ssd_news.htm**



GS-RAS Earthquake database

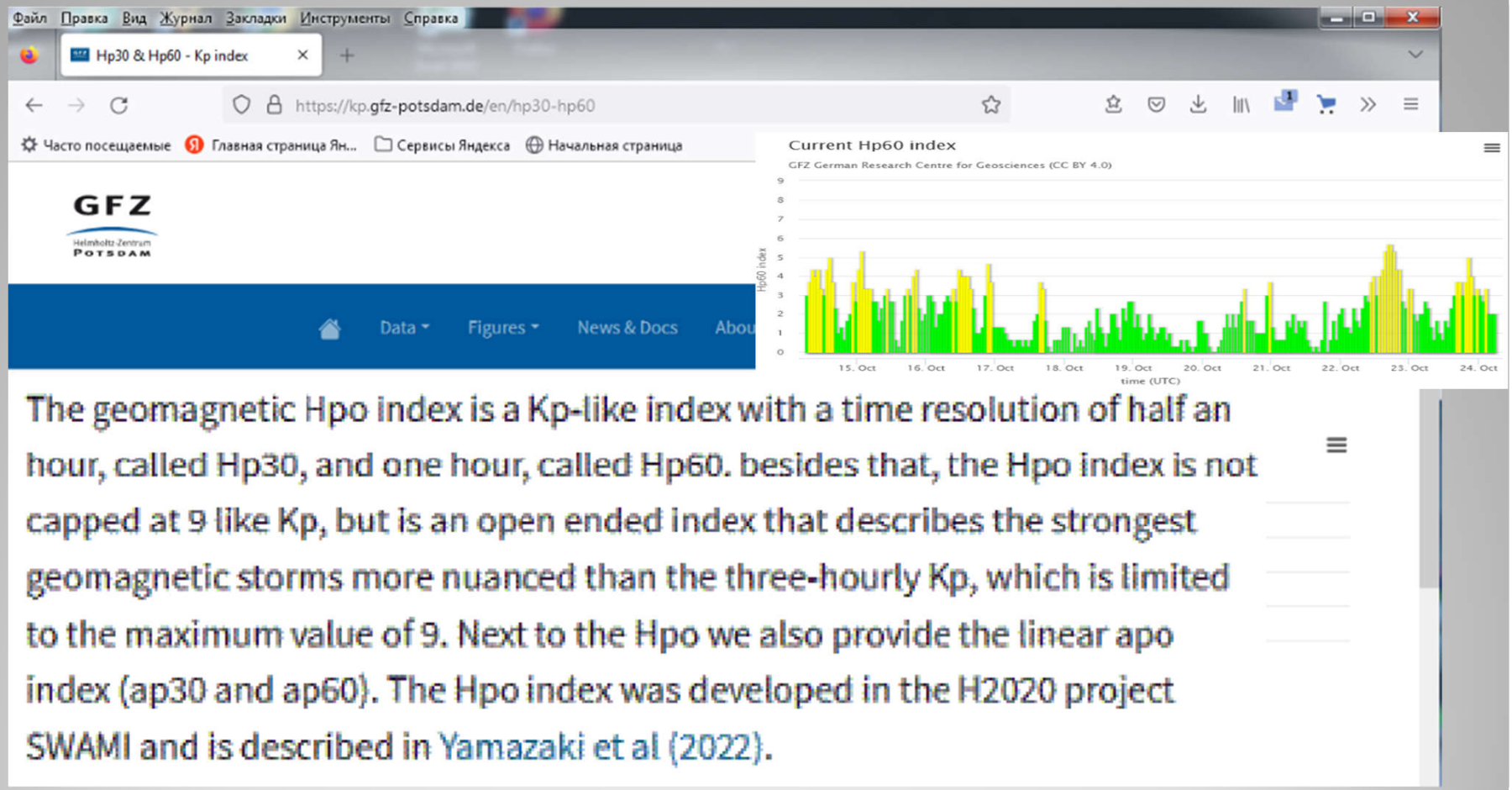
(a) Monthly number of EQs provided by GS-RAS and the 12-month smoothed sunspot number SSN2

(b) Daily number of EQs and fitting curve for the Sun spotless days used for the analysis from 1995 to 2020.



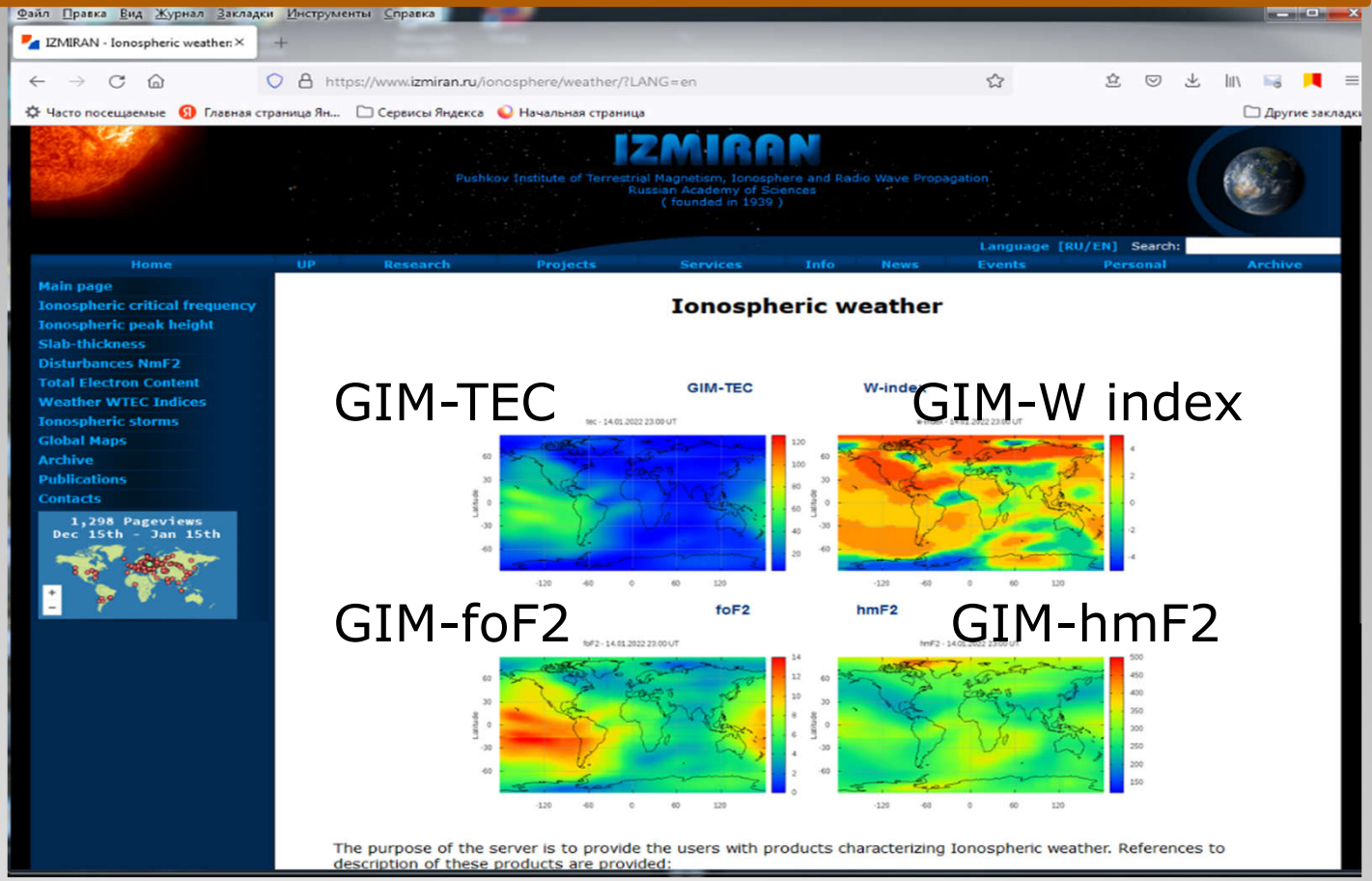
GS-RAS Earthquake database: Seismic activity is growing towards the solar minimum

https://kp.gfz-potsdam.de/en/hp30-hp60/



Database of geomagnetic indices: Kp, Ap, Hpo indices from 1995 to present

https://www.izmiran.ru/ionosphere/weather/

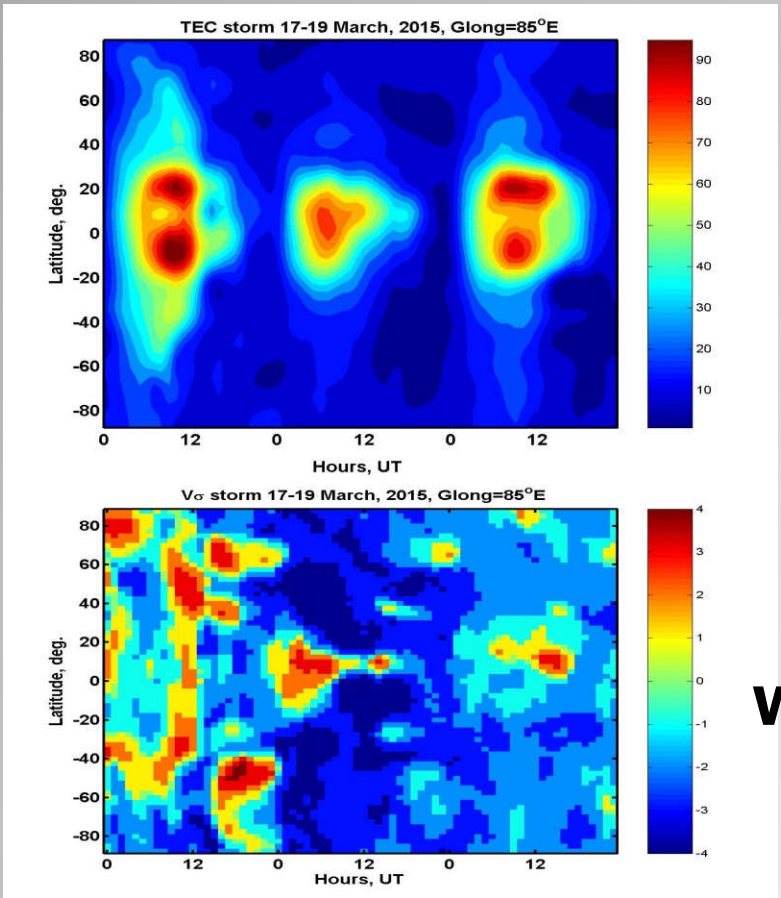


Database of ionospheric indices:

Archive of GIM-W maps, WU, WL, WE, Wp indices from 1994 to present

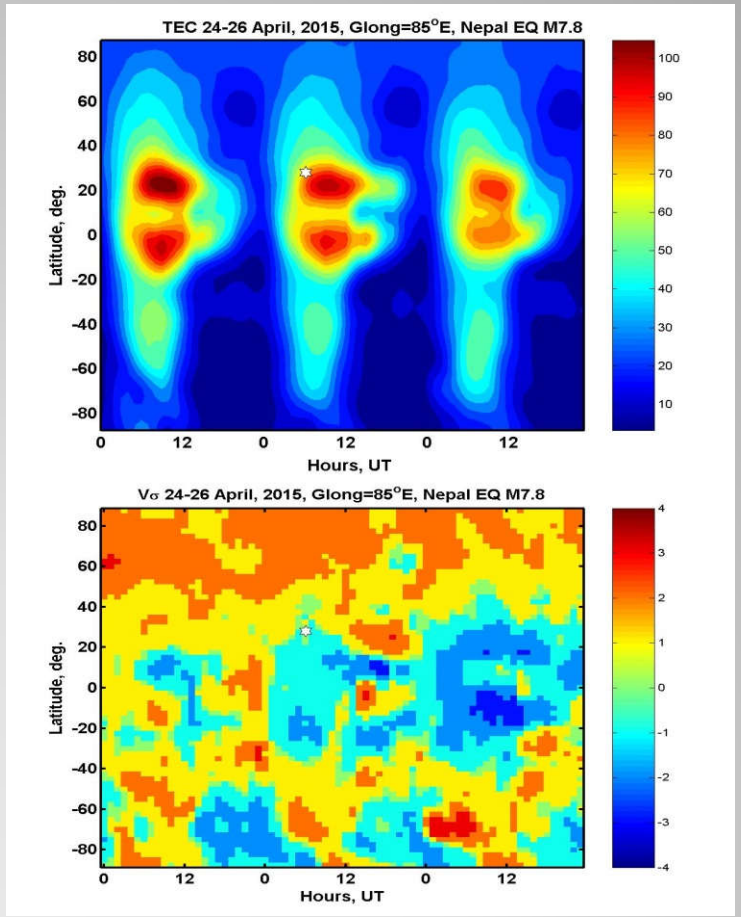
Storm 17-19 Mar 2015

Nepal EQ M7.8 24-26 Apr 2015

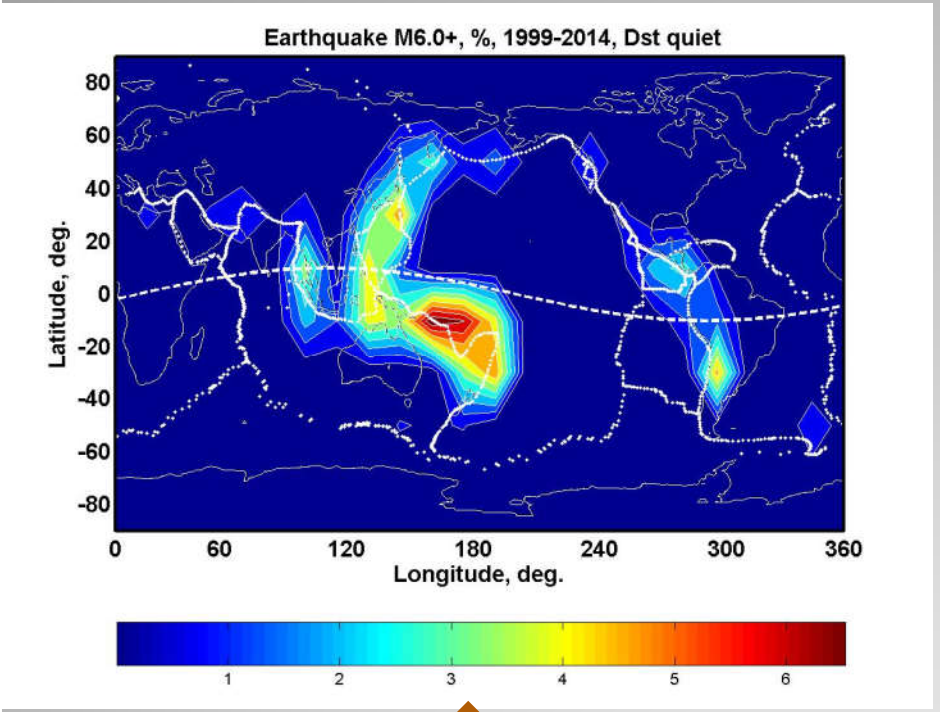


TEC

W(TEC)

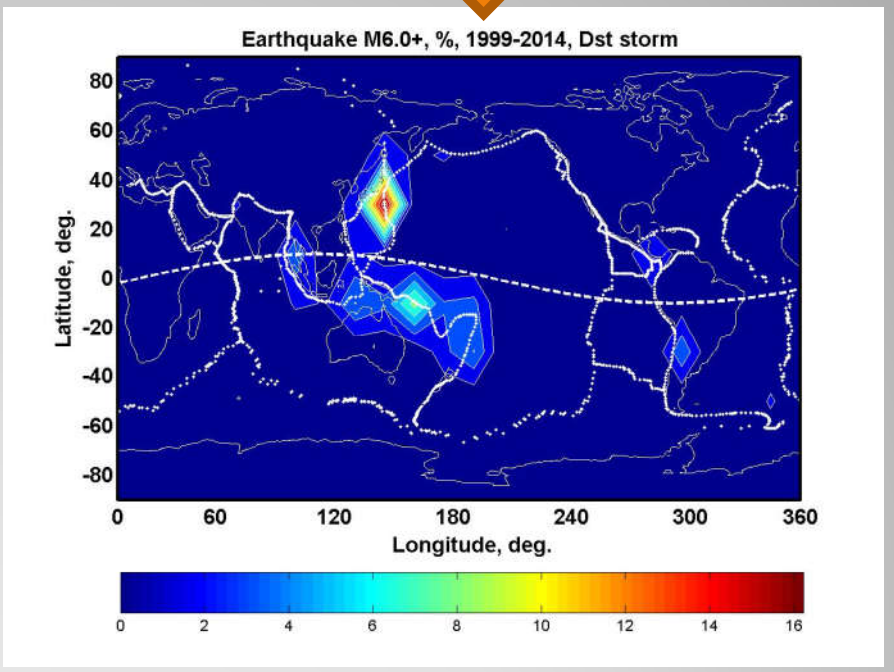


Different effects of geo-storm and EQ on TEC and W(TEC) at 85°E meridian



EQs data provided by NCEDC (doi:10.7932/NCEDC)

EQs at geo-storms 1999-2014



Eqs M6+ under quiet conditions

Zones of enhanced seismic activity under quiet space weather and geomagnetic storms

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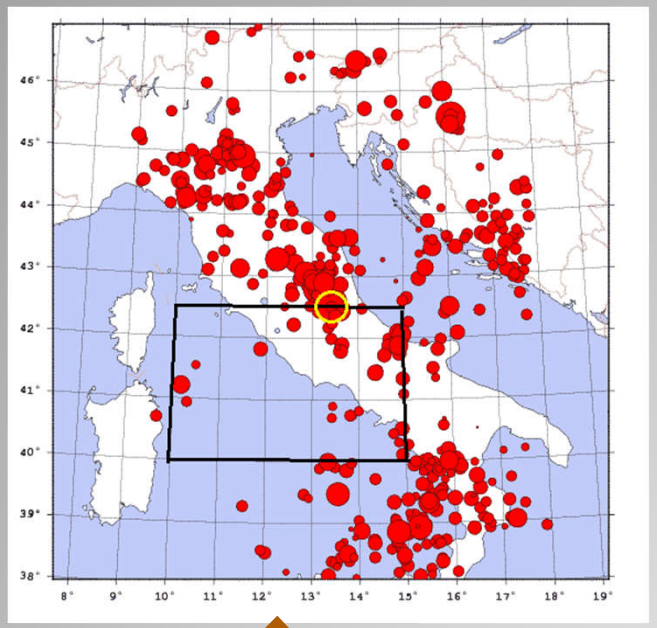
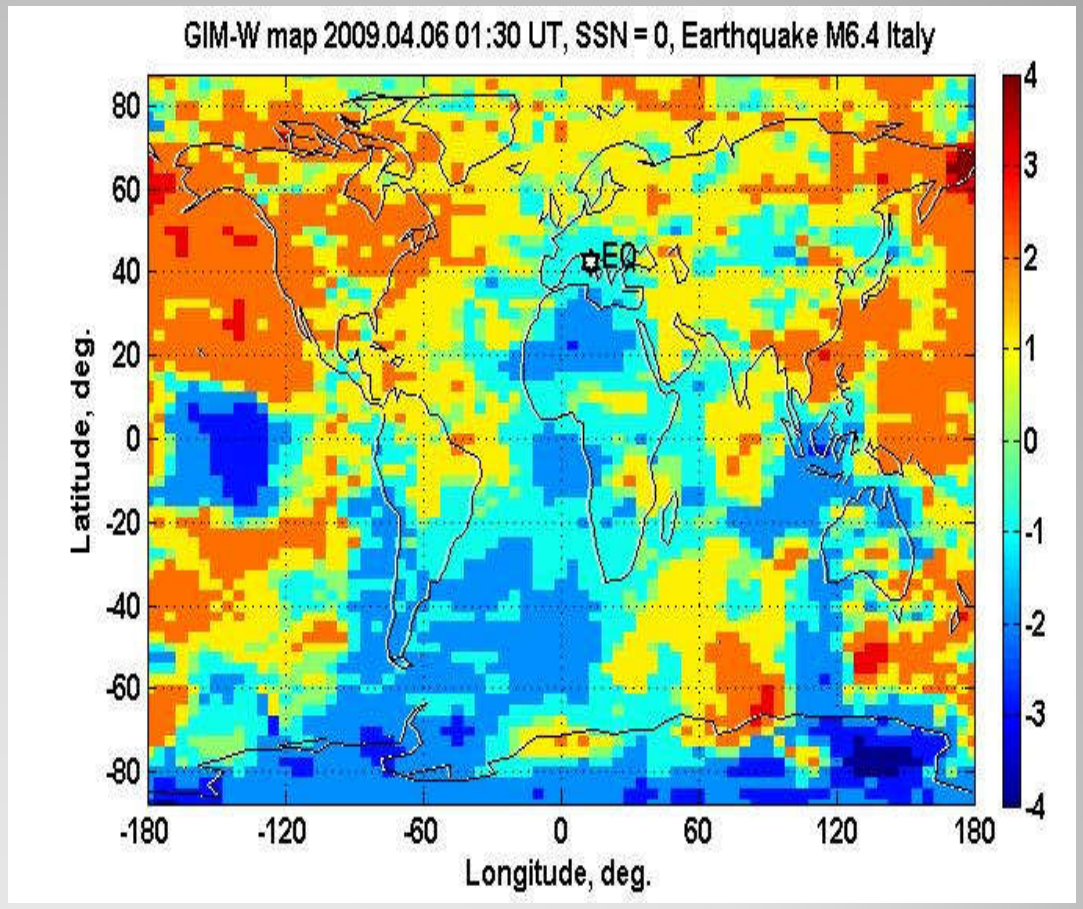
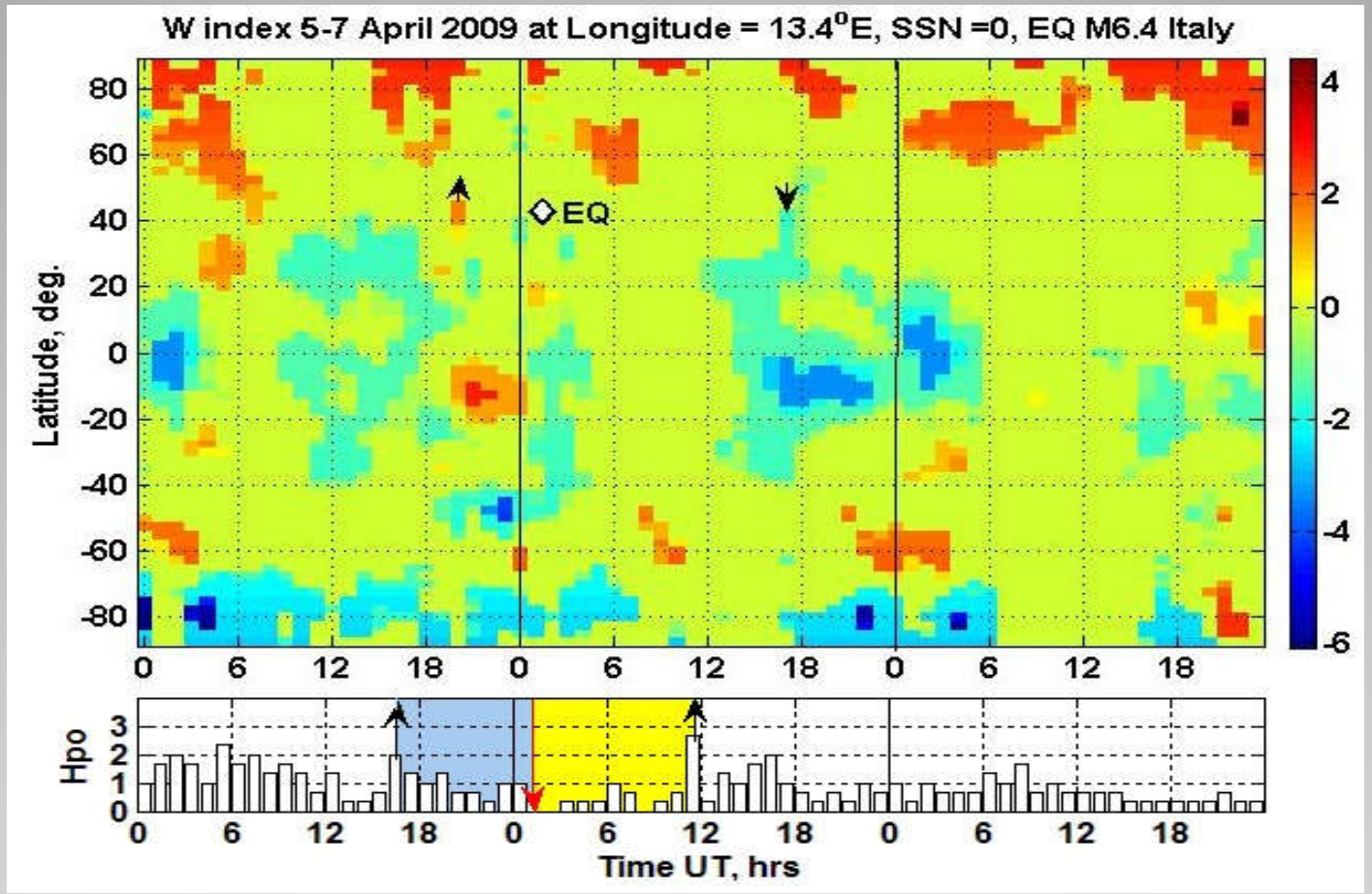


Cell 2.5°x5° in latitude & longitude used to calculate W_{EQ} index at EQ epicenter (M6.4, Italy, 7.04.2009 01:30 UT

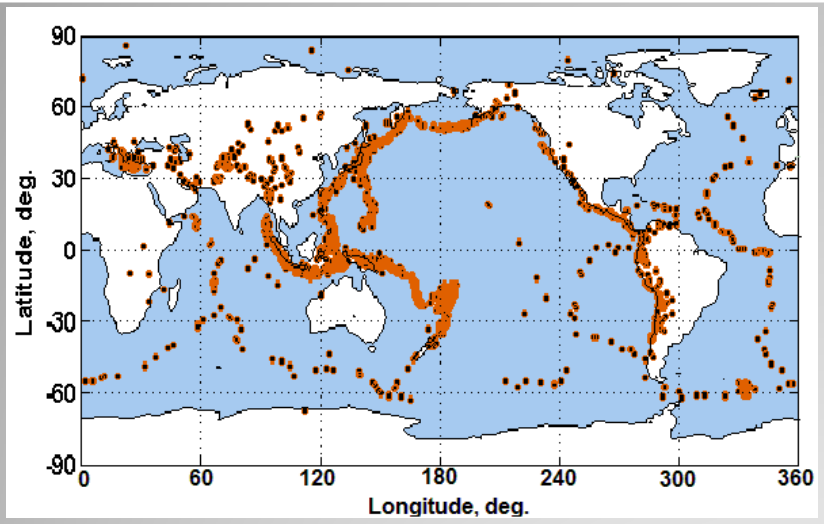


GS-RAS Collection of 500+ earthquakes over Italy and W(TEC) map including EQ M6.4, on 7.04.2009, 01:30 UT, at SSN = 0



W(TEC) at longitude 13.4°E 6-8 April 2009 including EQ M6.4, Italy, 7.04.2009, SSN=0. Bottom: geomagnetic Hpo index growing at t_0(EQ) ±24 h of preEQ and postEQ time

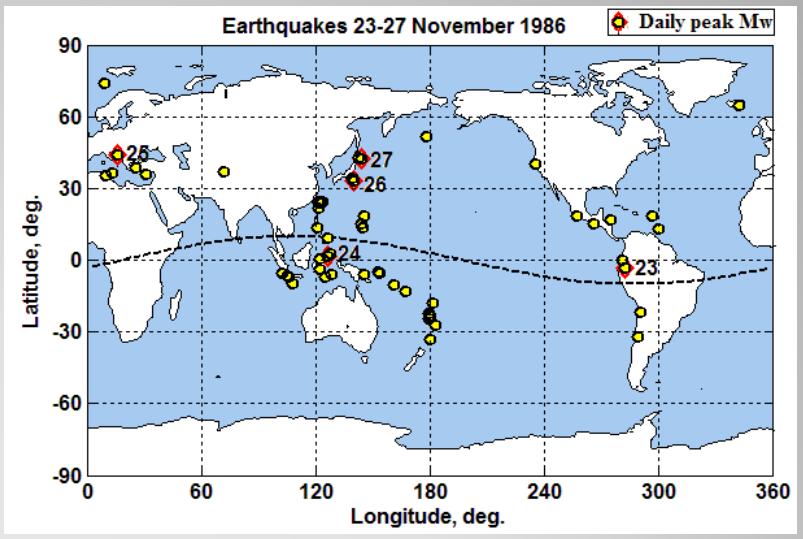
a



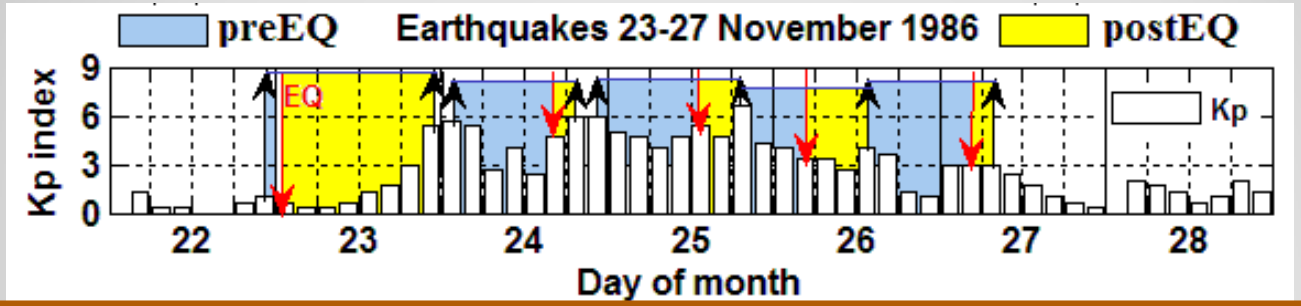
EQ data provided by GS-RAS

EQ data provided by NCEDC (doi:10.7932/NCEDC)

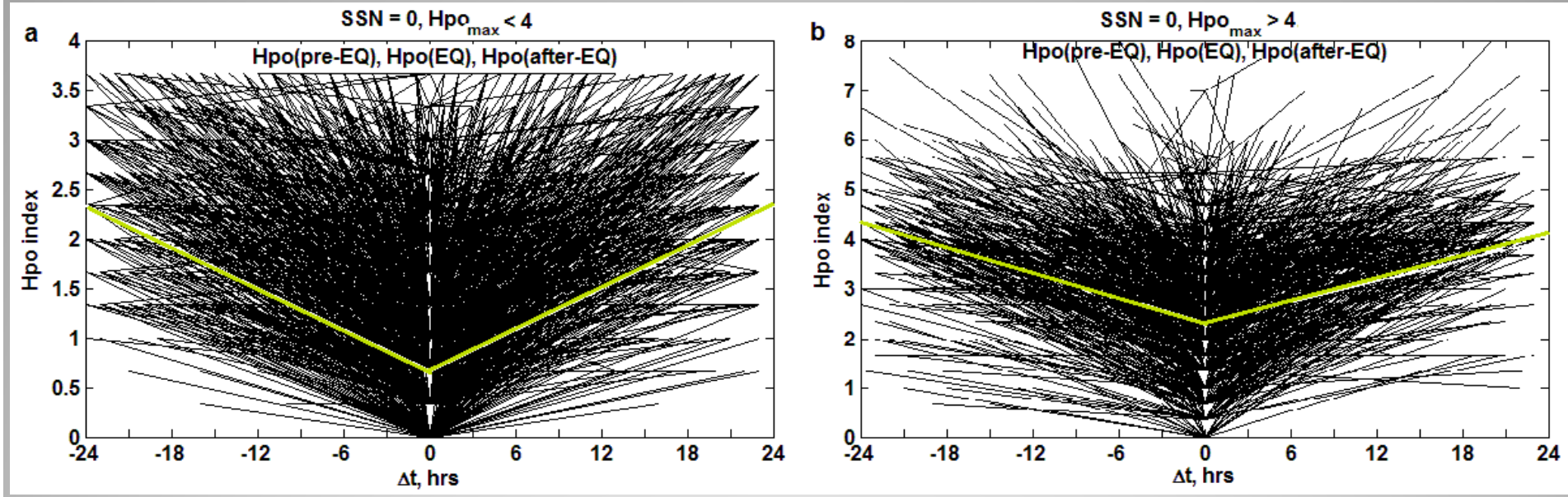
b



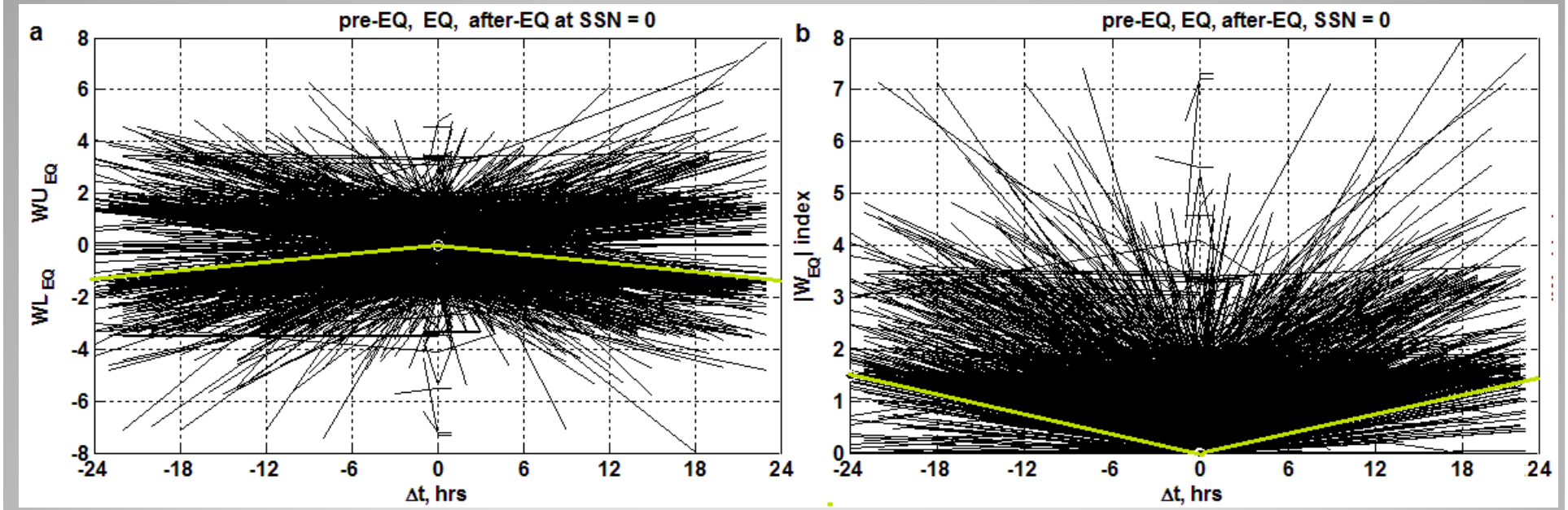
c



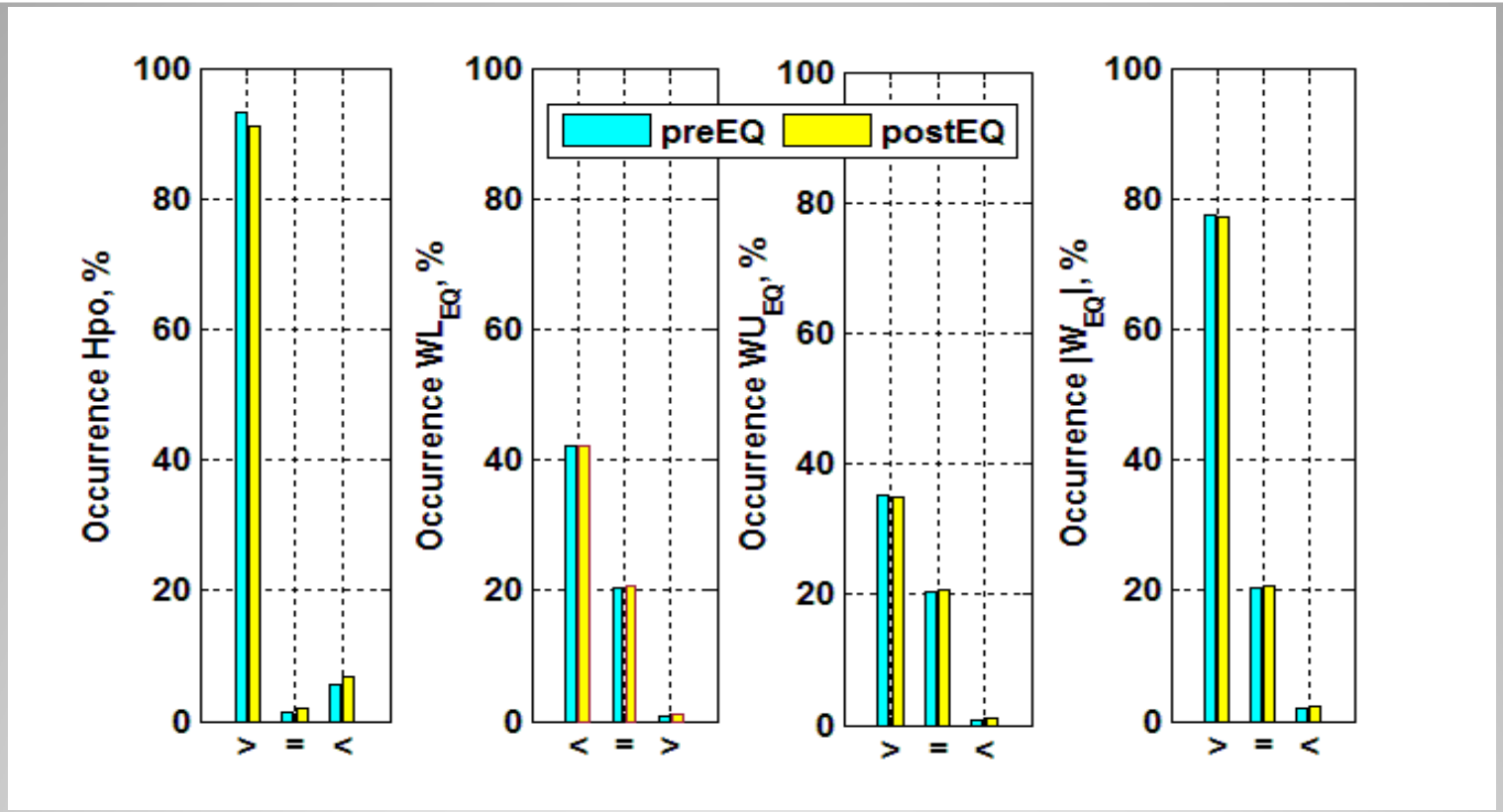
(a)EQs total set at SSN=0; (b) EQs on 23-27.11.1986; (c) Kp index is dropped down at daily peak EQ



The results of superposed effects analysis (SEA) of Hpo index. (a) Hpo < 4.0 i.u.; (b) Hpo ≥ 4.0 before and/or after EQ.



The results of SEA analysis of W_{EQ} index. (a) positive $WU_{EQ} > 0$ or negative $WL_{EQ} < 0$ indices; (b) absolute values $|W_{EQ}|$



Occurrence of relations between Hpo, WL, WU and $|W_{EQ}|$ index value prior earthquake and after earthquake with index value at EQ

Conclusions-1

- We investigate the geomagnetic and ionospheric effects of seismic activity during 1810 Sun spotless days (SSL) from 1995 to 2020.
- Newly developed 1h geomagnetic index Hpo and the ionospheric Weq index are used for the comparisons with the daily peak earthquake Mw.
- The ionosphere Weq index is derived at the EQ epicenter from GIM-W map based on JPL GIM-TEC map.

Conclusions-2

- Superposed epoch analysis is used with the zero epoch time t_0 taken at EQ.
- It is found that the magnitude of Hpo(t_0) is less that the both peaks of Hpo(preEQ) and Hpo(afterEQ) in 91% of EQs.
- Similar effect is observed in 71% of events with the peak of the absolute values of |W(preEQ)| and |W(afterEQ)| the both exceeding |Weq|.
- Our results provide evidence that EQ-related geomagnetic and ionospheric activities experience decline of intensity at the time of EQ during SSL.

Thank You!