



KYUSHU UNIVERSITY



# Application of MAGDAS Data in Analysis of Possible Solar-Seismicity Coupling

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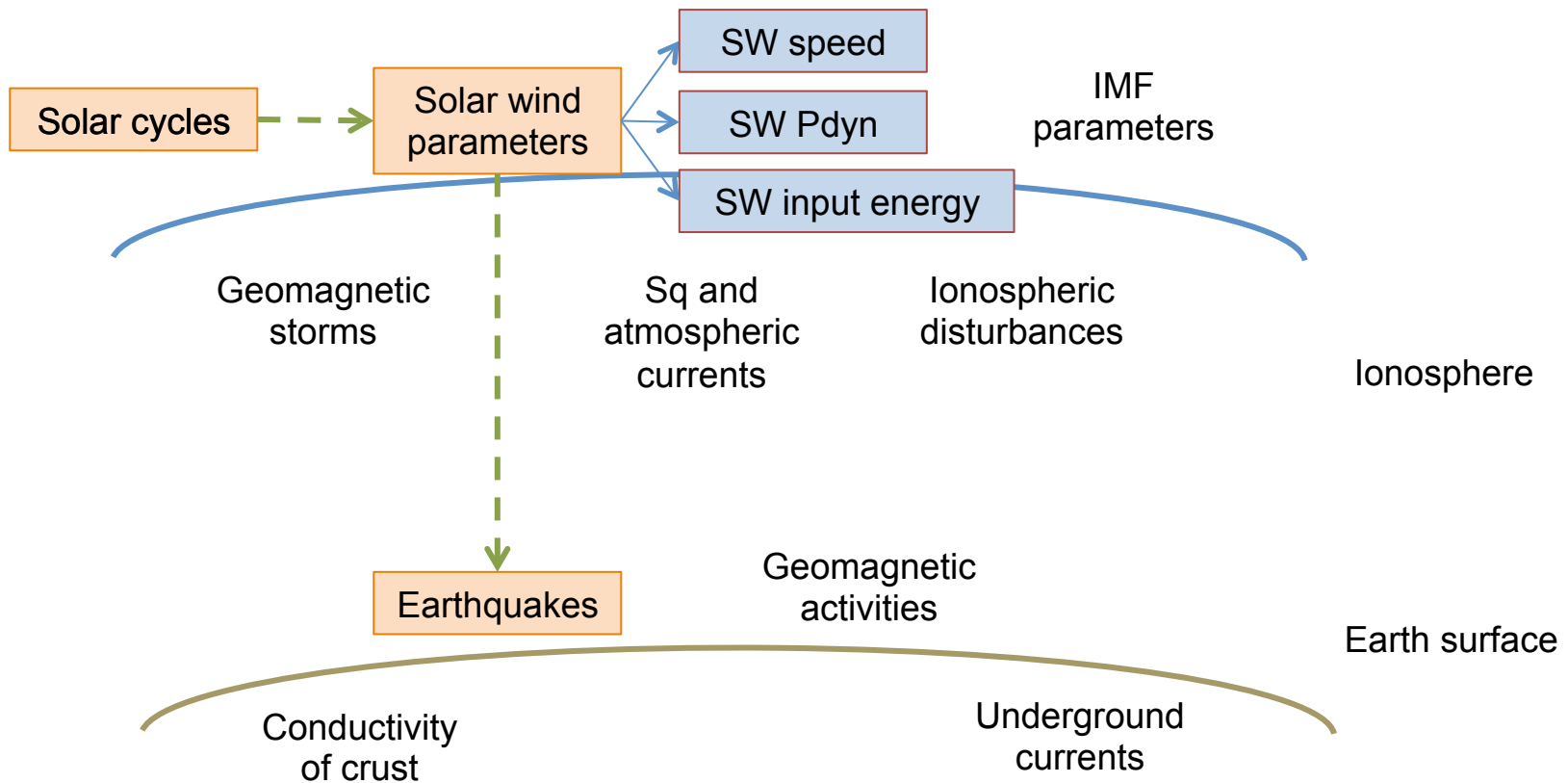


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  - ✧ Basic concept of geomagnetic field
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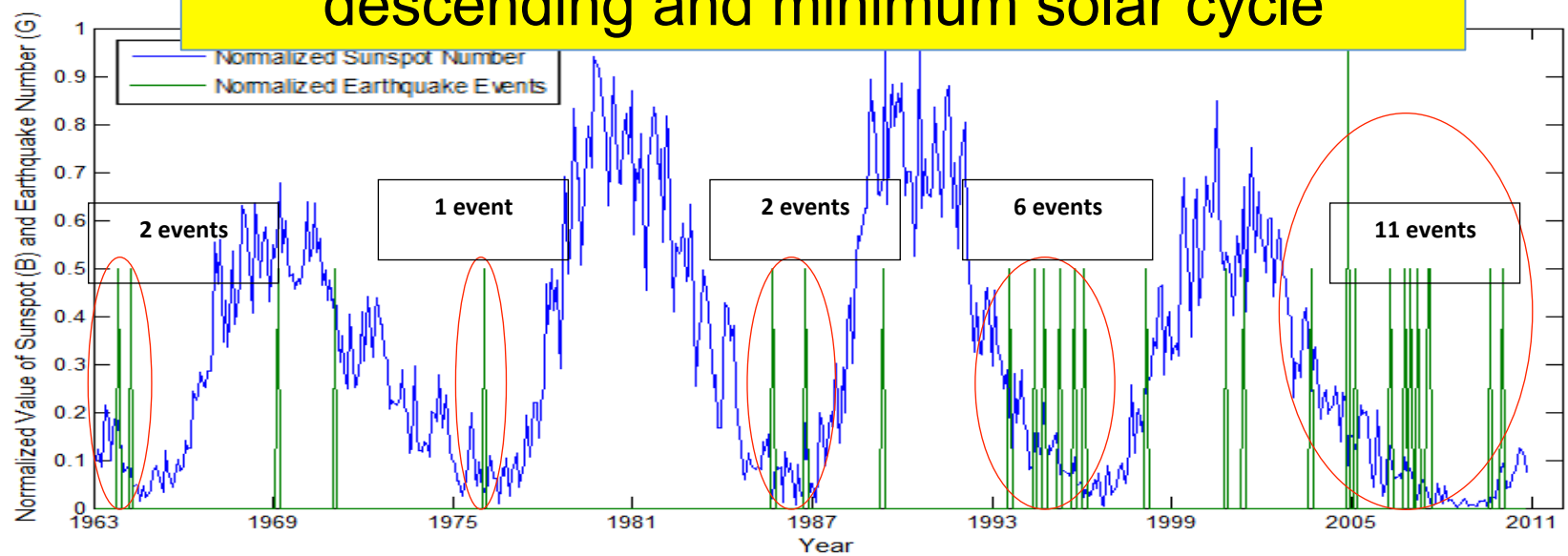
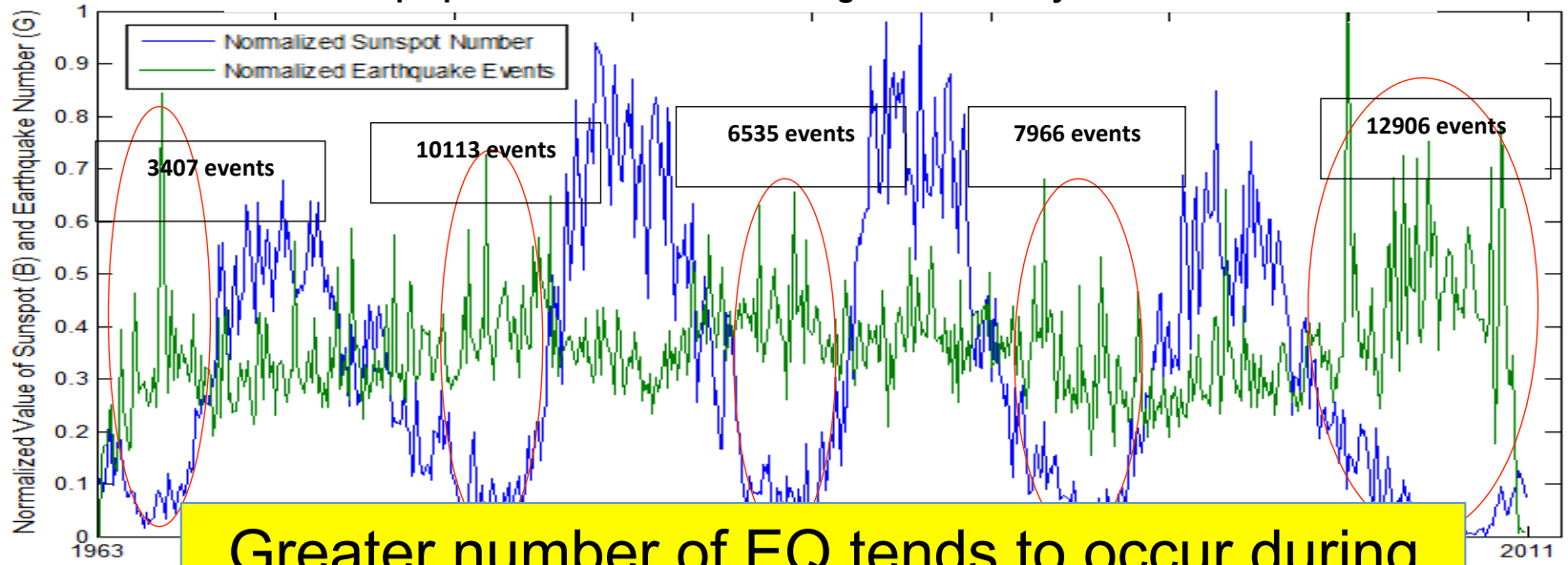
# Solar - Seismicity Coupling

- A comprehensive analysis for possible correlation of solar activity and global seismicity requires a large database of both extraterrestrial and terrestrial parameters.

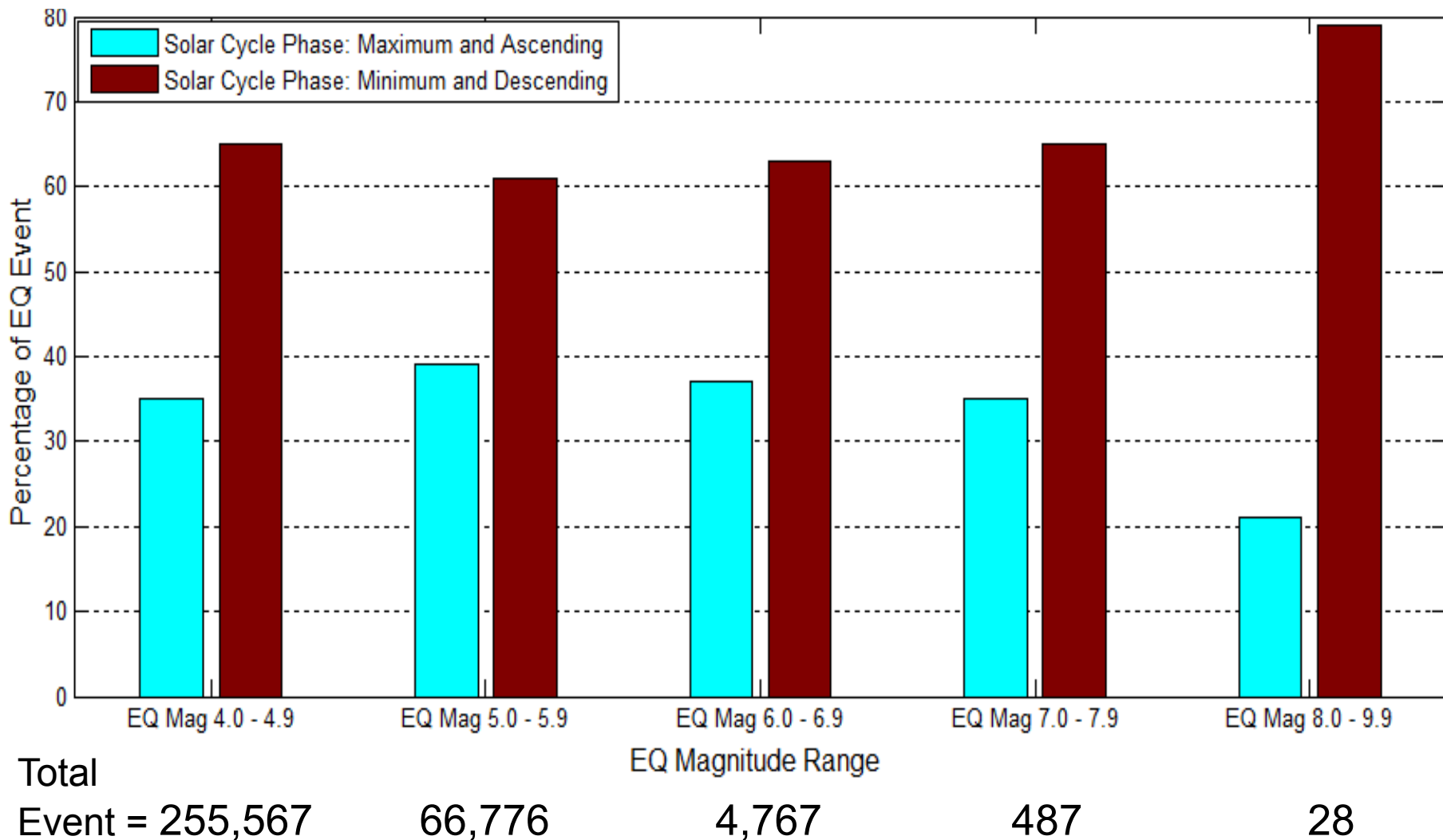


# 2.1 Occurrences of Earthquakes with Solar cycles

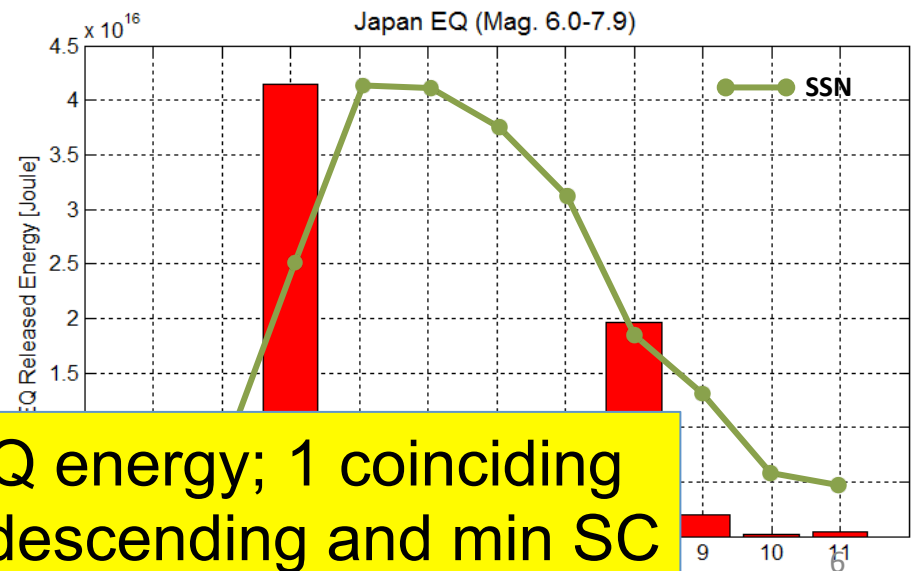
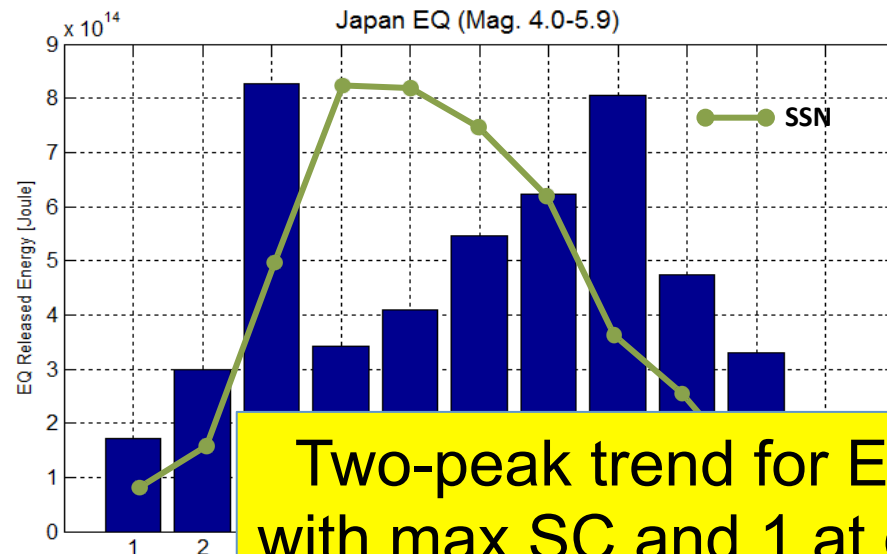
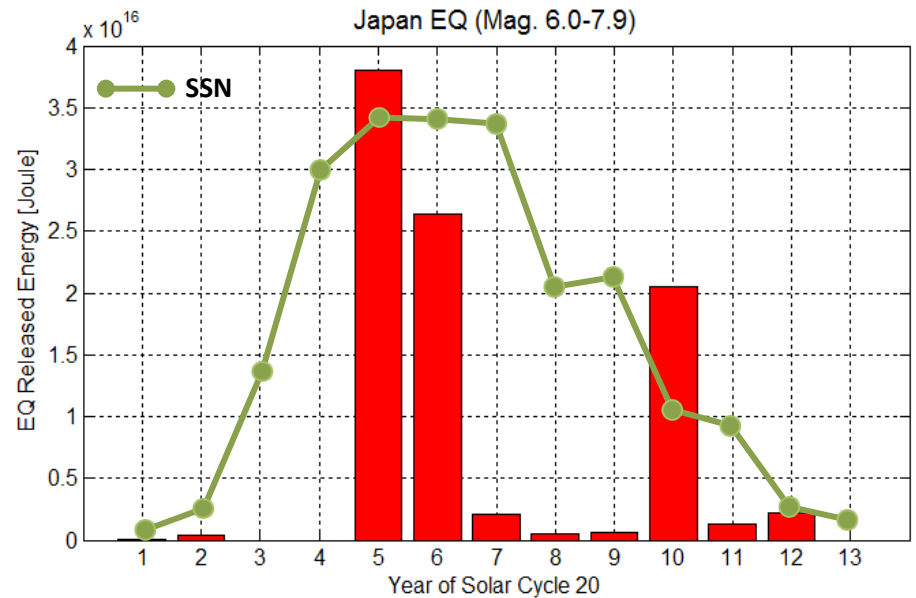
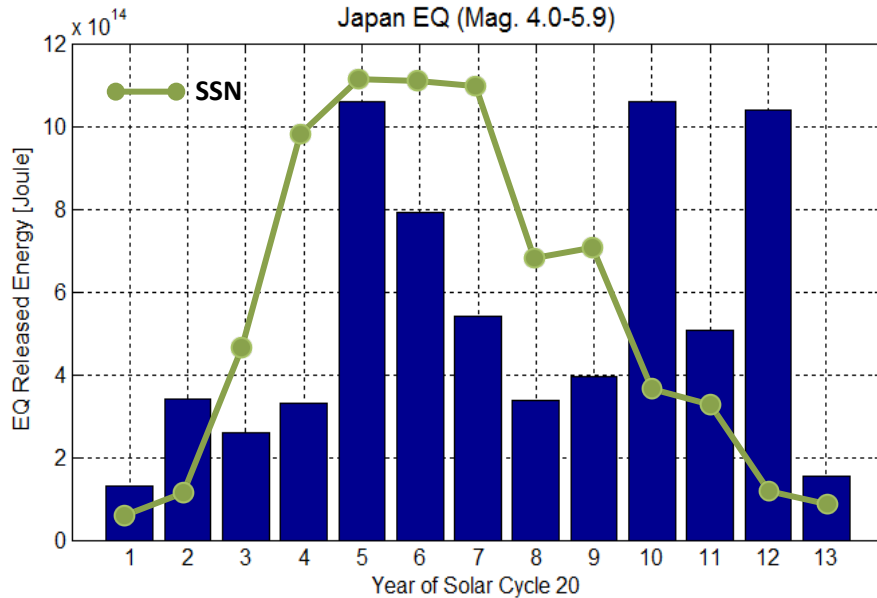
Superposition of SSN and EQ Mag. 5.0-5.9 from year 1963 to 2010



## 2.2 Percentage of EQ Occurrence during Different Phases of Solar Cycles 20 to 23

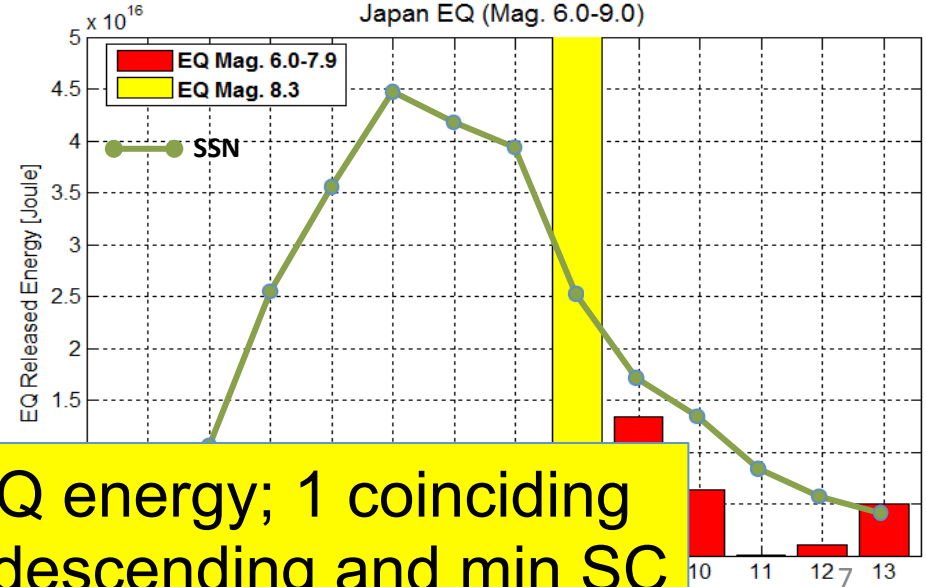
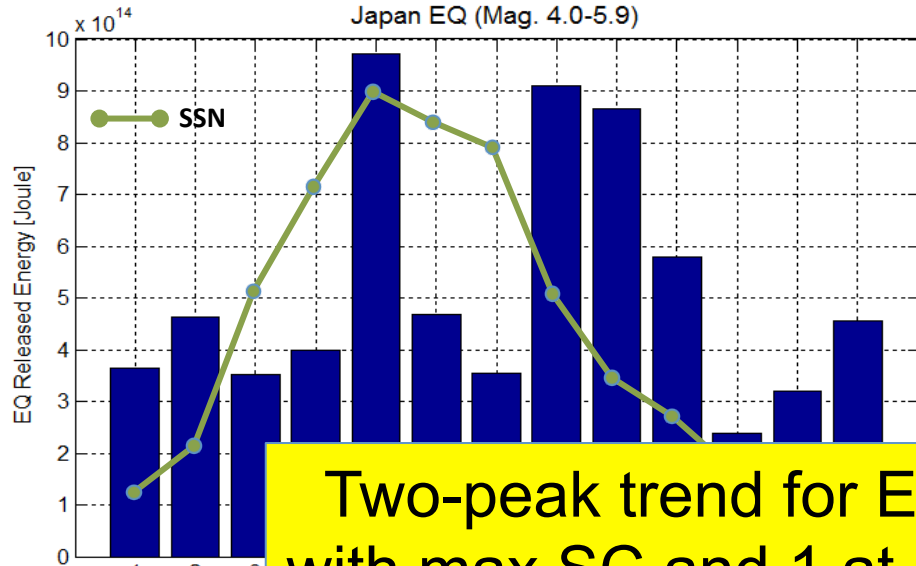
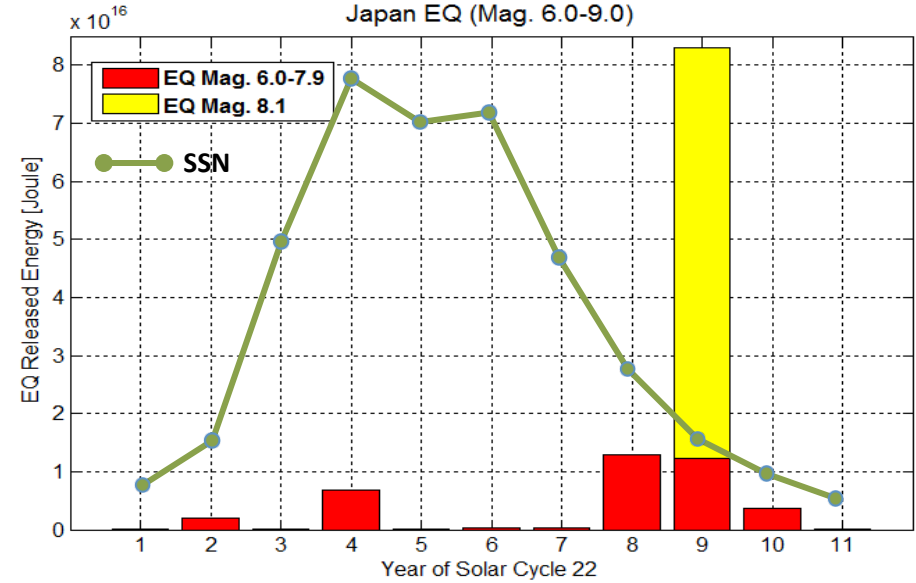
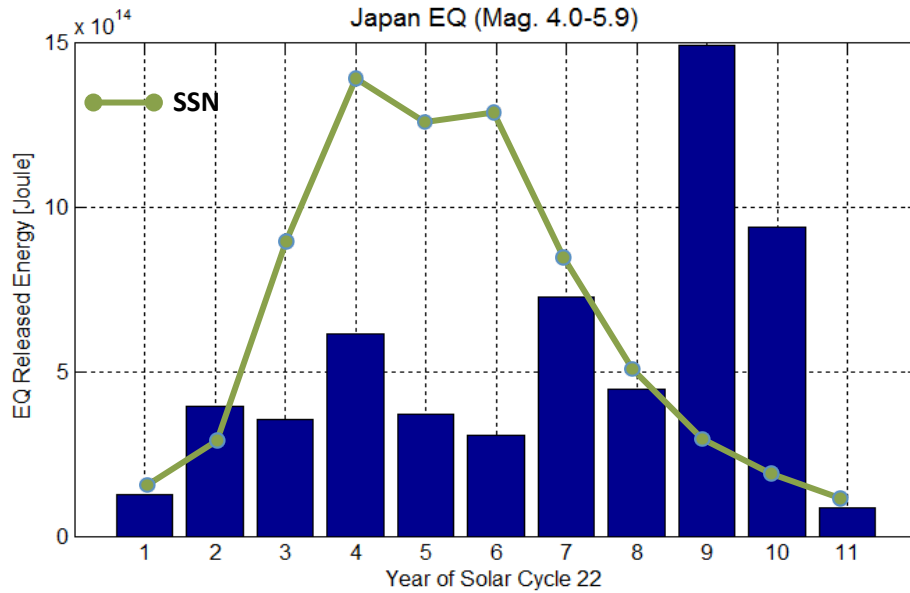


## 2.3 Distribution of Regional EQ Energy: Japan



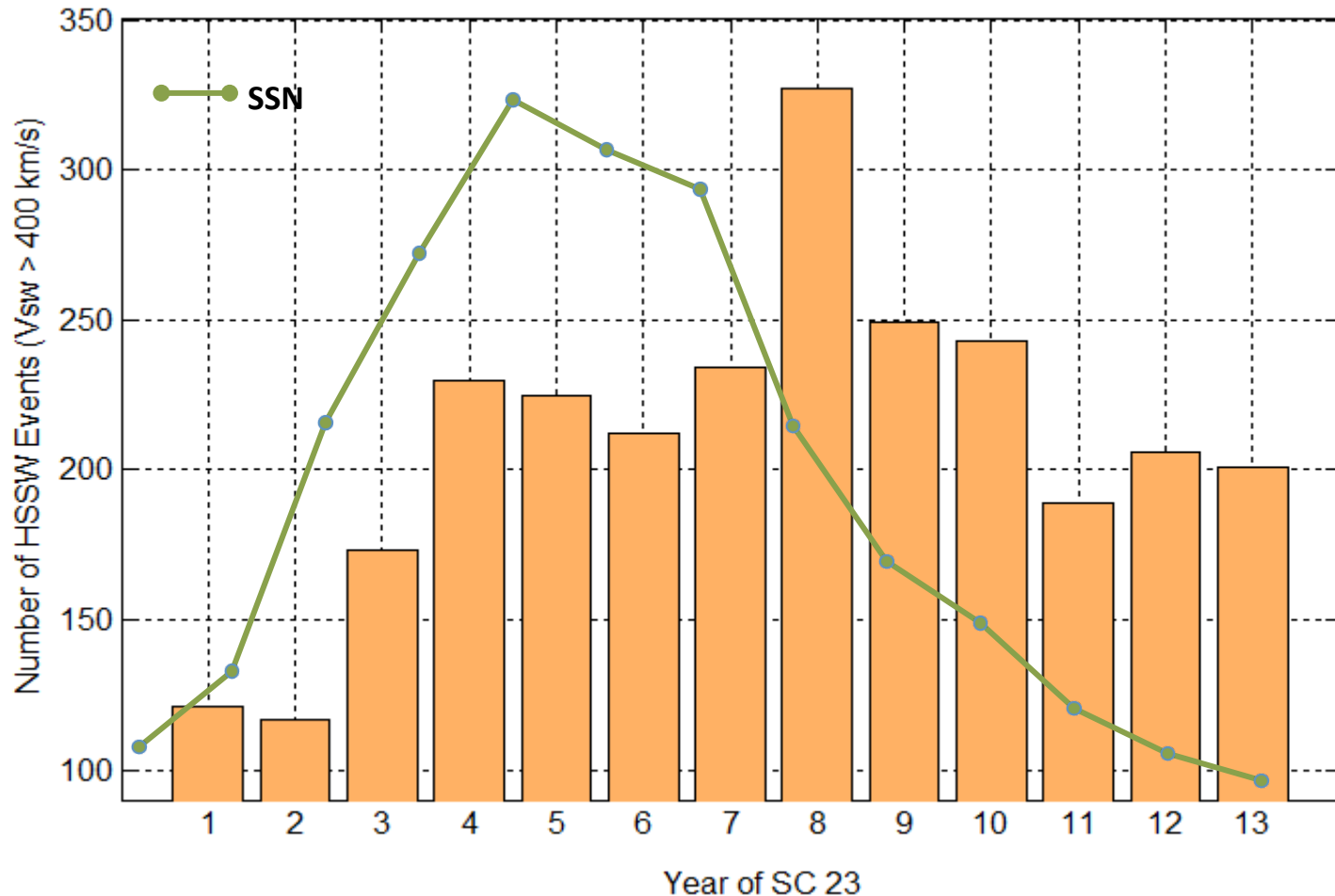
Two-peak trend for EQ energy; 1 coinciding with max SC and 1 at descending and min SC

## 2.3 Distribution of Regional EQ Energy: Japan (cont..)



Two-peak trend for EQ energy; 1 coinciding with max SC and 1 at descending and min SC

## 2.4 High Speed Solar Wind Events (HSSW) (SC 23)

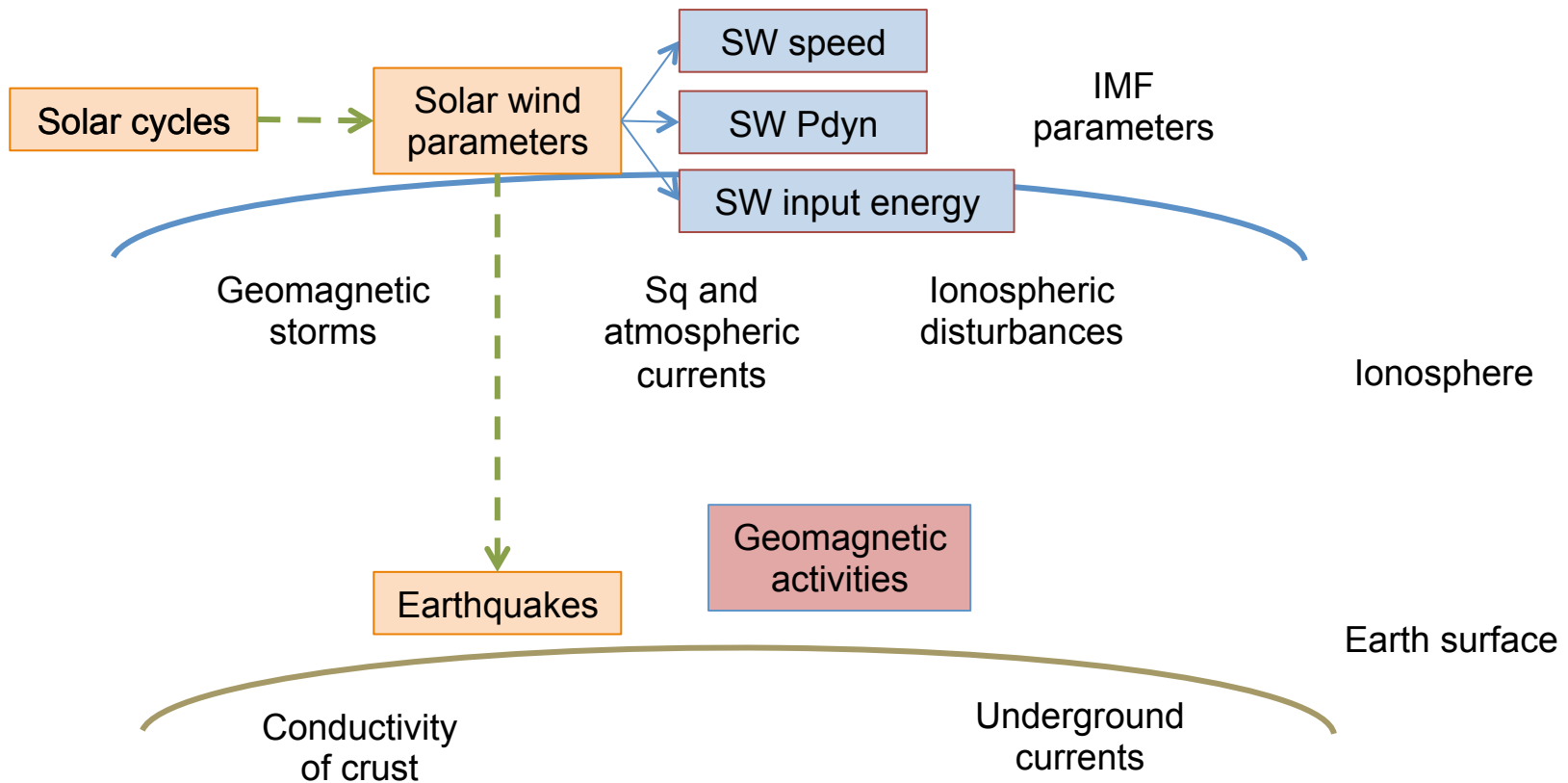


Greater number of EQ tends to occur during descending and minimum solar cycle



# Solar - Terrestrial Coupling

- A comprehensive analysis for possible correlation of solar activity and global seismicity requires a large database of both extraterrestrial and terrestrial parameters.



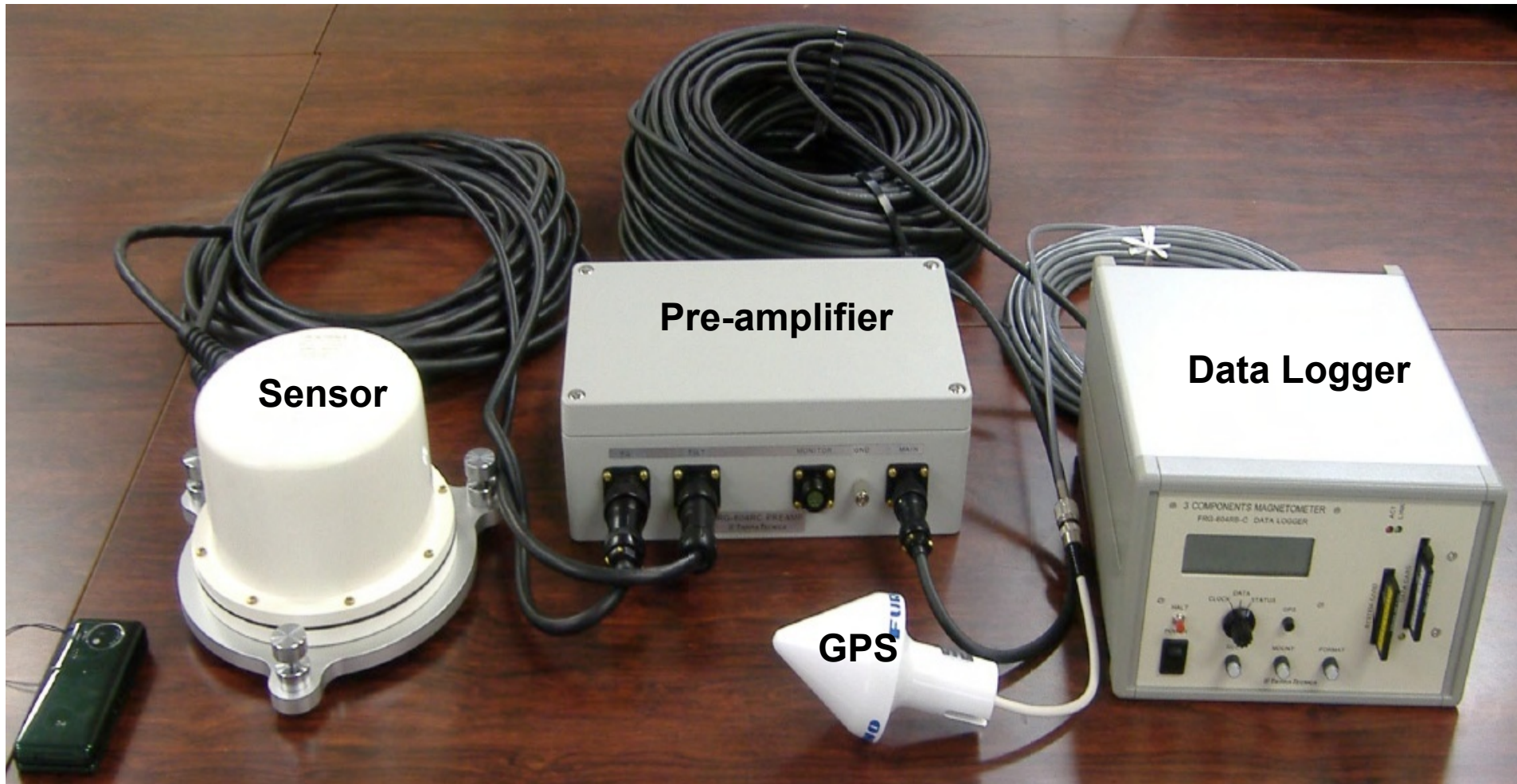
### 3. Earthquakes and geomagnetic variations



**First,**

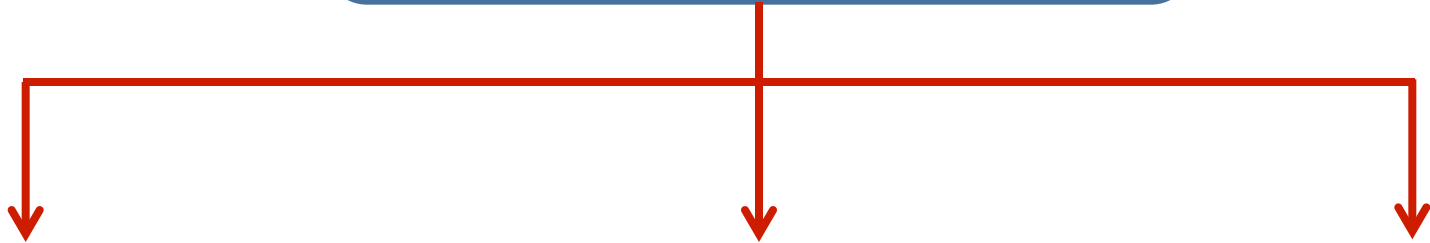
How we can measure the geomagnetic field?

We can measure the geomagnetic field by using an instrument called the **Magnetometer**



MAGDAS-9 Magnetometer

Total Geomagnetic Field



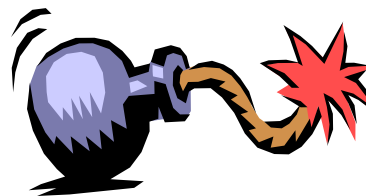
Main Core Field

Crustal Field

External Field

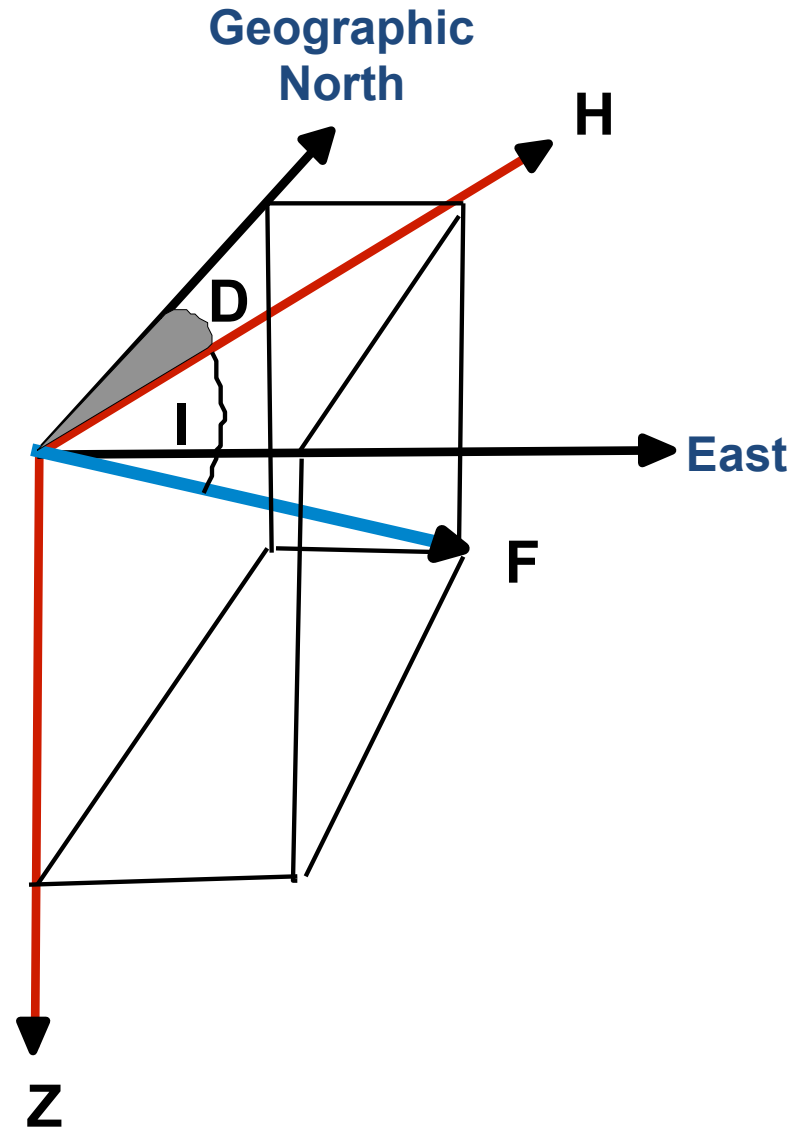


Earthquakes



# The components of the geomagnetic field

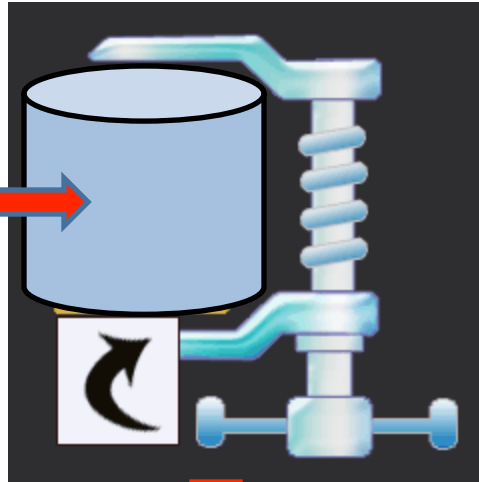
- **F**: Total geomagnetic field
- **H**: Horizontal component
- **Z**: Vertical component
- **D**: Declination angle
- **I**: Inclination angle



# Generation of anomalous geomagnetic variation related to earthquakes

at laboratory

Carry magnetization

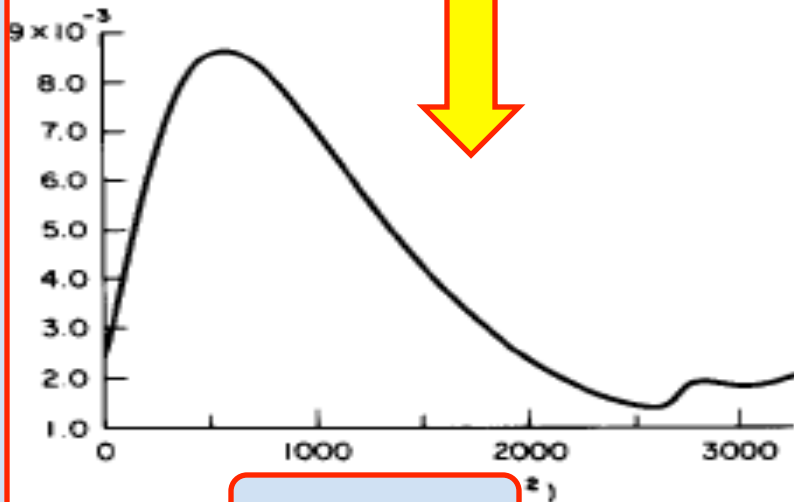


Stress



Rock samples contain magnetic minerals

Magnetic Intensity

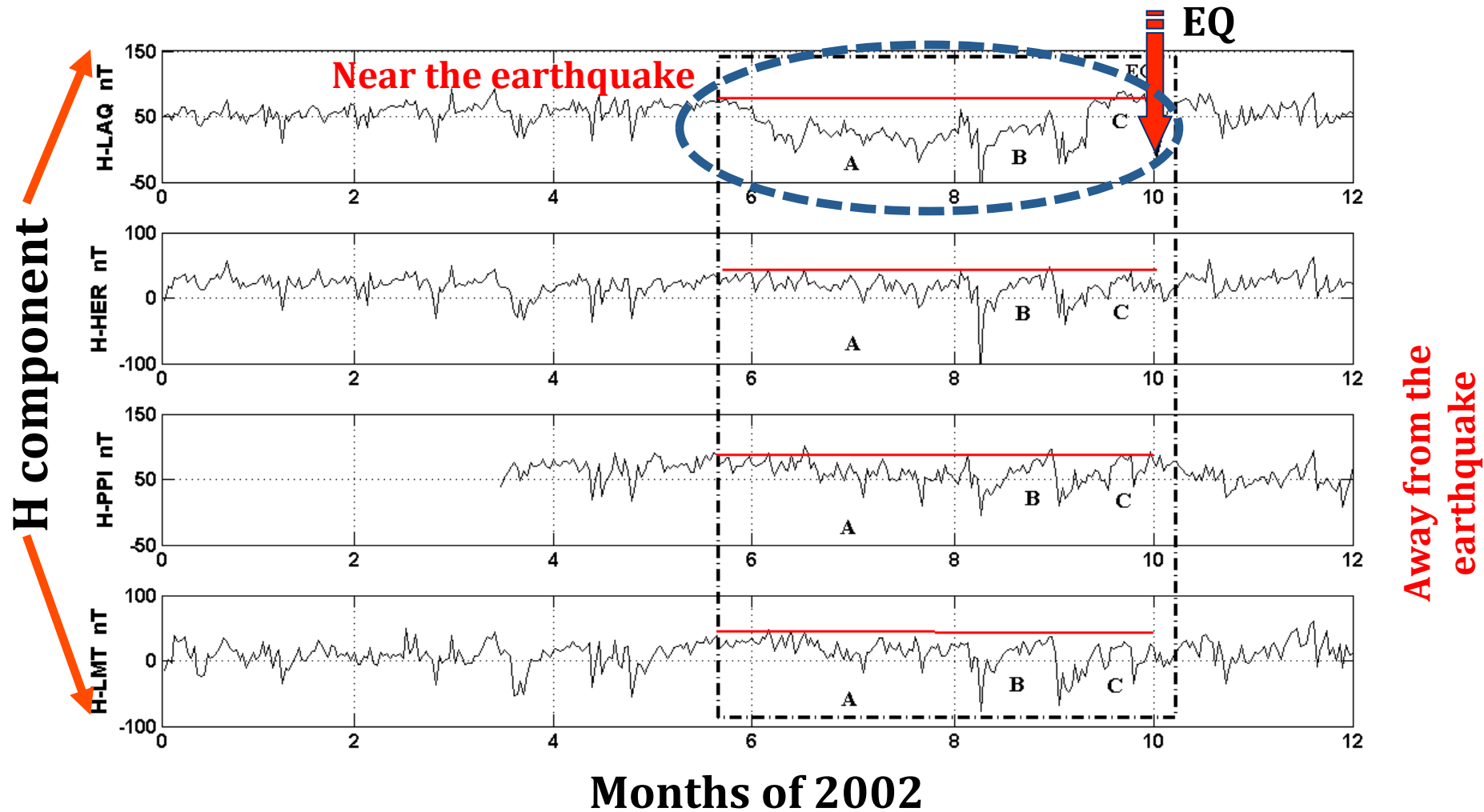


Stress

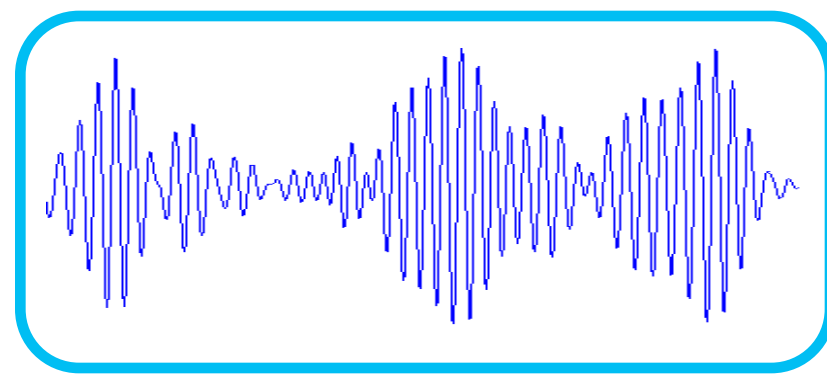
➤ Stress will produce changes in the rock magnetic properties such as the **magnetic intensity, susceptibility and conductivity.**

# 4. Examples

(A) Anomalous variation in the geomagnetic components

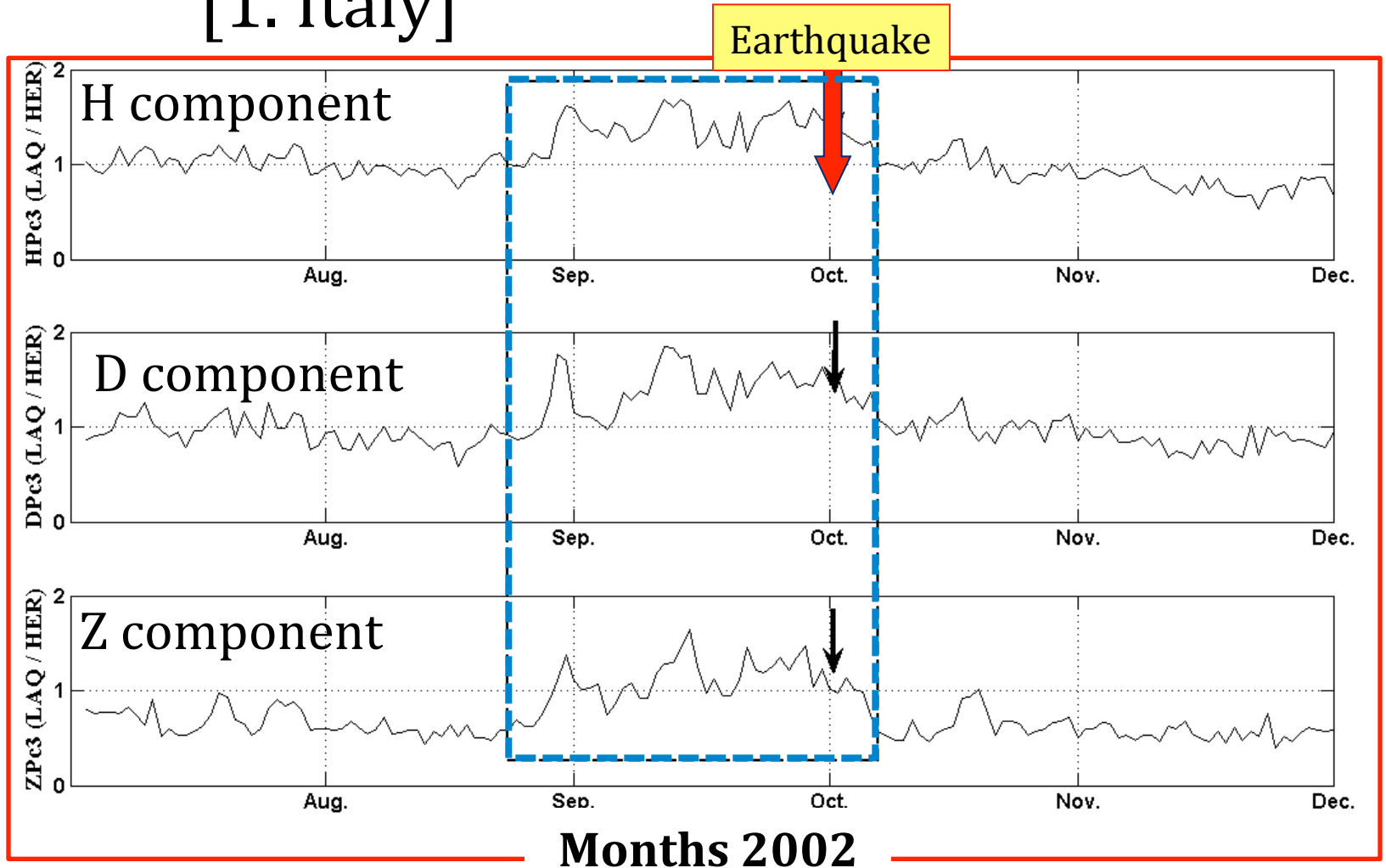


# (B) Anomalous Ultra Low Frequency emissions



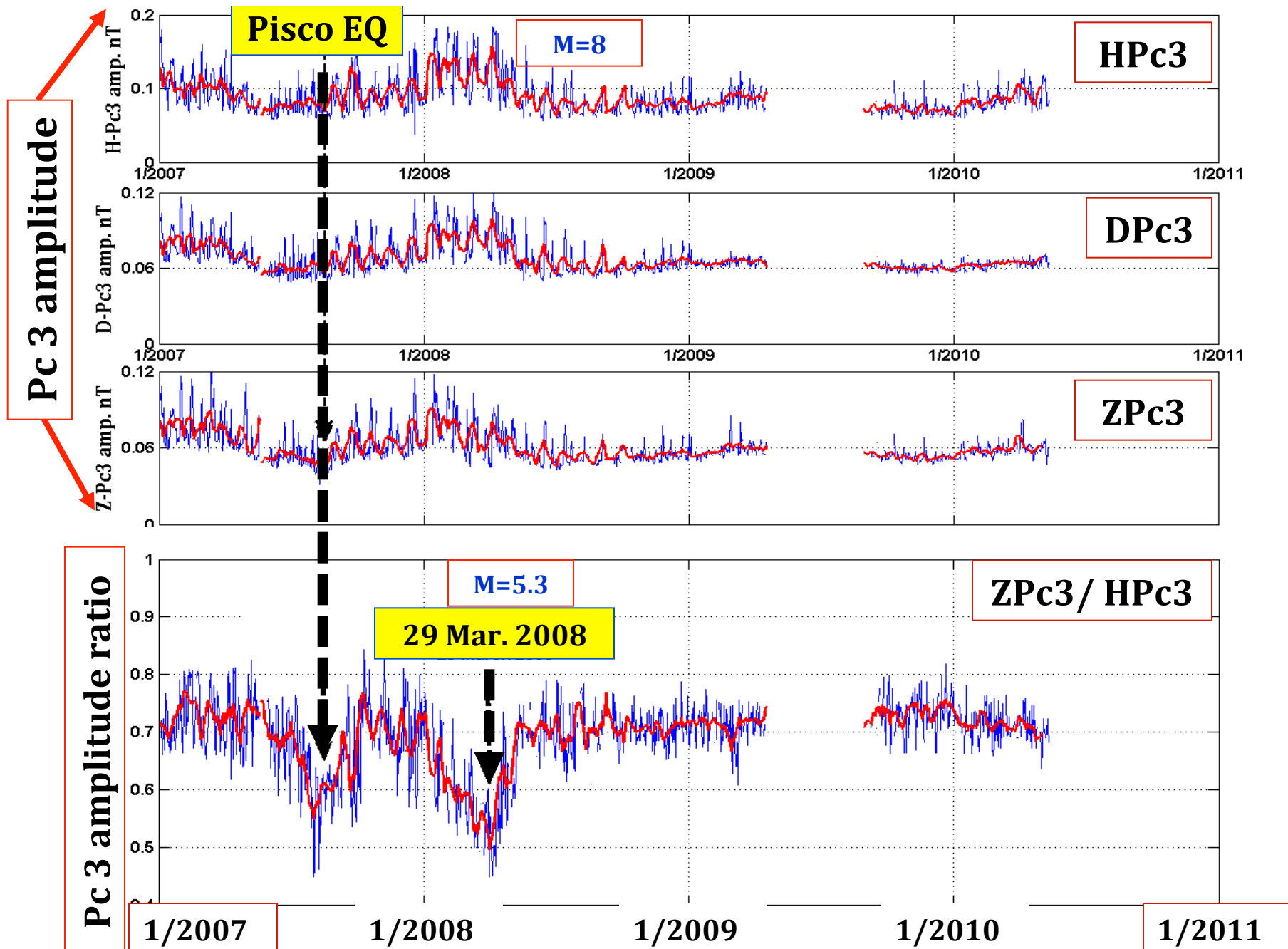
[1. Italy]

Pc3 amplitude ratio

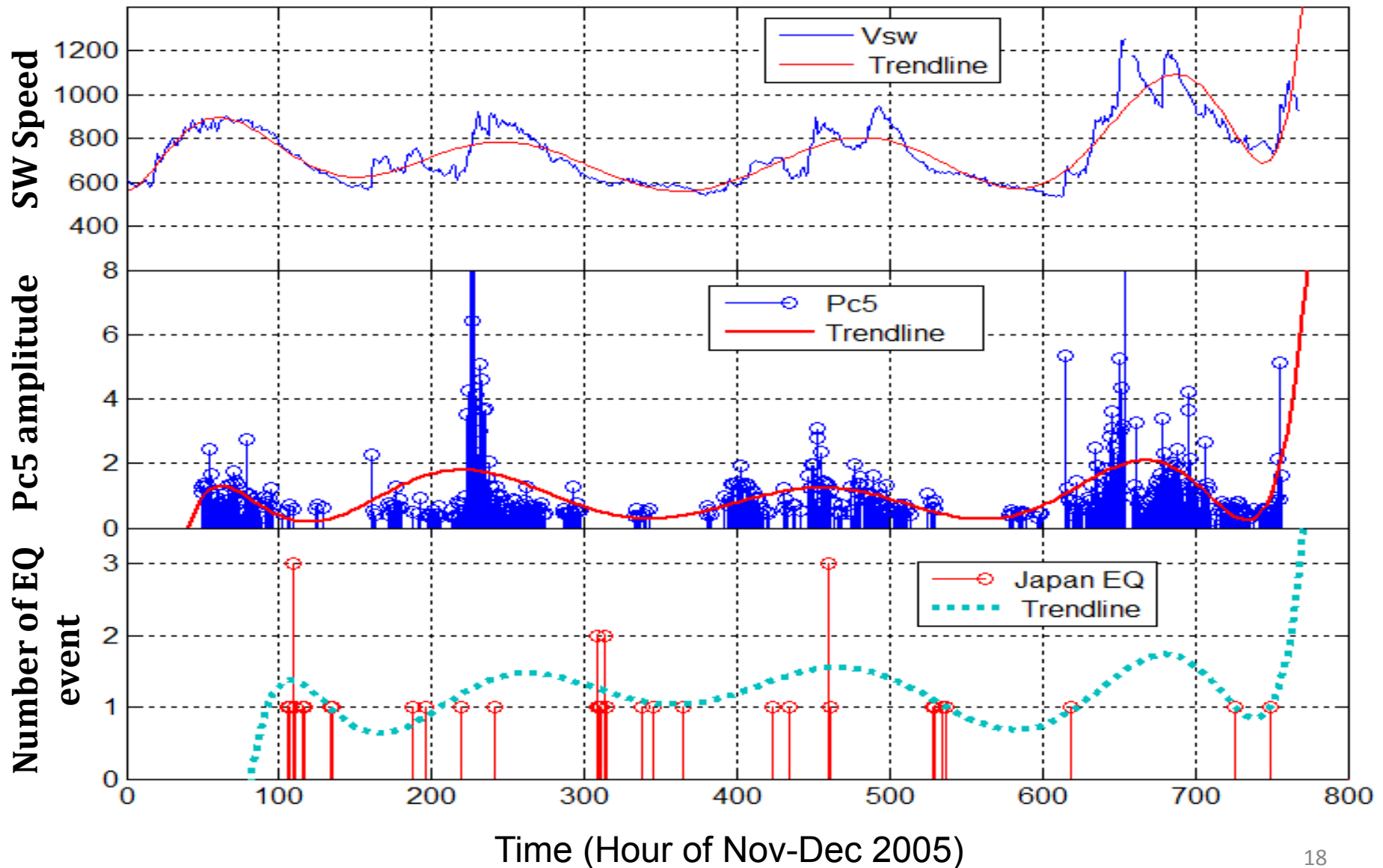




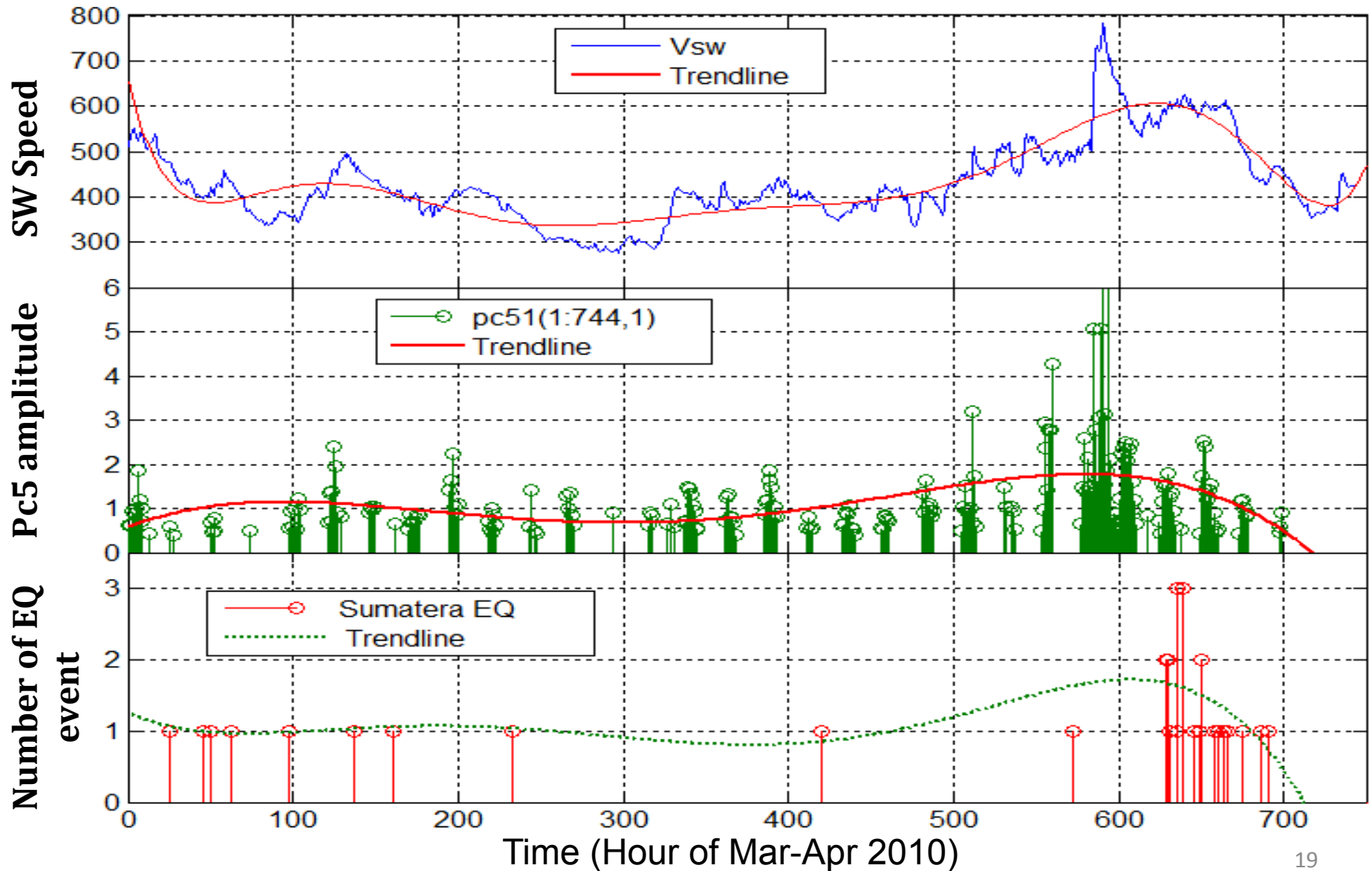
# [2. Peru]



# Possible relationship on HSSW-Earth Magnetic Activity-EQ: Japan region (Nov-Dec 2005)



# Possible relationship on HSSW-Earth Magnetic Activity-EQ: Sumatera region (March-April 2010)

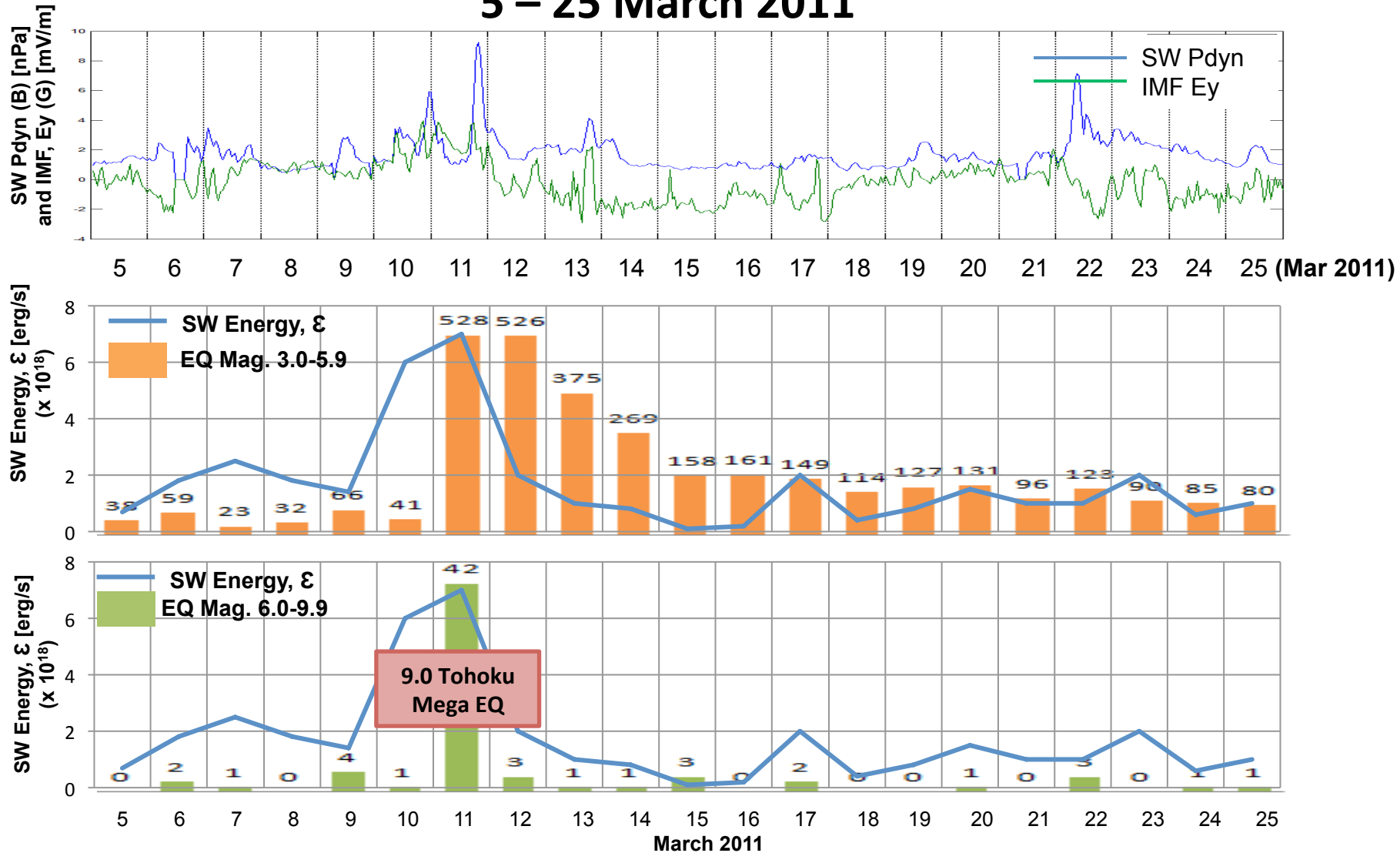


# Summary

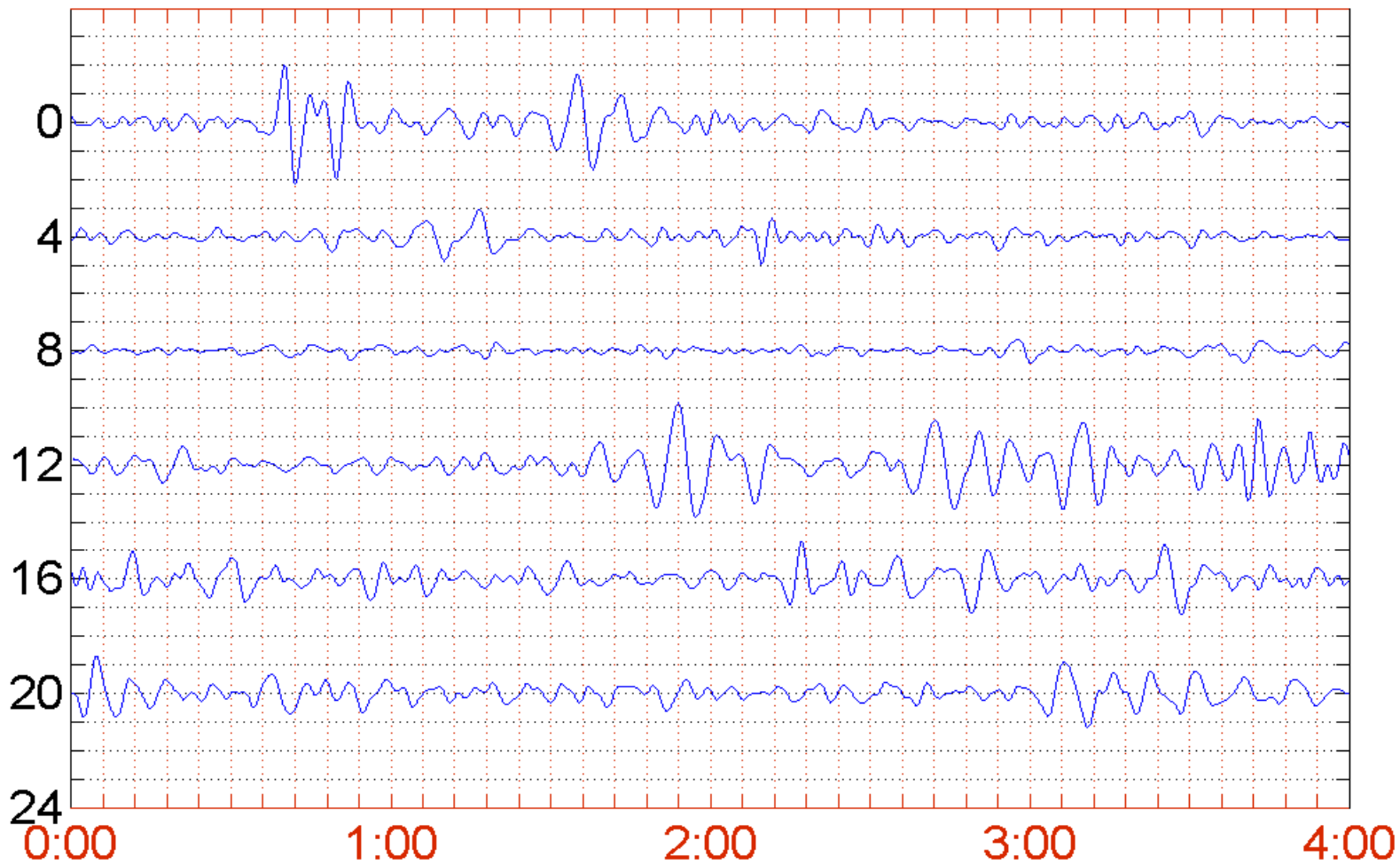
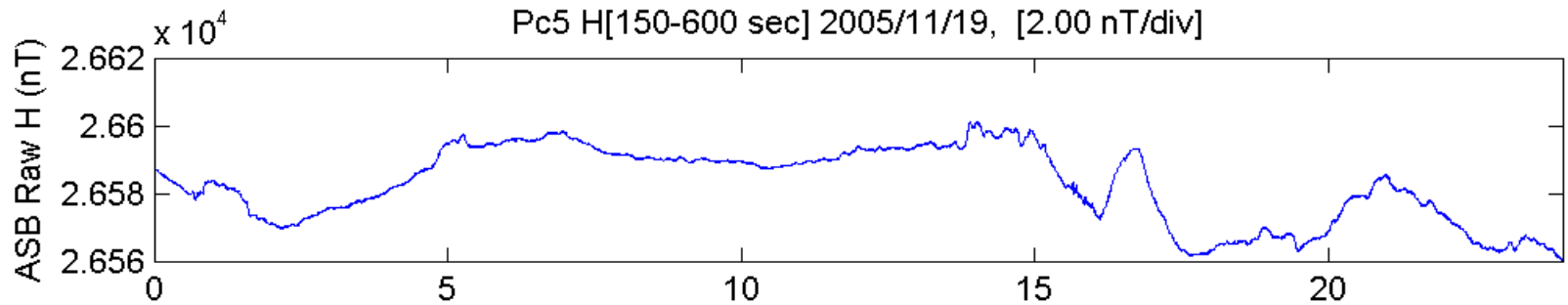
1. Observation analysis of **solar cycles** and **High Speed Solar Wind (HSSW) with EQs** shows a **possible interconnection** between them.
2. We have found that when the number of HSSW events increases, there is an increase in the occurrences of EQs of all kinds (magnitude 4.0 – 9.9) during the **minimum** and **descending** phases of solar cycle.
3. But **one HSSW event does not trigger one EQs**. Rather, the increase of solar wind speed and detected ground magnetic pulsations increase the probability of the occurrence of EQs during the entire solar cycle.
4. The analysis shows significant correlations between solar wind speed, magnetic pulsations and earthquake events, where the **increasing of solar wind speed will increase the number of observed magnetic pulsations especially on Pc5 range and simultaneously increase the number of localized earthquakes**.

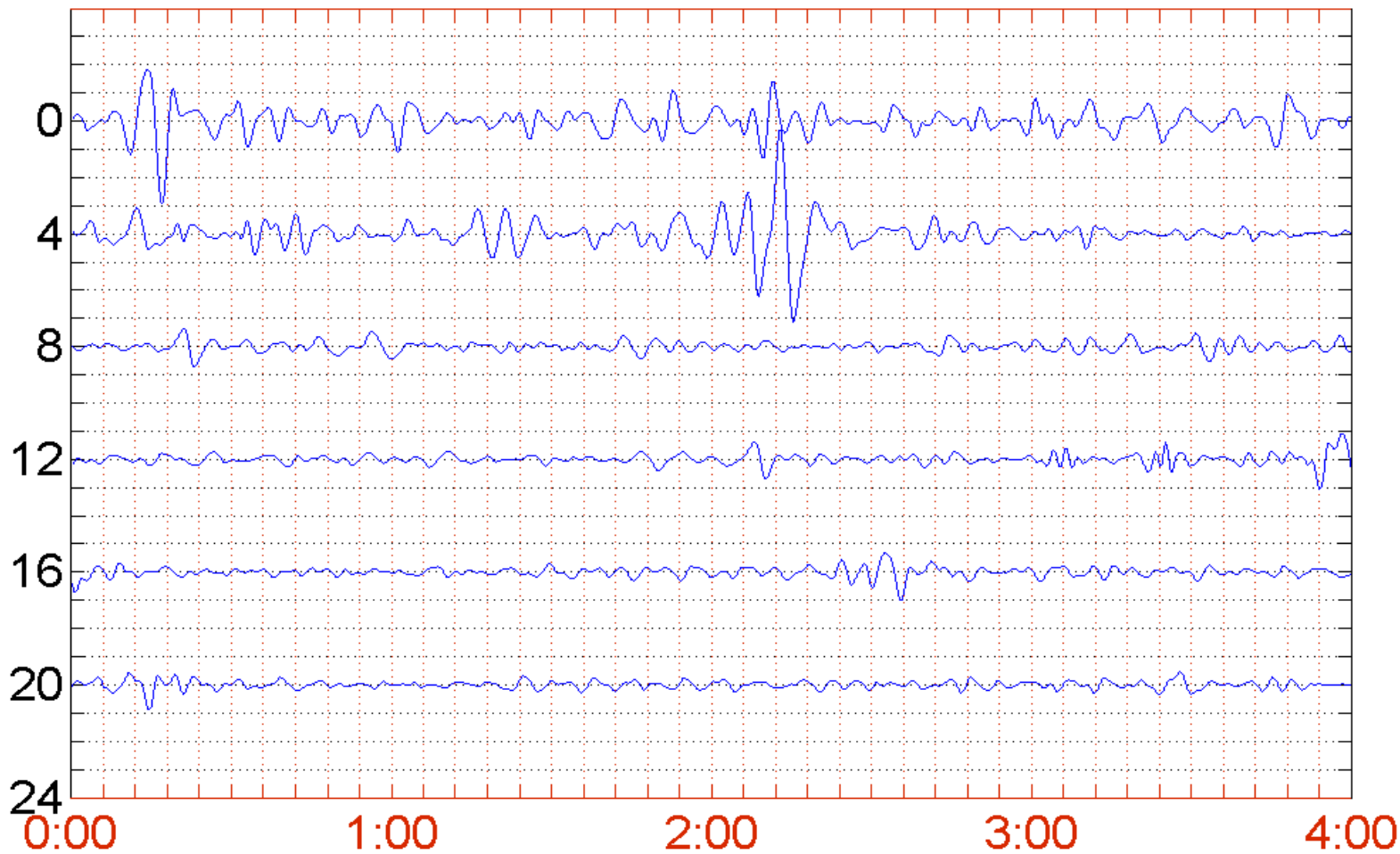
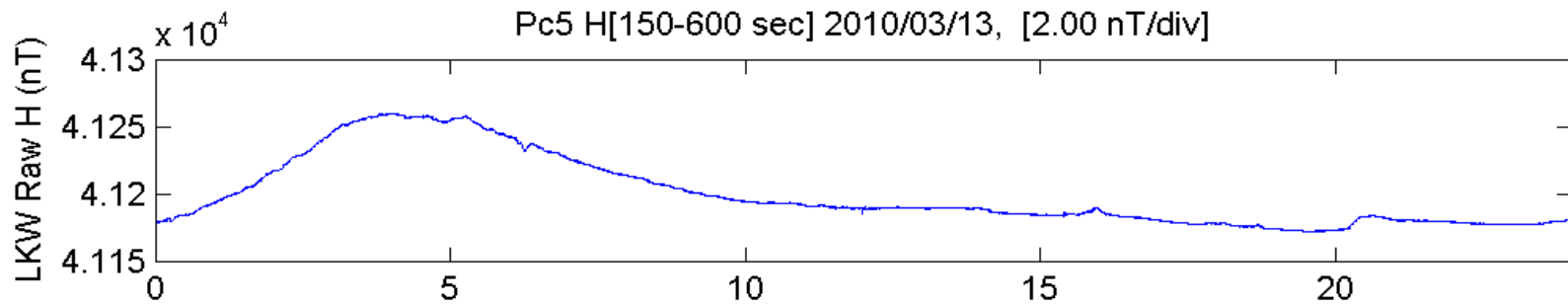
**THANK YOU**

## 2.6 Relationship of Solar Wind Energy with Earthquakes: 5 – 25 March 2011



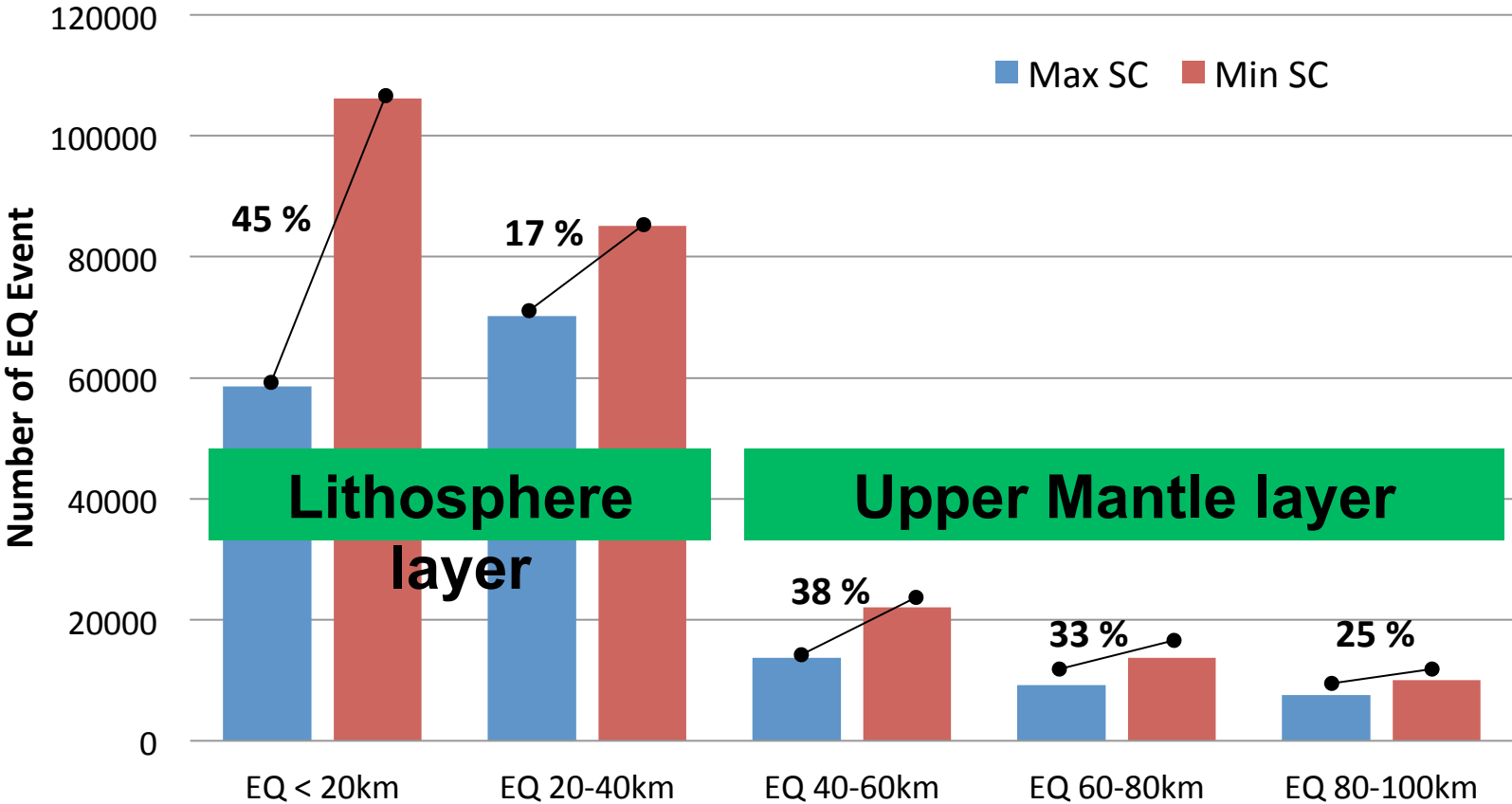
- On 11 Mar 2011, SW Pdyn increased more than 4 times, on the same day SW energy reached its maximum. SW energy starts to increase 1 day before max number of EQ.







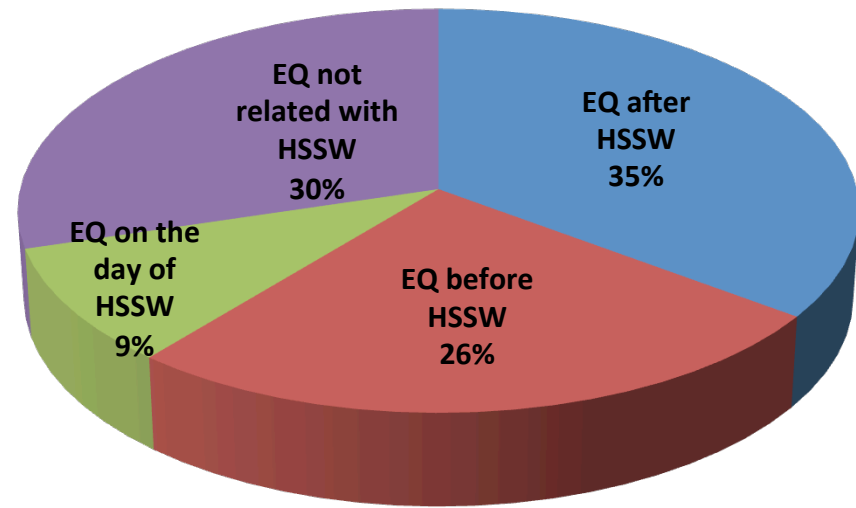
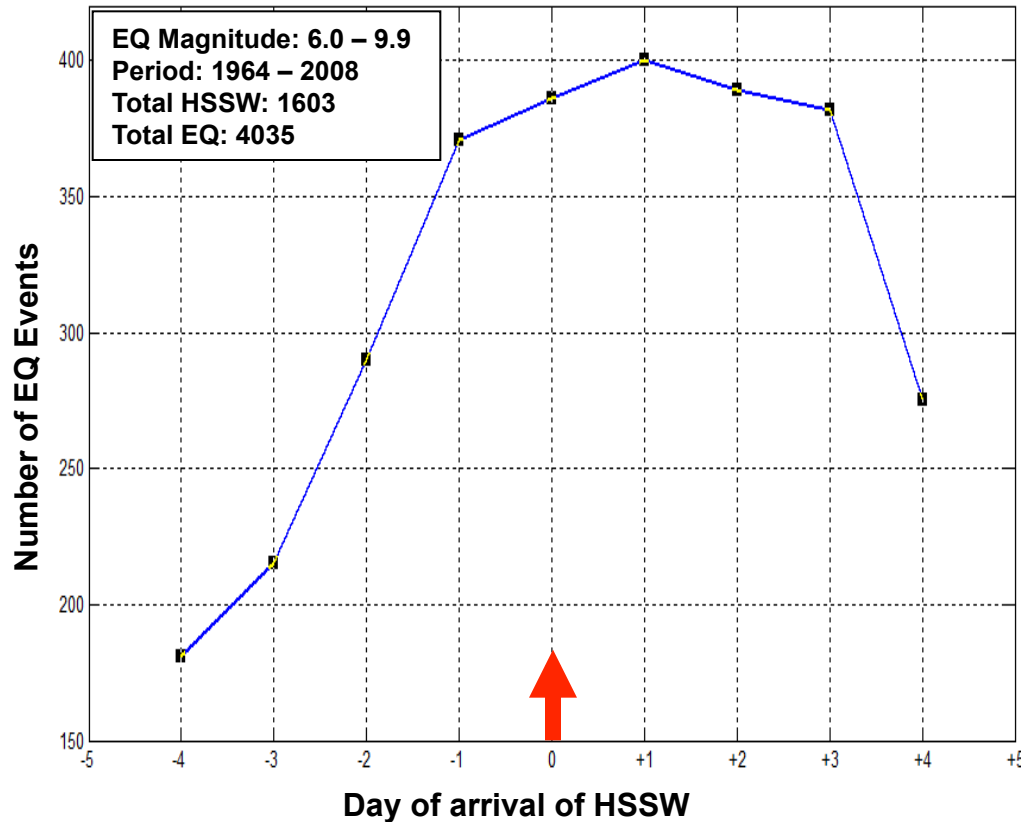
# Occurrences of EQ (Mag 4.0-9.9) at Different Depth during SC 20 to 23



- Number of EQ is higher at 0 to 40 km depth and getting lower for deeper-depth EQ (from 40 to 100km)
- The percentage of different is decreasing from shallow to deeper-depth EQ for both layers.

## 2.5 High Speed Solar Wind and Great EQs (M=6.0-9.9)

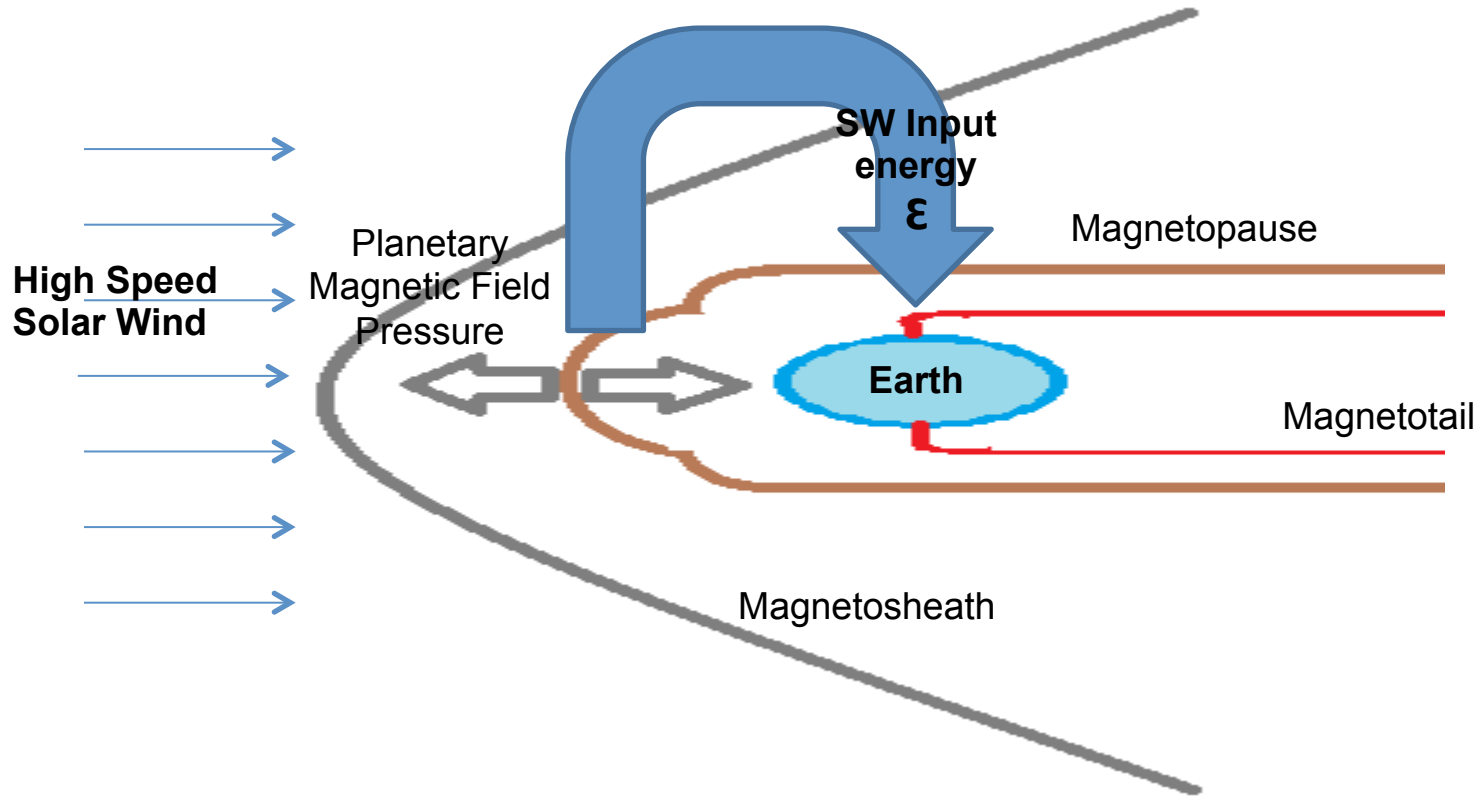
Relationship of Earthquake Onset Time (Magnitude 6.0-9.9) with High Speed Solar Wind during Solar Cycle 20-23



Occurrence of Great EQ with respect to HSSW

- 97 events or 26 % of HSSW recorded 4 days before the great EQ events.
- The number of EQ events reach maximum 1 day after the arrival of HSSW. The total amount of EQs that occurred after the HSSW is 35 %.
- In total, 70 % of EQ events observed during the period within 4 days (before and after) of the arrival of HSSW.

# Solar Wind Parameters – Earth's Coupling



Artistic rendition of Earth's magnetopause

