EGU2020-13795
EGU General Assembly 2020

Romanian Academy
Institute of Geodynamics

POSSIBLE CORRELATION BETWEEN THE PRE-SEISMIC GEOMAGNETIC SIGNAL AND THE M6.4 EARTHQUAKE GENERATED IN THE COASTAL ZONE OF ALBANIA, ON NOVEMBER 26, 2019

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OUTLINE

EARTHQUAKE LOCATION AND SEISMICITY

- Map with the placements of the M6.4 earthquake on November 26, 2019, and geomagnetic observatories Panagjurishte (PAG) - Bulgaria and Surlari (SUA) - Romania;
- Seismicity map with felt reports related to the M6.4 earthquake;
- Geotectonic cross-section emphasizing the Mw6.4 earthquake location on the Adria plate subduction zone.

BASIC THEORETICAL CONCEPTS

- Polarization parameter (BPOL);
- Long range effect of strain-related to the pre-seismic geomagnetic signals.

DATA COLLECTION, PROCESSING AND ANALYSIS

- Geomagnetic data have been collected on the interval October 15 – November 30, 2019, from the Panagjurishte(PAG)-Bulgaria and Surlari (SUA)-Romania observatories, via internet (www.intermagnet.org);
- FFT band-pass filter analysis in the frequency range (0.001 Hz to 0.0083 Hz) was used to obtain the BPOL time series at the both geomagnetic observatories (PAG and SUA);
- Statistical analysis based on the standardized random variable equation was used to emphasize the pre-seismic anomalous intervals reflected by BPOL* (PAG) and BPOL*(PAG-SUA) time series.

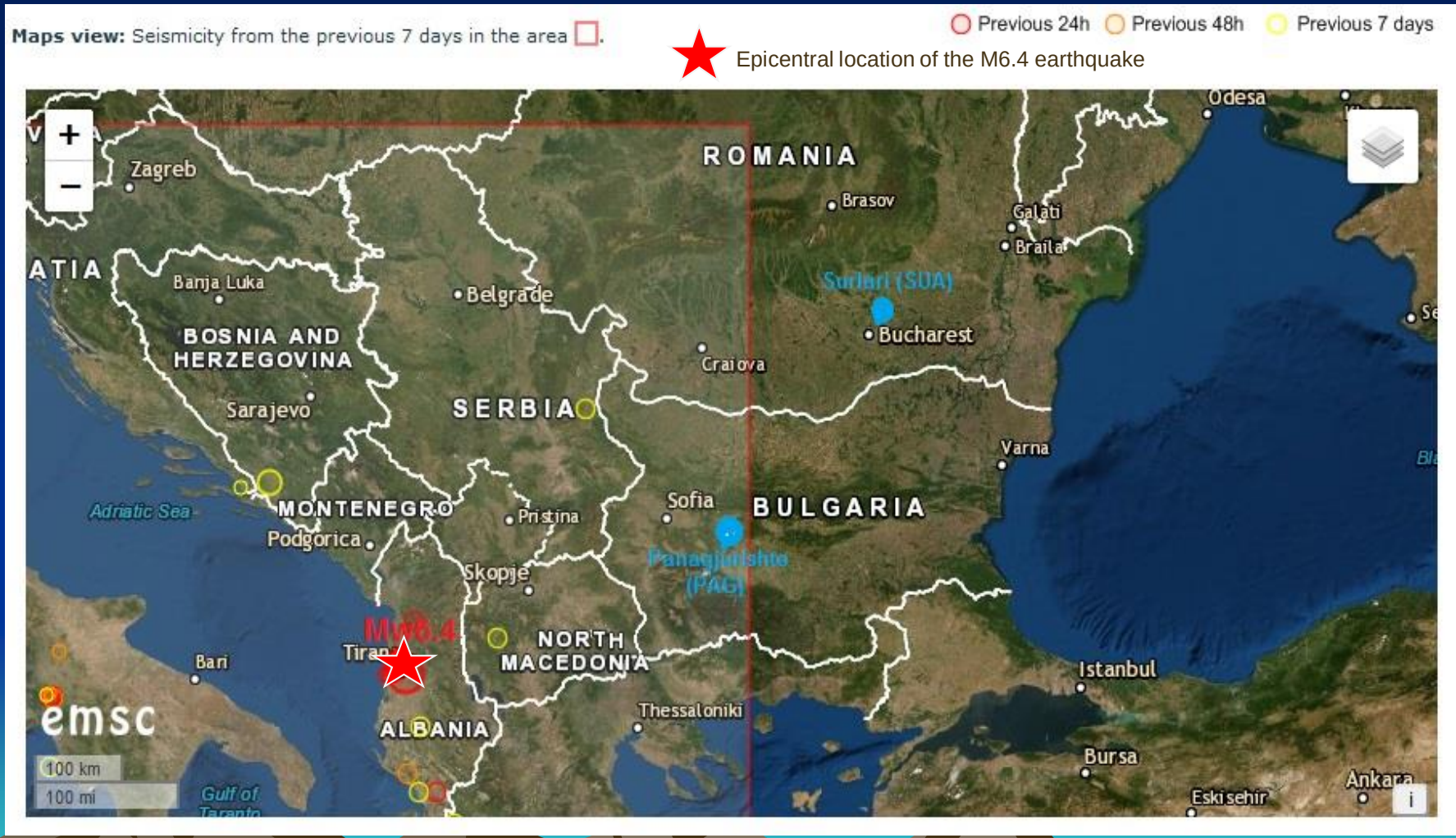
RESULTS

- Daily mean distributions of the BPOL and SD obtained on the interval 01- 30 November, 2019, for the PAG observatory;
- Pre-seismic anomalous intervals related to the M6.4 earthquake are emphasized by the following time series: BPOL* (PAG), ABS BPOL* (PAG) and BPOL*(PAG-SUA).

CONCLUSIONS

EARTHQUAKE LOCATION AND SEISMICITY

- Map with the placements of the M6.4 earthquake on November 26, 2019, at 2:54:11 UTC, and geomagnetic observatories: Panagjurishte (PAG) - Bulgaria and Surlari (SUA) - Romania



EARTHQUAKE LOCATION AND SEISMICITY

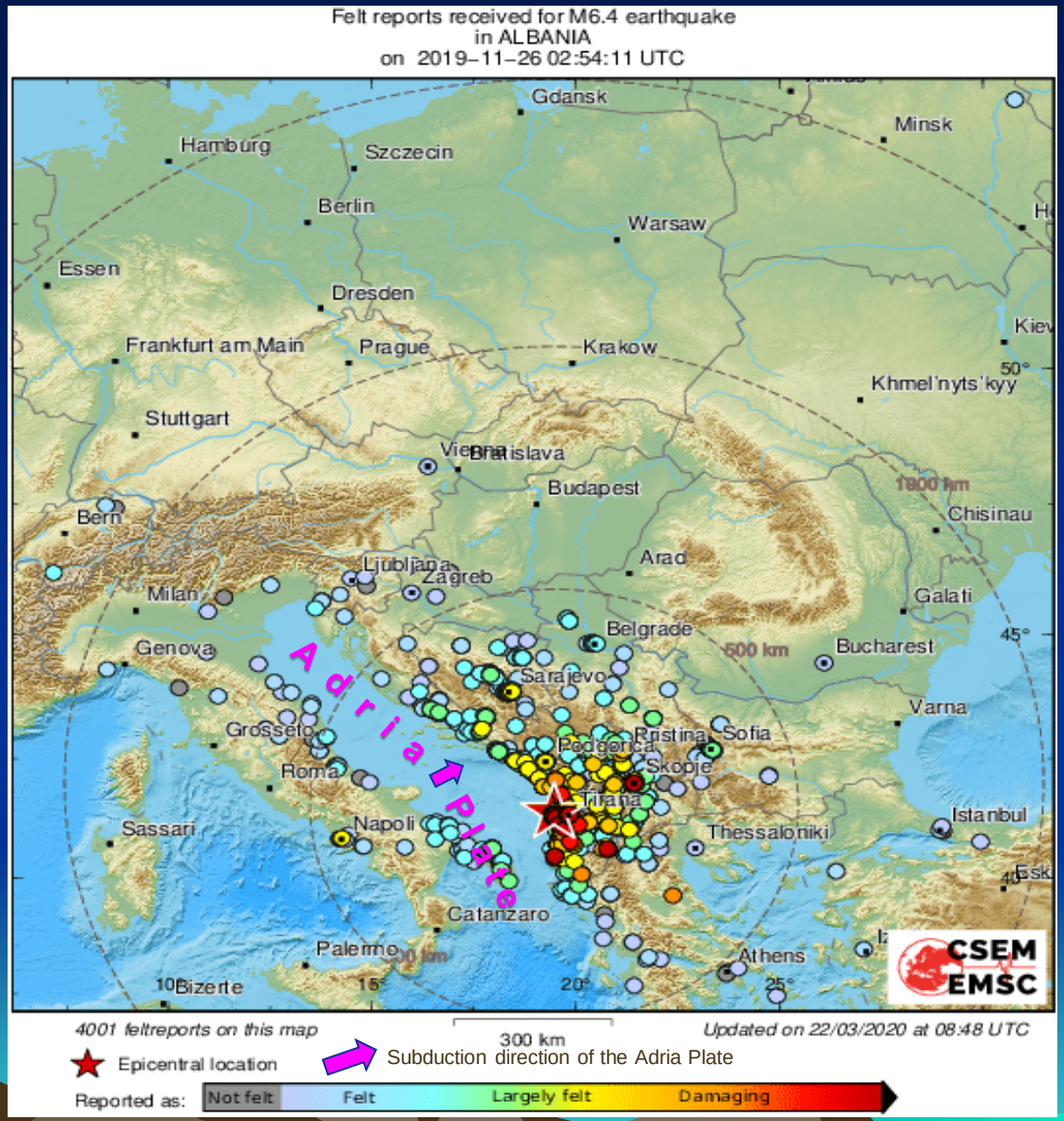
An earthquake with Mw6.4 which was generated at about 10km depth, struck the central western part of Albania on November 26, 2019 (02:54:11 UTC). Earthquake epicenter was located in the Adriatic Sea, near the costal zone of Albania, at about 30 km distance from the capital city Tirana.

The main shock was felt in Montenegro, Italy and Greece (Corfu Island) and it has been followed by more than hundred aftershocks, from which 22 with magnitude larger than M4.0 and 4 with M ≥ 5.0.

Unfortunately, due to this earthquake 51 peoples died and more than 900 families have been evacuated. The most affected area was in the central-western part of Albania (Durres city and the town of Thumane).

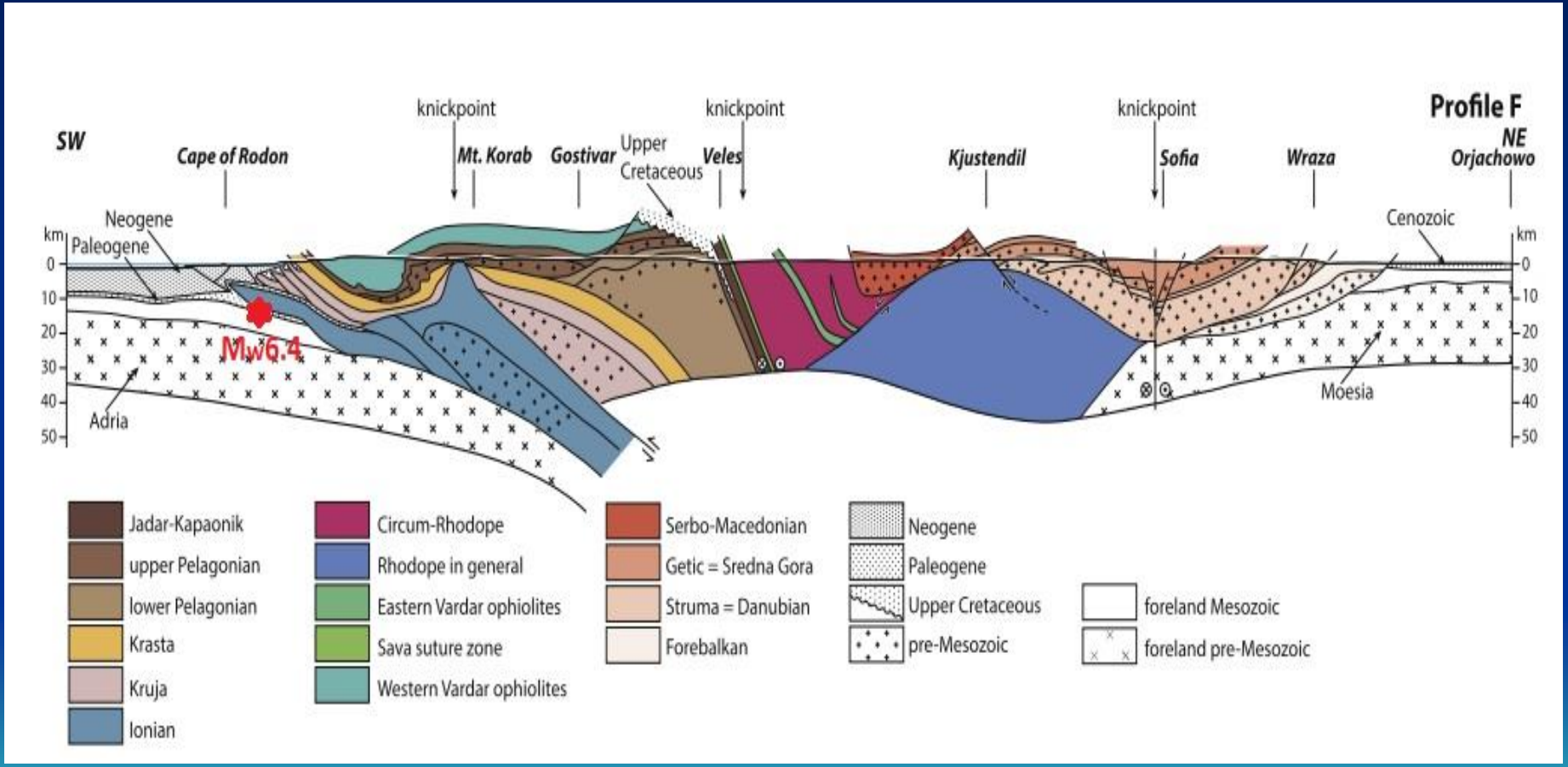
More information in: The November 26, Mw6.4 Durres earthquake, “Newsletter of Environmental, Disaster and Crises Management Strategies, ISSN 2653-9454, Issue No.15, November 2019”

Seismicity map with << Felt reports related to the ALBANIA M6.4 earthquake>>
Modified after EMSC



Geotectonic cross-section emphasizing the Mw6.4 earthquake location on the Adria plate subduction zone

(Profile F in: Schmidt, S.M., et al., Adria and Africa derived tectonic units, Gondwana Research 78, 2000, 308-374, www.elsevier.com/locate/gr)



BASIC THEORETICAL CONCEPTS

In order to identify pre-seismic geomagnetic anomalous signals in this paper we used following relations:

- Polarization parameter (BPOL):

For a given 2D geoelectric structure the vertical magnetic component (Bz) is a totally secondary field being produced essentially by the horizontal magnetic component $H = SQRT(Bx^2 + By^2)$ and, consequently, the Polarization parameter expressed as :

$$BPOL(f) = Bz(f) / SQRT[Bx^2(f)+By^2(f)] , \quad (1)$$

is time invariant in non seismic conditions and it becomes unstable before the onset of the seismic event (Stanica et al., 2015, Stanica and Stanica, 2019 a, Stanica and Stanica, 2019 b);

- Long range effect of the strain-related to the pre-seismic geomagnetic signals (Morgunov and Malzev, 2007):

$$R(km) = 10^{0.5M-0.27} , \quad (2)$$

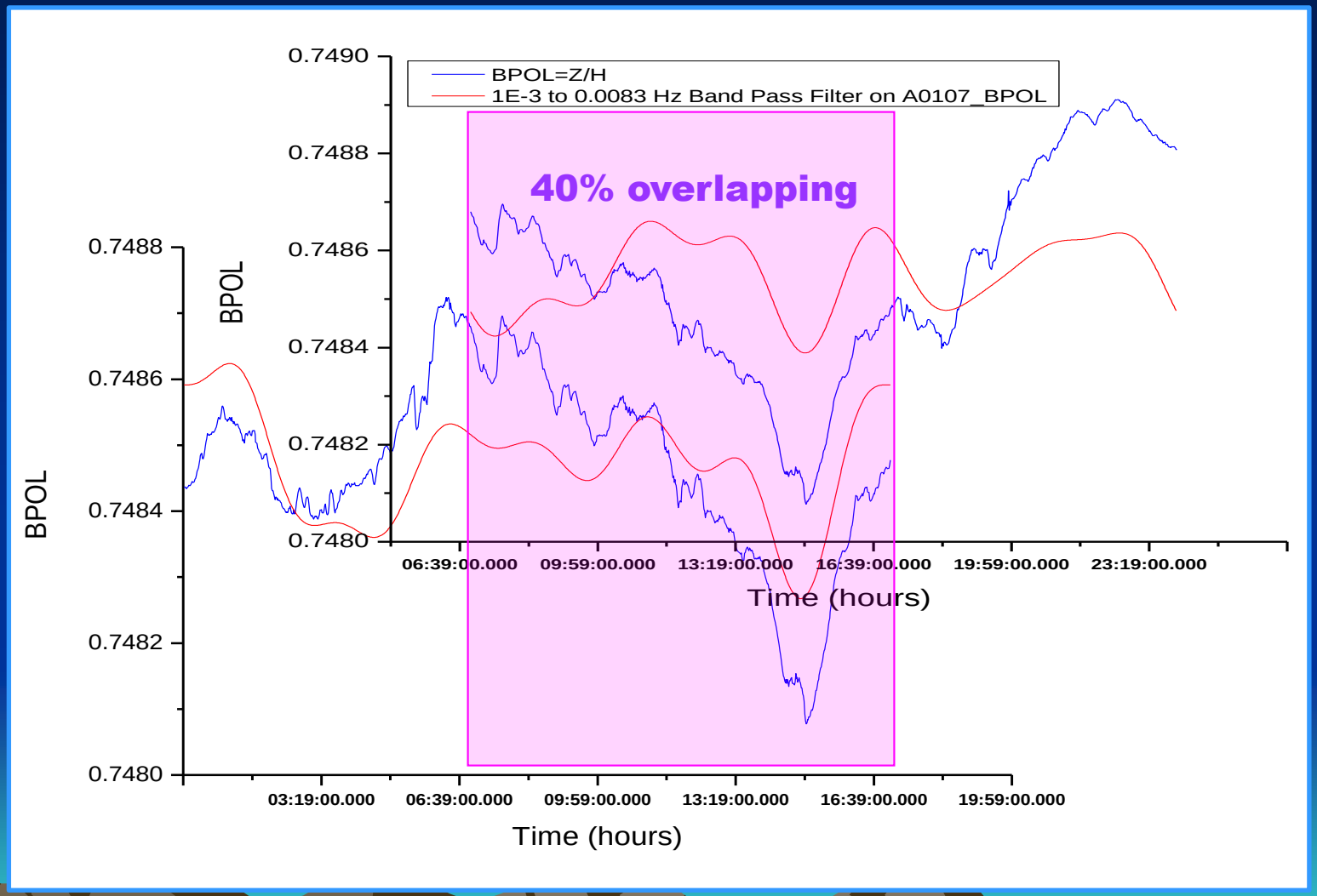
where: M is earthquake magnitude

Thus, according to the relation (2) the range effect of the strain-related to the M6.4 earthquake is R ≈ 800 km

As the both epicentral distances are less than 800 km: ≈ 450km for PAG and respectively, ≈ 750Km for SUA, there are conditions to identify a pre-seismic geomagnetic anomalous signals, taken SUA observatory as reference.

DATA COLLECTION, PROCESSING AND ANALYSIS

- A FFT band-pass filtering analysis, in the frequency range 0.001 Hz to 0.0083 Hz, has been performed for two successive time windows of 1024 samples, with 40% overlapping, on the entirely BPOL time series of 1440 data points acquired each day in the both observatories (PAG and SUA)



DATA PROCESSING AND ANALYSIS

The new geomagnetic FFT_BPF time series, have been used to calculate the daily averaged values of the BPOL and its standard deviation (SD) at the observatory PAG.

In order to investigate the singularity of the pre-seismic anomalous interval related to the M6.4 earthquake, a statistical analysis based on the standardized random variable Equation (3) was performed:

$$BPOL^* = (X - Y)/W, \qquad (3)$$

where:

X is 1day running average of BPOL (PAG) for a particular day;
Y is 15 days running average of BPOL (PAG) before a particular day;
W is 15 days running average of SD (PAG) before a particular day
BPOL* is threshold for anomaly using SD

RESULTS

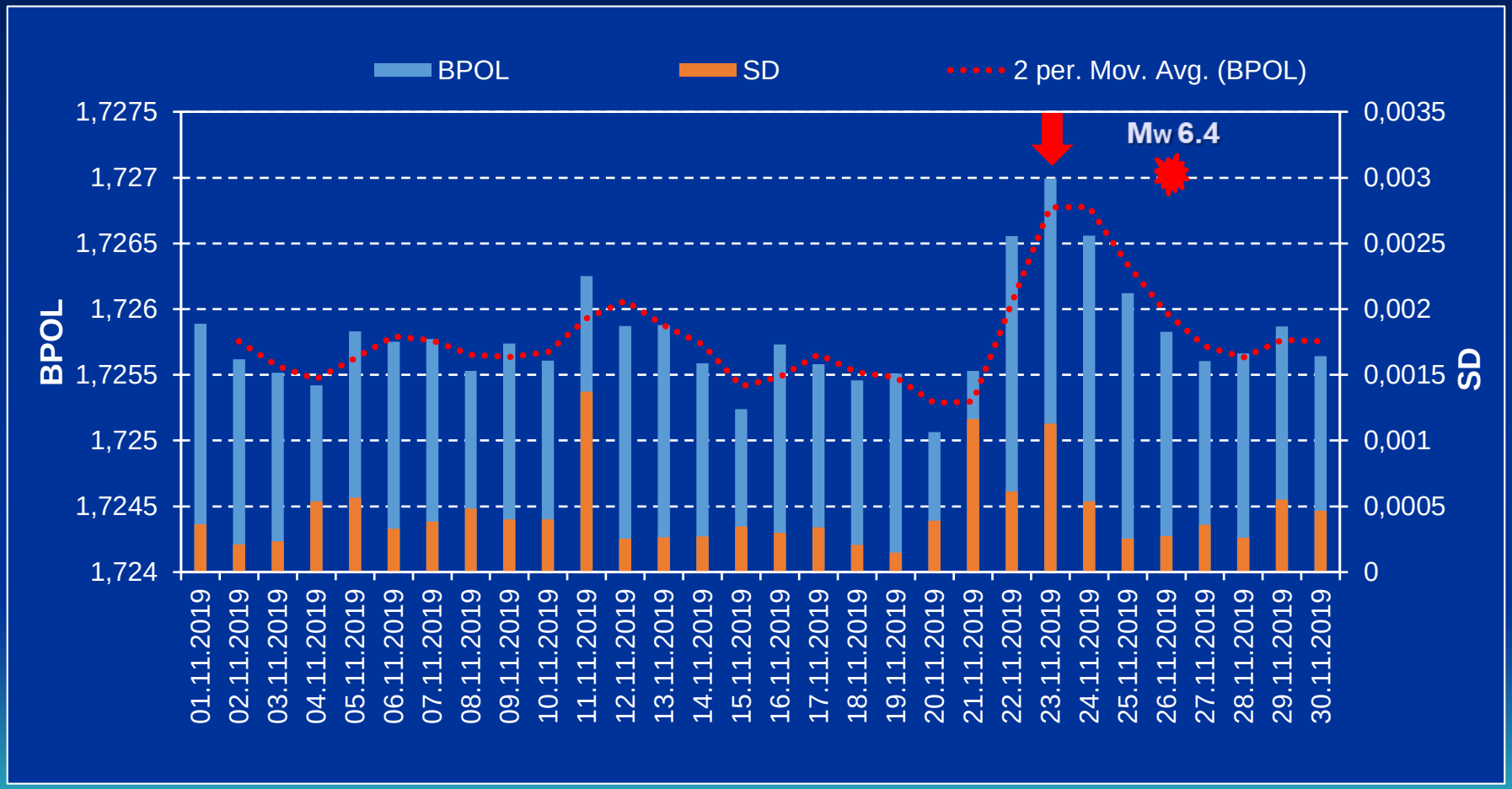
In this paper, the pre-seismic geomagnetic anomalous signal is postulated to be due to the electrical conductivity changes, the most probably associated with the earthquake - induced tectonic stress, followed by rupture and electrochemical processes deployed along the Adriatic Plate subduction zone.

Thus, to emphasize a pre-seismic geomagnetic signal related to Mw 6.4 earthquake the following results are presented further on:

1. Daily mean distributions of the **BPOL (PAG)** and **SD** obtained on the interval 01–30 November, 2019;
2. **BPOL* (PAG) and ABS BPOL*(PAG)** time series carried out on the interval 01 – 30 November, 2019; (**ABS** = **absolute value**)
3. **BPOL*(PAG – SUA)** time series on the interval 01 – 30 November, 2019, **SUA** observatory taken as reference and the Equation 3 has been be modified accordingly (Stanica and Stanica, ENTROPY, 2019, 21, 29;DOI:10.3390/E 21010029)

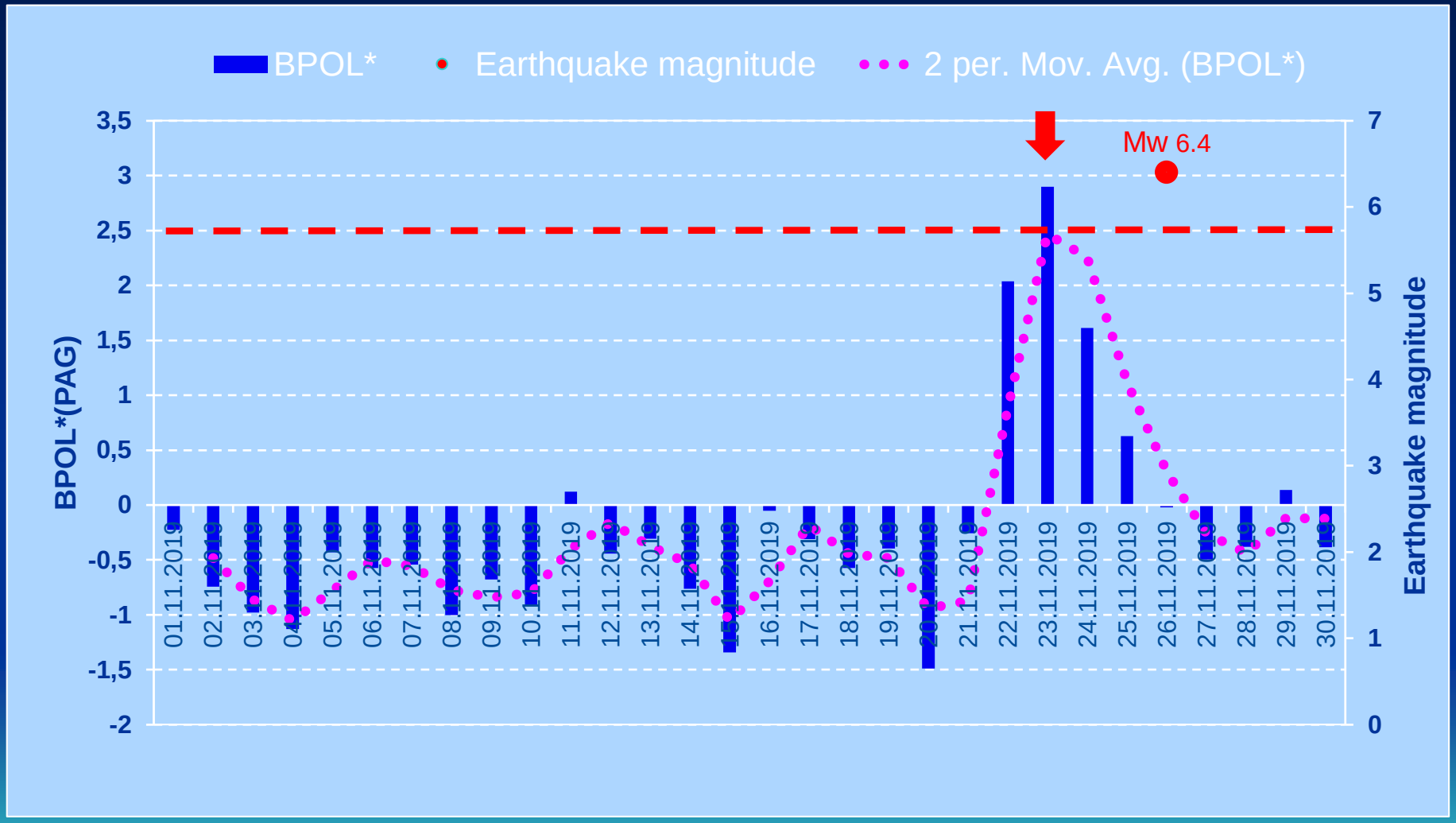
1. Daily mean distributions of the BPOL and SD obtained for the PAG observatory on the interval 01– 30 November, 2019 (see relation 1)

- Vertical **red arrow** emphasizes on 23 November, 2019 a pre-seismic anomalous signal, with 3 days before the onset of the Mw6.4 earthquake.



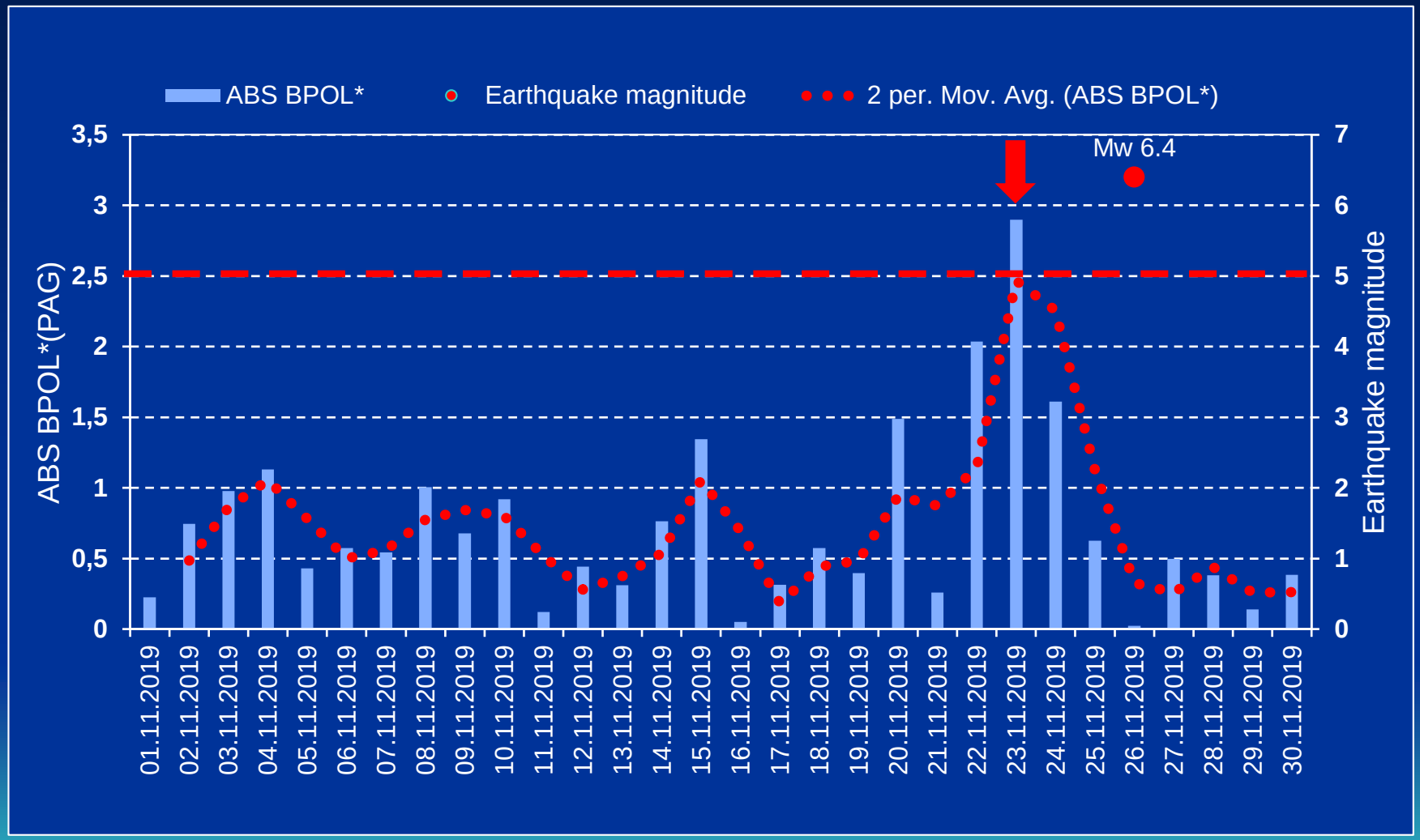
2. BPOL*(PAG) time series carried out on the interval 01–30 November, 2019

-Vertical red arrow emphasizes on 23 November, 2019 a pre-seismic anomalous signal, with 3 days before the onset of the Mw6.4 earthquake.



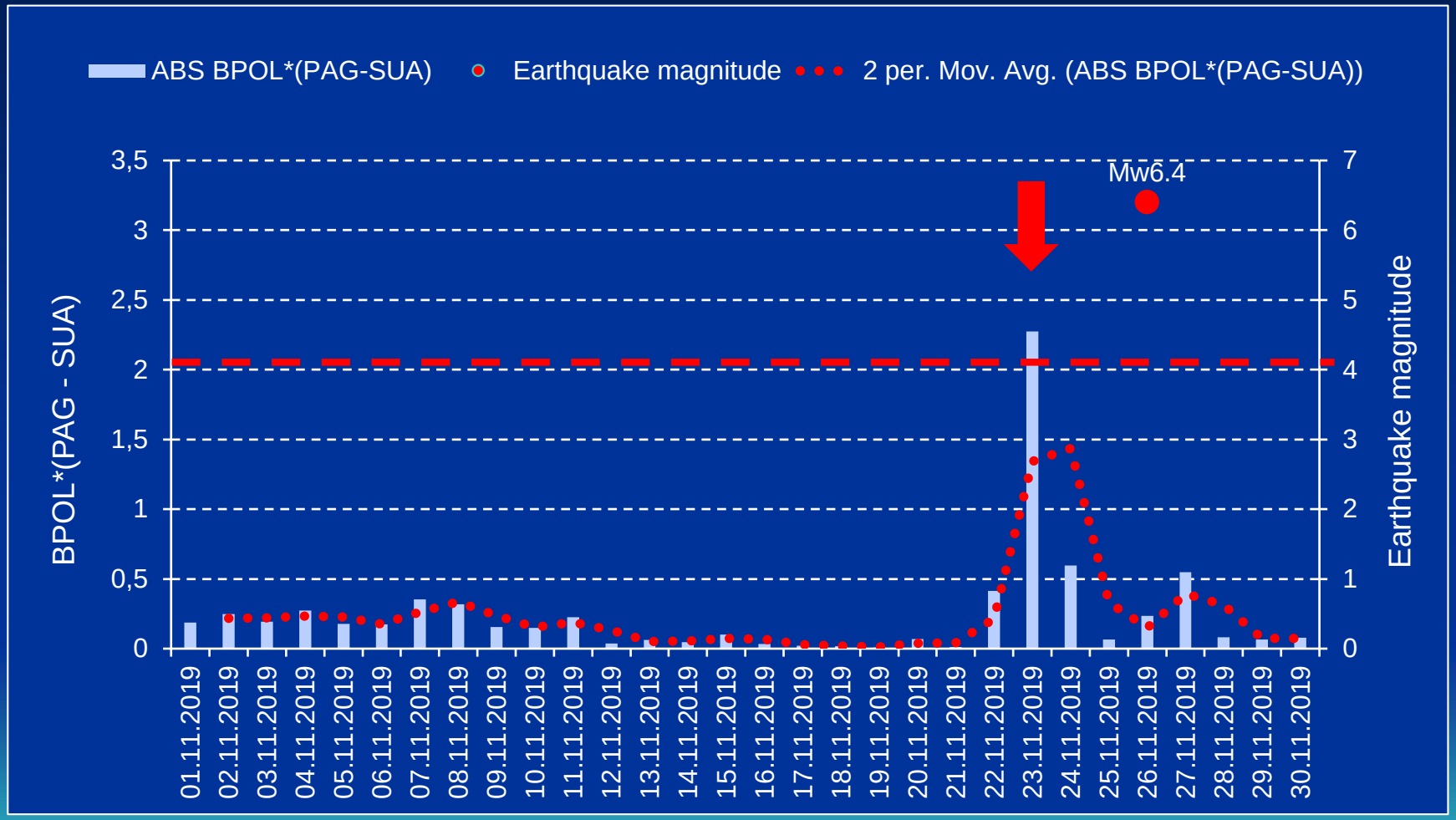
3. ABS BPOL*(PAG) time series carried out on the interval 01–30 November, 2019

- Vertical red arrow emphasizes on 23 November, 2019 a pre-seismic anomalous signal, with 3 days before the onset of the Mw6.4 earthquake (ABS = Absolute value)



4. **BPOL*(PAG–SUA)** time series obtained on the interval 01 – 30 November, 2019

Vertical red arrow emphasizes on 23 November, 2019 a pre-seismic anomalous signal, with 3 days before the onset of the Mw6.4 earthquake



CONCLUSIONS

In order to identify the pre-seismic anomalous signals associated with the Mw 6.4 earthquake, in this paper we investigated the ULF geomagnetic data collected via internet (www.intermagnet.com), on the interval October 15 - November 30, 2019, from the two observatories Panagjurishte (PAG) - Bulgaria and Surlari (SUA) - Romania, the last one taken as reference with the aim to separate the seismic signals from the non-seismic external geomagnetic variations.

It is to mention that on the all time series of BPOL (PAG), BPOL*(PAG), ABS BPOL*(PAG) an anomalous interval having an apex on 23 November may be observed, with 3 days before the onset of the Mw 6.4 earthquakes.

The last time series related to BPOL*(PAG-SUA) demonstrates that the proposed methodology, based on two monitoring site, provided adequate information to identify, with high accuracy, a pre-seismic peak level higher than 2xSTDEV, on November 23, 2019.

REFERENCES

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