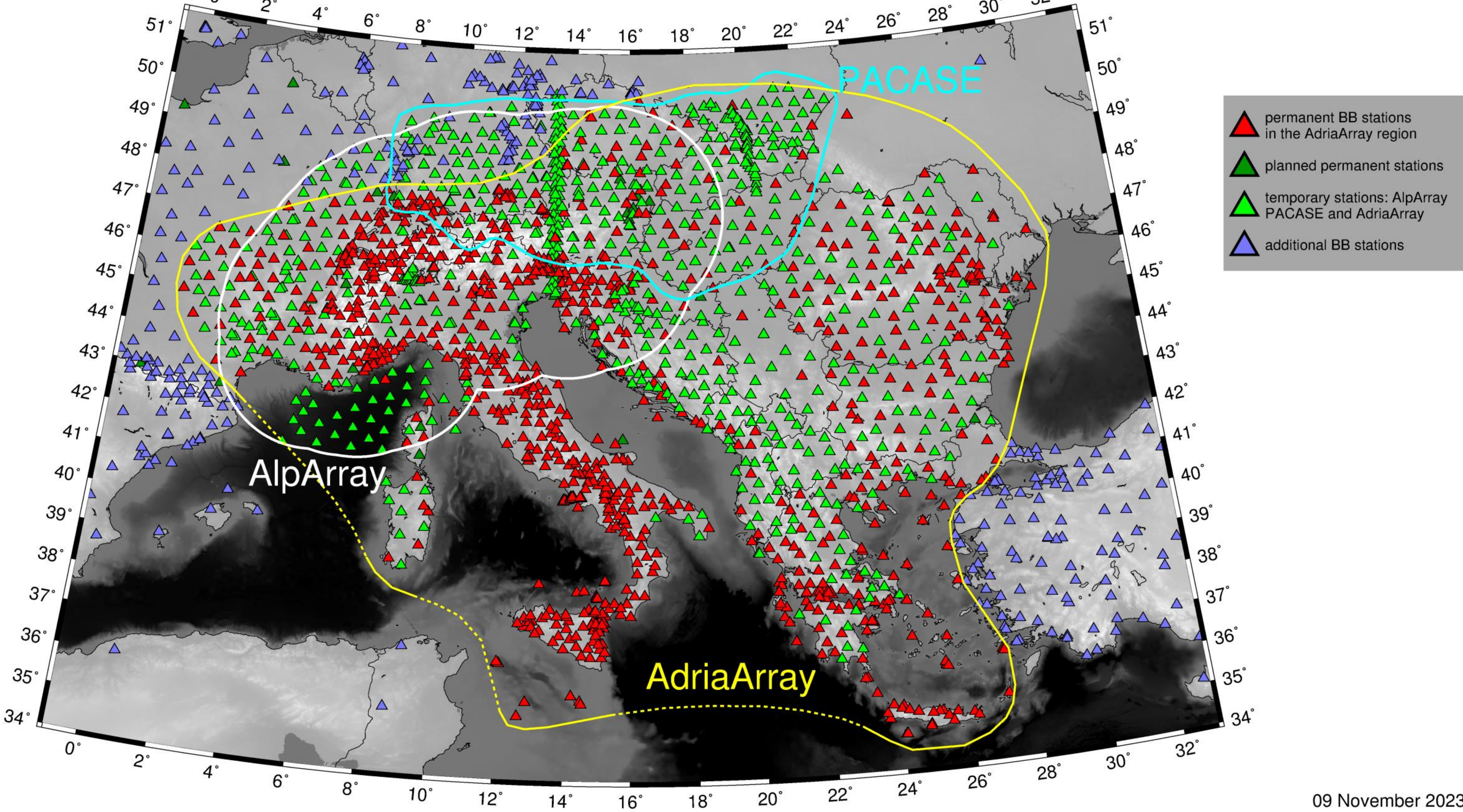
First preliminary result from new AdriaArray data in Vrancea

Renata Lukešová

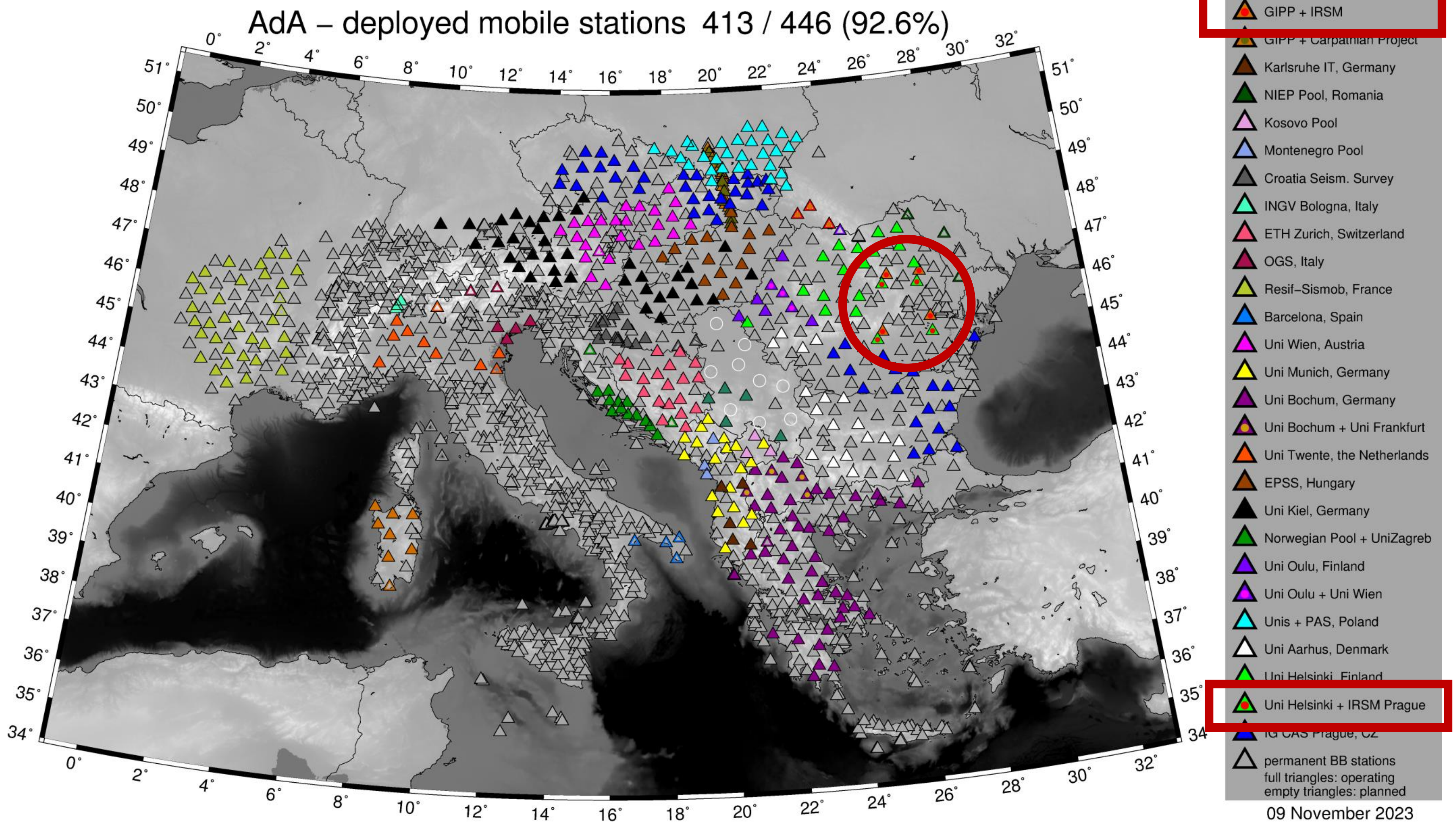
Vrancea zone

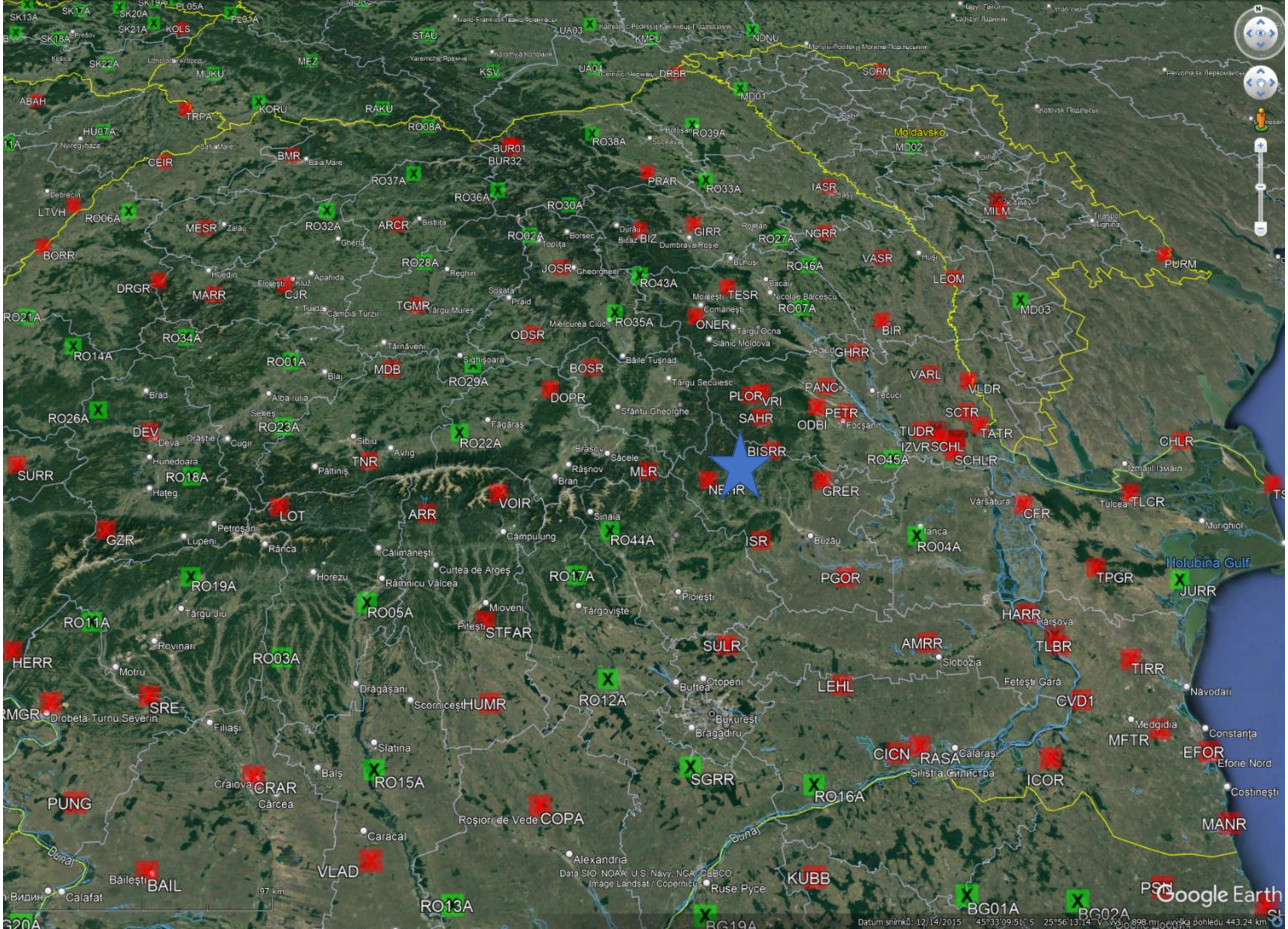
AlpArray + PACASE + AdriaArray



09 November 2023

AdriaArray - Local experiments: Denser network in Romania

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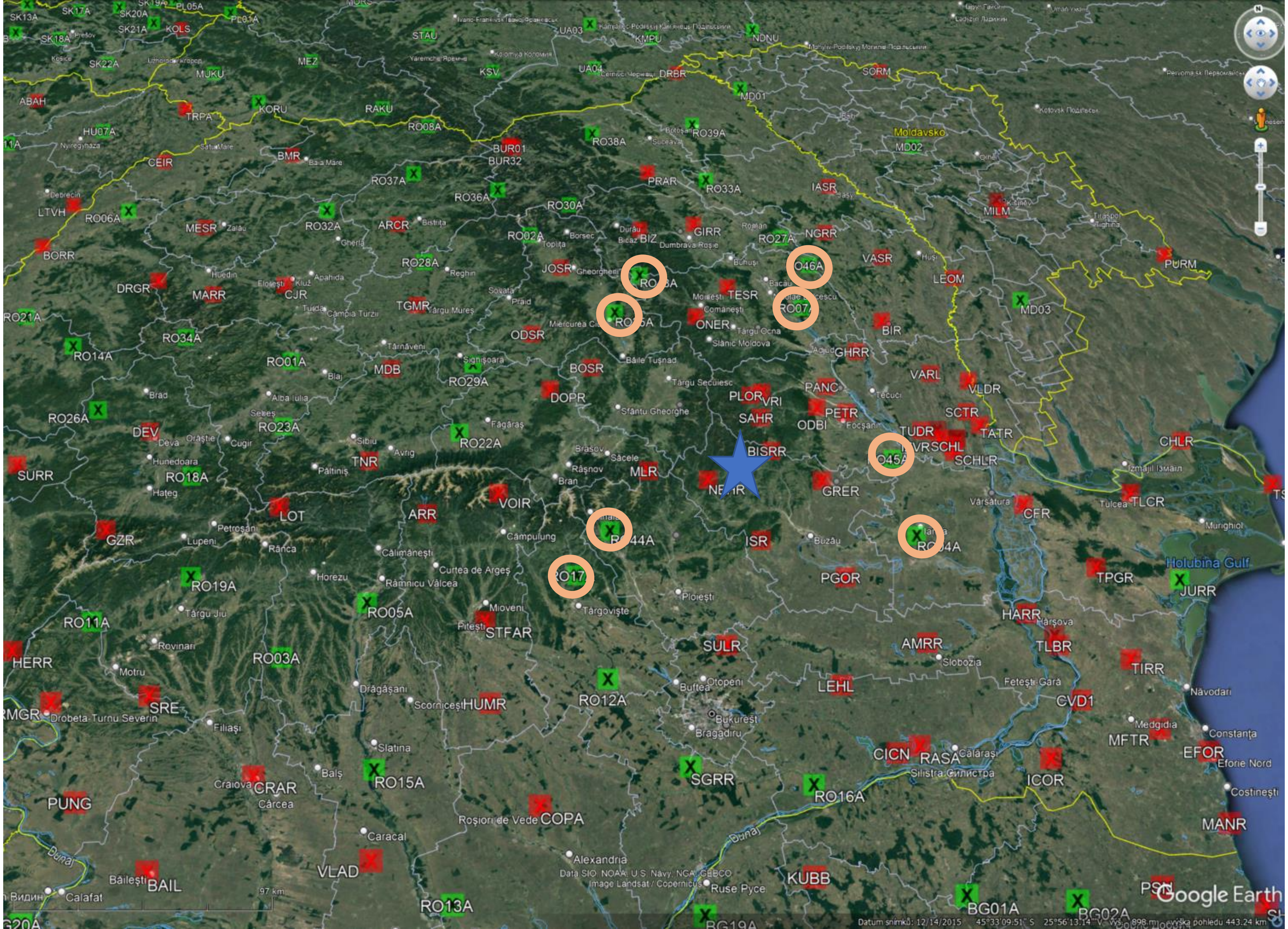
SK20A
SK21A
SK18A
SK22A
PL05A
PL01A
KOLS
MEZ
MUKU
STAU
UA03
KMPU
NDNU
UA04
DRBR
SORM
ABAH
TRPA
KORU
RAKU
MD01
HU07A
RO08A
BUR01
BUR32
RO38A
RO39A
Moldavsko
MD02
CEIR
BMR
Baia Mare
PRAR
RO33A
IASR
RO37A
RO36A
LTVH
RO06A
RO32A
ARCR
RO30A
MILM
MESR
RO02A
BIZ
GIRR
RO27A
NGRR
BORR
RO28A
JOSR
RO46A
VASR
LEOM
PURM
DRGR
MARR
CJR
Cluj
TGMR
RO43A
TESR
Bacău
RO07A
RO21A
MD03
RO34A
ODSR
RO35A
ONER
BIR
RO14A
Târgu Ocna
GHRR
RO01A
MDB
RO29A
BOSR
VARL
VLDR
Alba Iulia
DOPR
PLOR
VRI
PANC
RO26A
SAHR
PETR
SCTR
Sfântu Gheorghe
ODBI
DEV
Deva
RO23A
RO22A
Făgăraș
TUDR
TATR
CHLR
IZVRSCHL
Sibiu
BISRR
SCHLR
RO45A
SURR
RO18A
TNR
MLR
Brașov
NEHR
GRER
TLCR
LOT
ARR
VOIR
Sinaia
CFR
GZR
Petroșani
RO44A
ISR
Buzău
RO04A
Câmpulung
RO19A
Horezu
RO17A
PGOR
TPGR
Holubina Gulf
JURR
RO05A
Ploiești
Târgoviște
HARR
RO11A
Pitești
STFAR
SULR
AMRR
TLBR
HERR
RO03A
Slobozia
TIRR
RMGR
Drobeta Turnu Severin
SRE
HUMR
RO12A
LEHL
CVD1
Drăgășani
Otopeni
Năvodari
București
Bragadiru
MFTR
Constanța
Slatina
CICN
RASA
Călărași
EFOR
Eforie Nord
RO15A
SGRR
ICOR
CRAR
Craiova
RO16A
Costinești
PUNG
COPA
Roșiori de Vede
MANR
Caracal
Dunaj
VLAD
Alexandria
KUBB
BAIL
Băilești
Calafat
RO13A
BG01A
BG02A
RG19A
G20A
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth
97 km
Datum snímků: 12/14/2015


SK13A
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KSV
UA04
DRBR
SORM
ABAH
TRPA
KORU
RAKU
MD01
HU07A
RO08A
BUR01
BUR32
RO38A
RO39A
Moldavsko
MD02
CEIR
BMR
RO37A
PRAR
RO33A
IASR
MILM
LTVH
RO06A
MESR
RO32A
ARCR
RO36A
RO30A
GIRR
NGRR
RO02A
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BORR
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VASR
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DRGR
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BOSR
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VLDR
DOPR
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PETR
SCTR
ODBI
DEV
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RO22A
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CHLR
SCHL
BISRR
SCHLR
SURR
TNR
RO18A
MLR
GRER
TLCR
VOIR
ARR
CER
LOT
GZR
ISR
TPGR
PGOR
Holubina Gulf
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STFAR
HARR
RO11A
SULR
AMRR
TLBR
RO03A
TIRR
HERR
LEHL
HUMR
RO12A
CVD1
RMGR
SRE
MFTR
EFOR
CICN
RASA
ICOR
CRAR
RO15A
SGRR
RO16A
PUNG
COPA
MANR
VLAD
KUBB
BAIL
RO13A
BG01A
BG02A
97 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth

BACKBONE STATIONS (RO04A, RO07A, RO17A, RO35A)
sensor: Guralp 3ESPC 120s 100Hz 2x1000 V/m/s
digitizer: Guralp minimus (4-channel)
sampling frequency: 100 Hz

The digital data recorded by these stations are transmitted in real time to the NIEP node of EIDA.





minimus
RUT240
R140761


minimus
FEB42

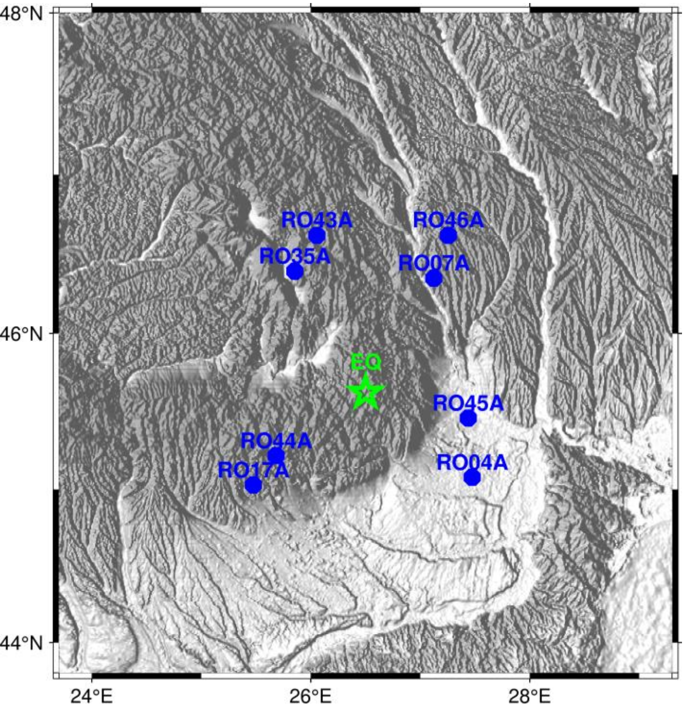

SCOALA GENERALA
CLASELE I-IV
JUD ALBA

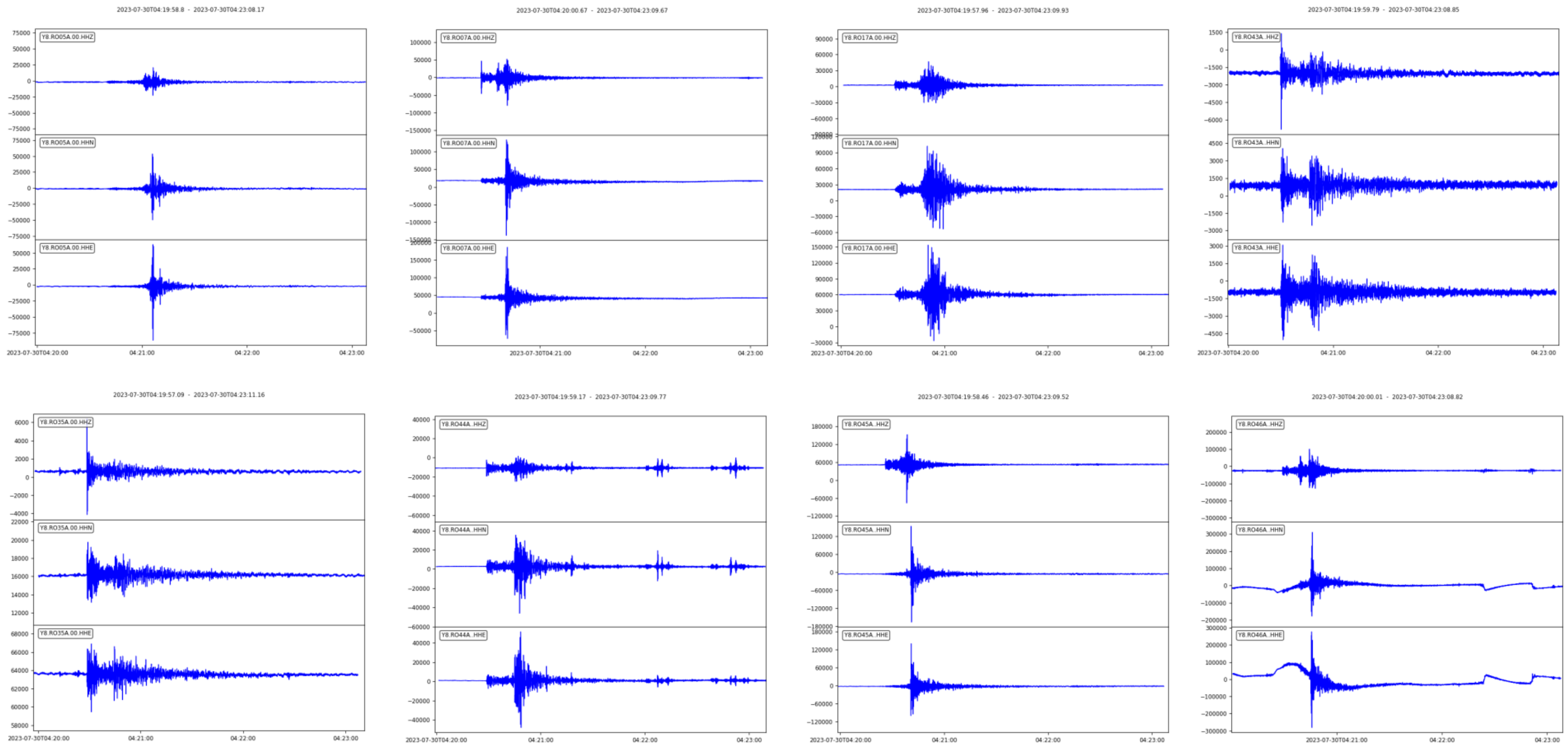
LOCAL EXPERIMENT STATIONS (RO43A, RO44A, RO45A, RO46A)
GIPP (Geophysical Instrument Pool Potsdam) - GFZ Potdsdam
sensor: Trillium Compact - Model TC120-SV1 (16838)
digitizer: Earth Data EDR-210
sampling frequency: 100 Hz

The digital data recorded by these stations are transmitted in real time to the NIEP node of EIDA.

Vrancea – example of measured data

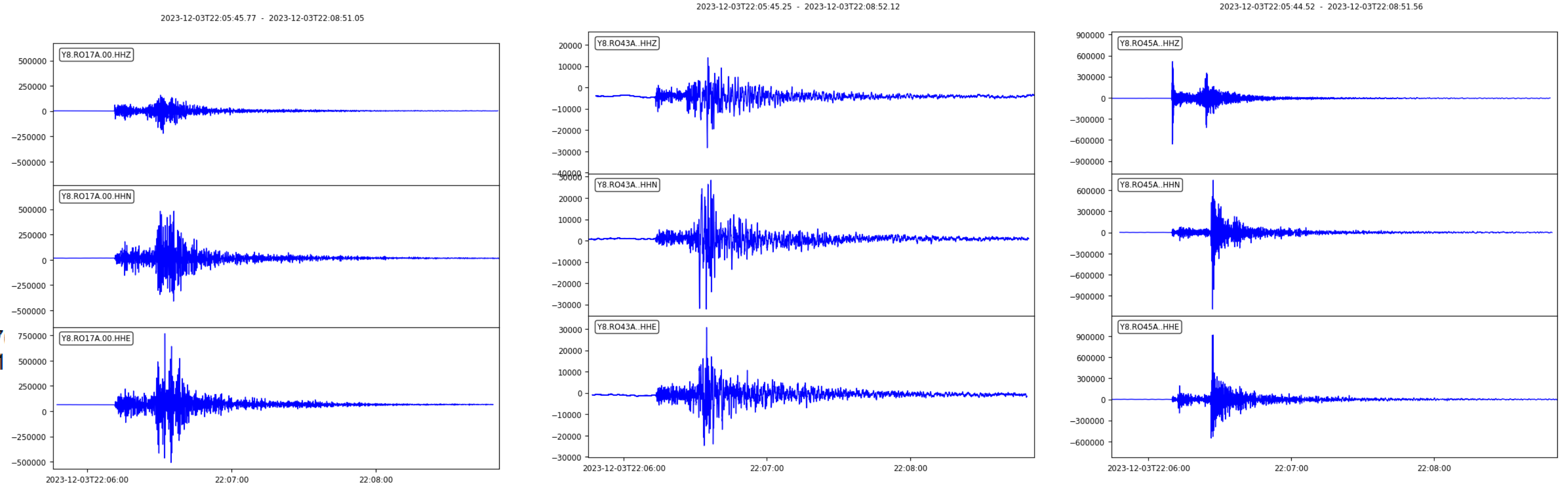
Earthquake M = 4.1   2023-07-30 04:20:06.5 UTC   Depth 123 km

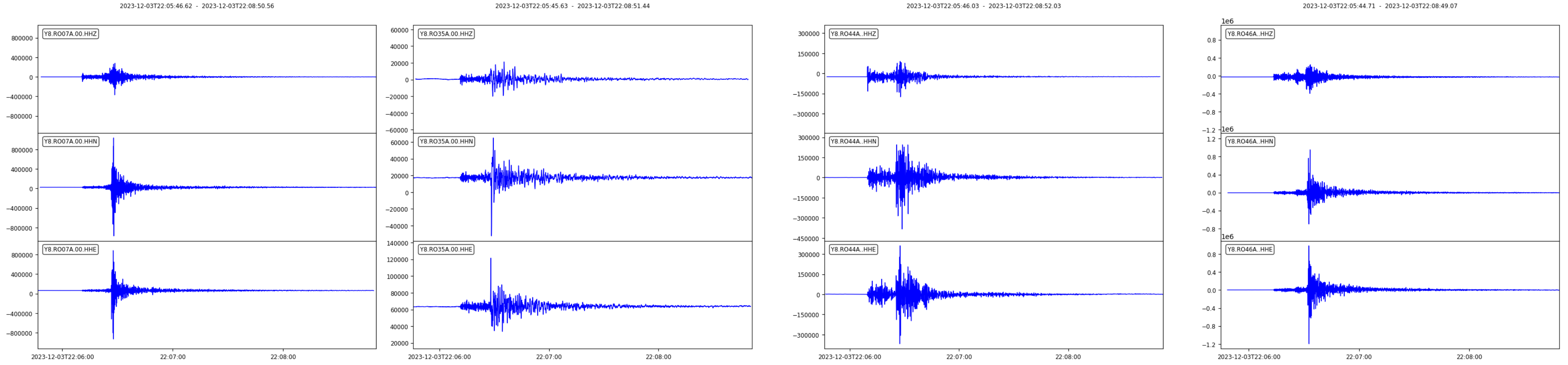


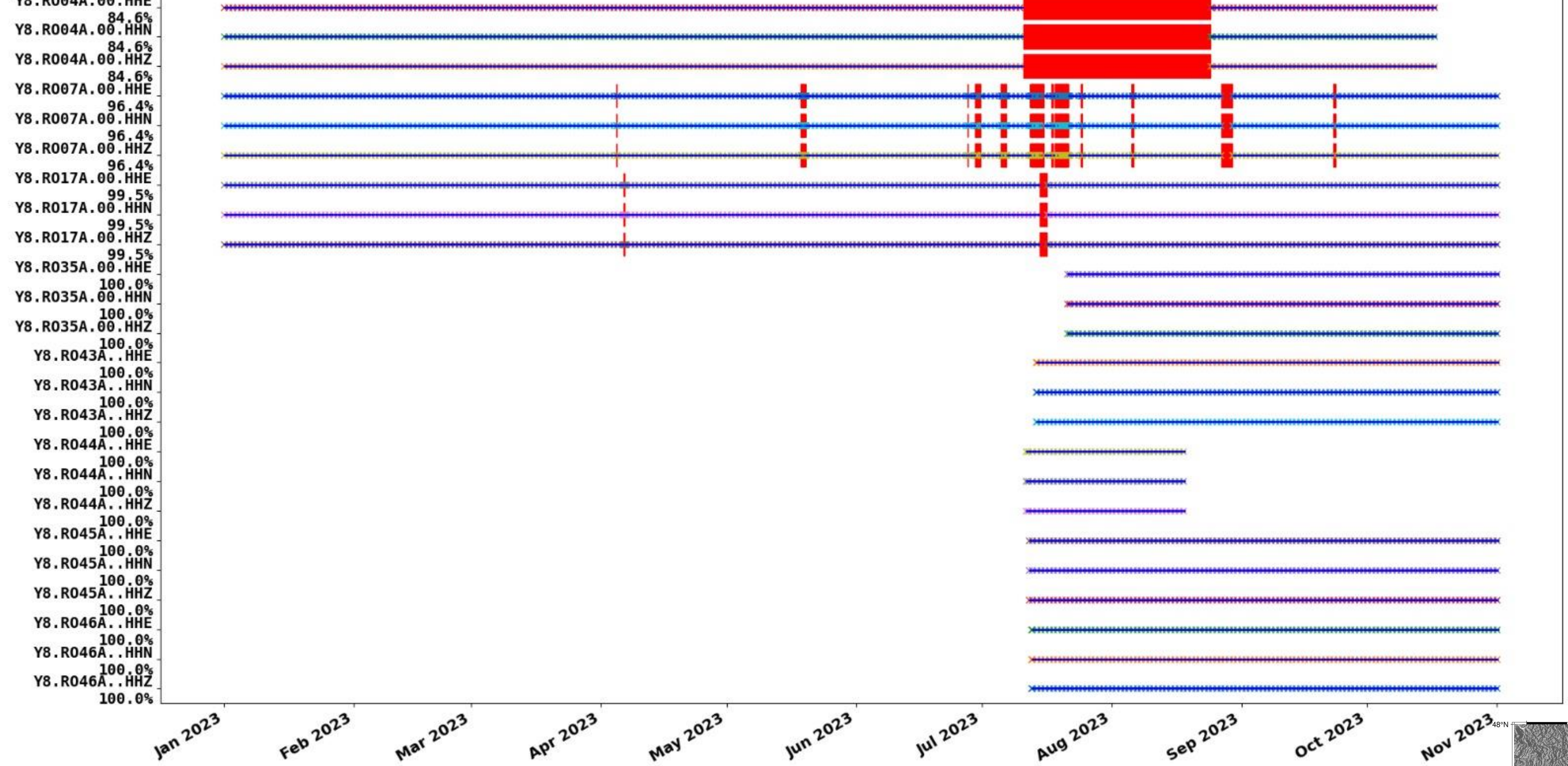


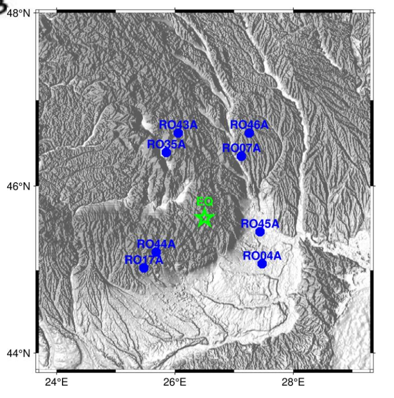
CSEM EMSC
Centre Sismologique Euro-Méditerranéen
Euro-Mediterranean Seismological Centre

Magnitude	4.6
Region	ROMANIA
Date time	2023-12-03 22:05:48.6 UTC
Location	45.637 ; 26.407
Depth	137 km
Distance	62 km E of Braşov, Romania / pop: 27 26 km N of Nehoiu, Romania / pop: 11

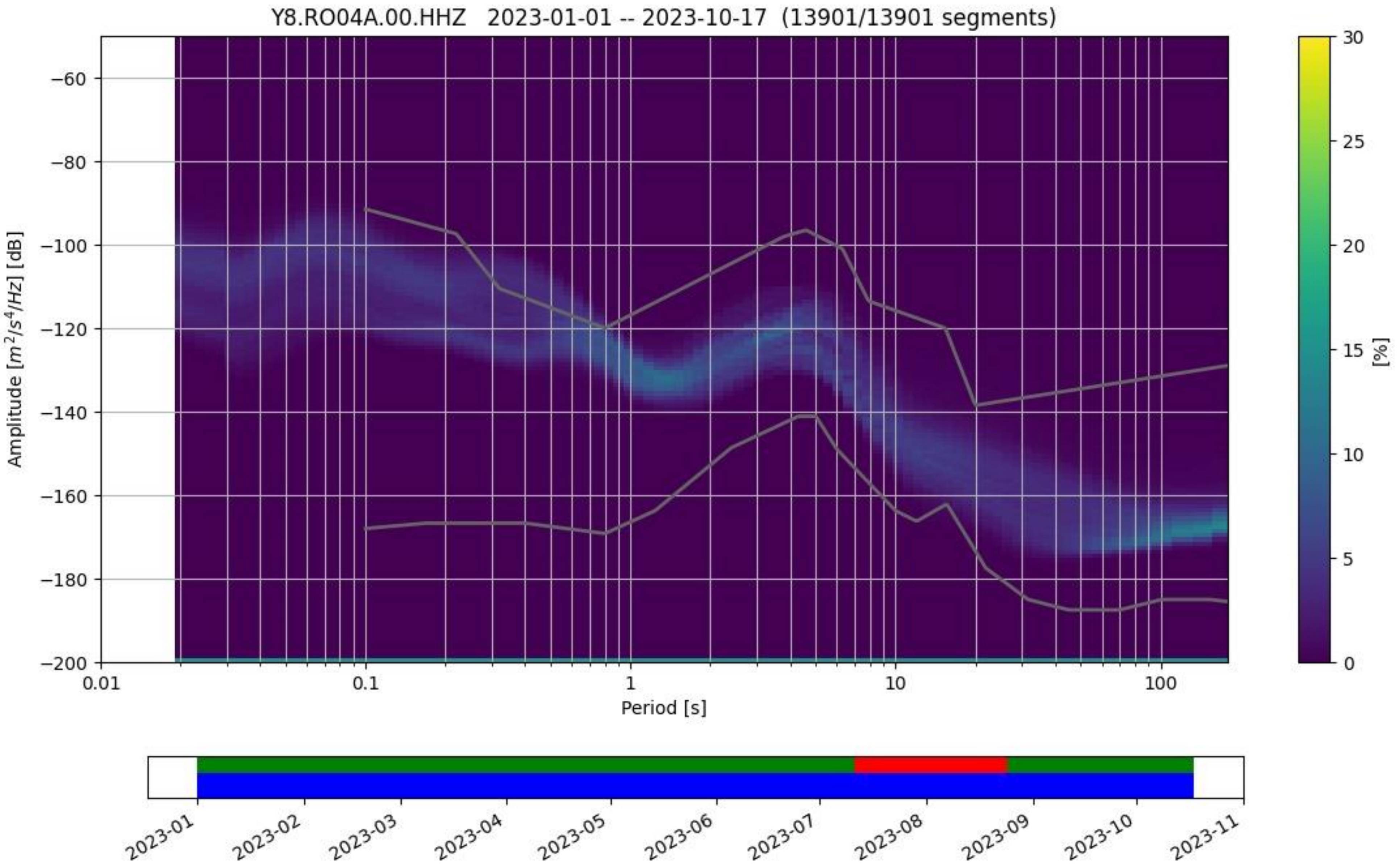


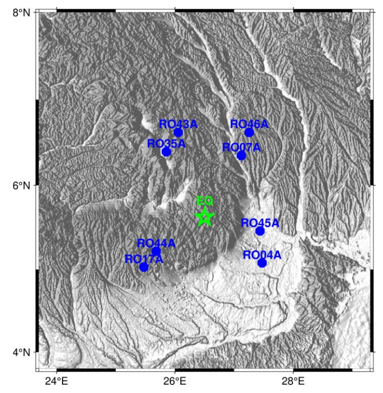



Y8.RO04A.00.HHE
84.6%
Y8.RO04A.00.HHN
84.6%
Y8.RO04A.00.HHZ
84.6%
Y8.RO07A.00.HHE
96.4%
Y8.RO07A.00.HHN
96.4%
Y8.RO07A.00.HHZ
96.4%
Y8.RO17A.00.HHE
99.5%
Y8.RO17A.00.HHN
99.5%
Y8.RO17A.00.HHZ
99.5%
Y8.RO35A.00.HHE
100.0%
Y8.RO35A.00.HHN
100.0%
Y8.RO35A.00.HHZ
100.0%
Y8.RO43A..HHE
100.0%
Y8.RO43A..HHN
100.0%
Y8.RO43A..HHZ
100.0%
Y8.RO44A..HHE
100.0%
Y8.RO44A..HHN
100.0%
Y8.RO44A..HHZ
100.0%
Y8.RO45A..HHE
100.0%
Y8.RO45A..HHN
100.0%
Y8.RO45A..HHZ
100.0%
Y8.RO46A..HHE
100.0%
Y8.RO46A..HHN
100.0%
Y8.RO46A..HHZ
100.0%
Jan 2023
Feb 2023
Mar 2023
Apr 2023
May 2023
Jun 2023
Jul 2023
Aug 2023
Sep 2023
Oct 2023
Nov 2023

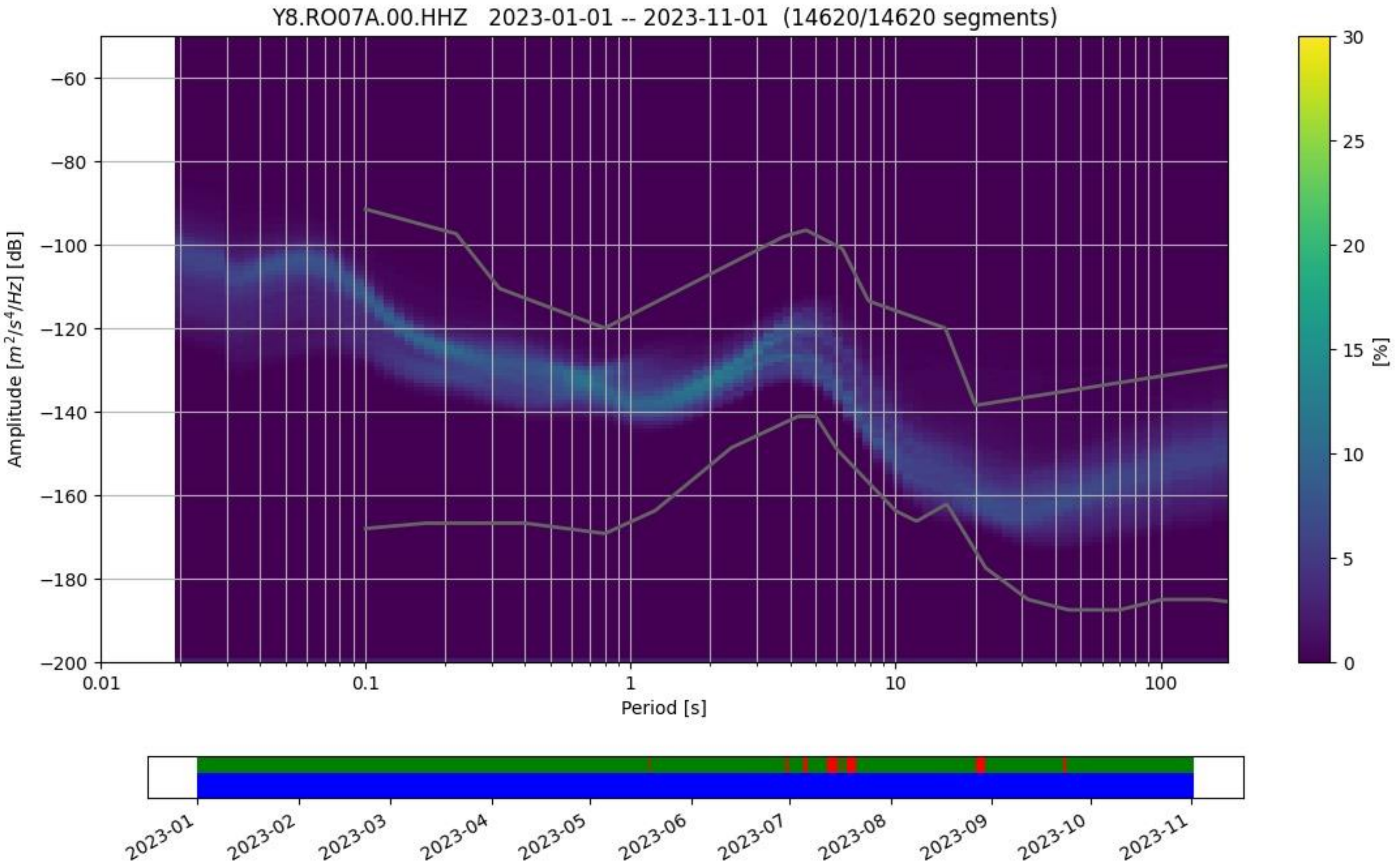

48°N
46°N
44°N
24°E
26°E
28°E
RO43A
RO46A
RO35A
RO07A
RO45A
RO44A
RO17A
RO04A

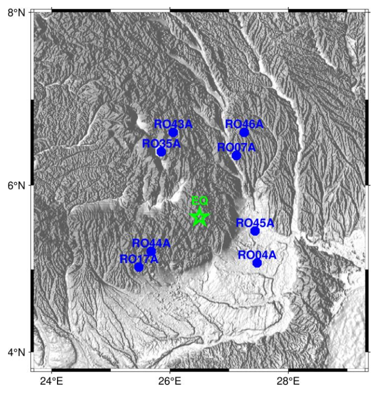
Probabilistic power spectral density (PPSD)



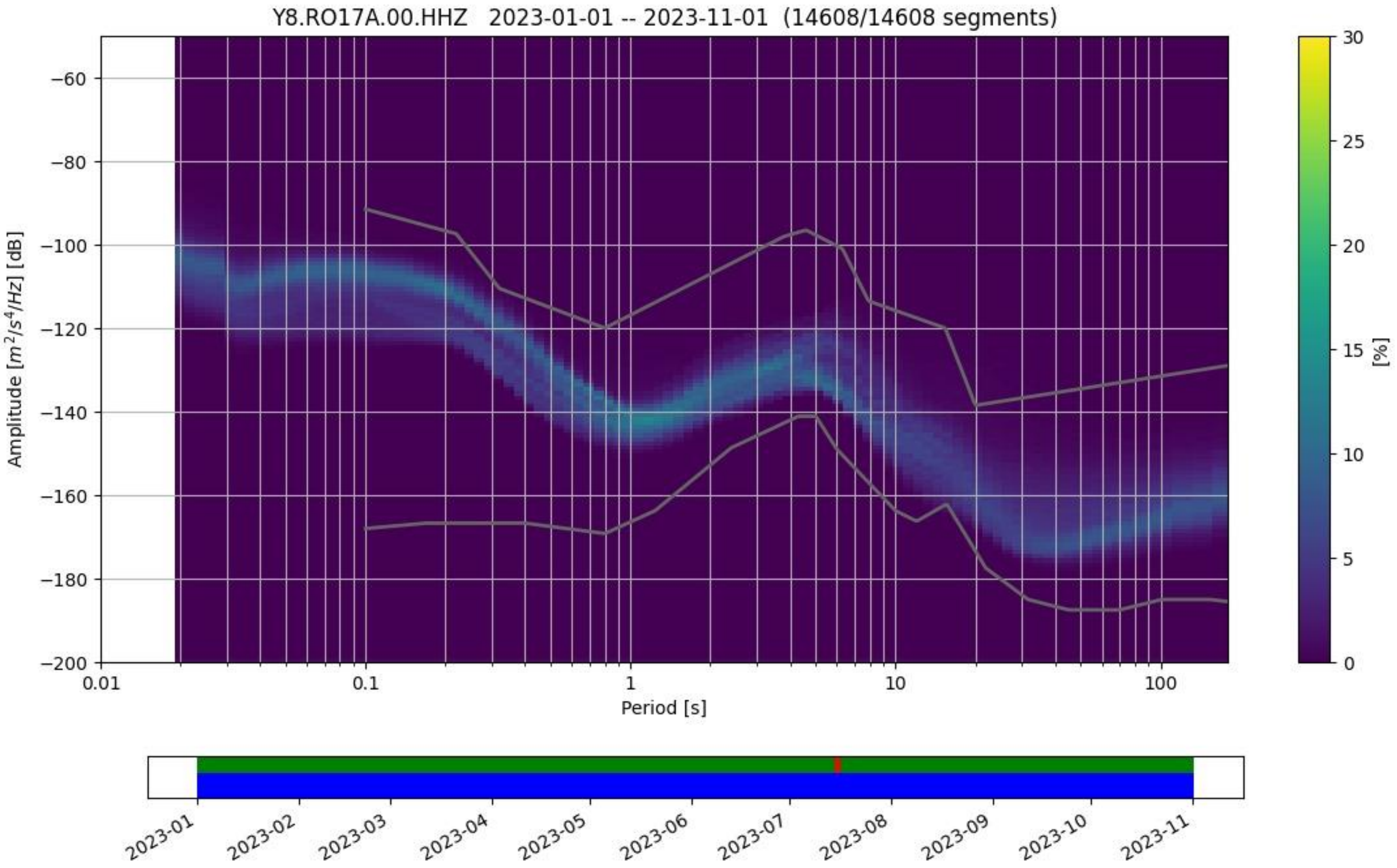


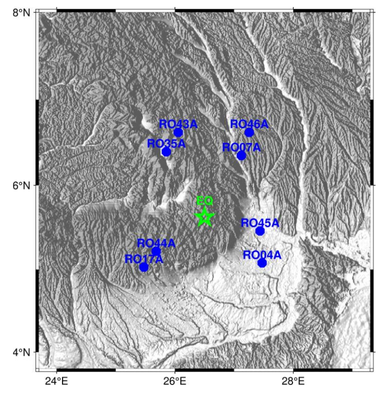
Probabilistic power spectral density (PPSD)



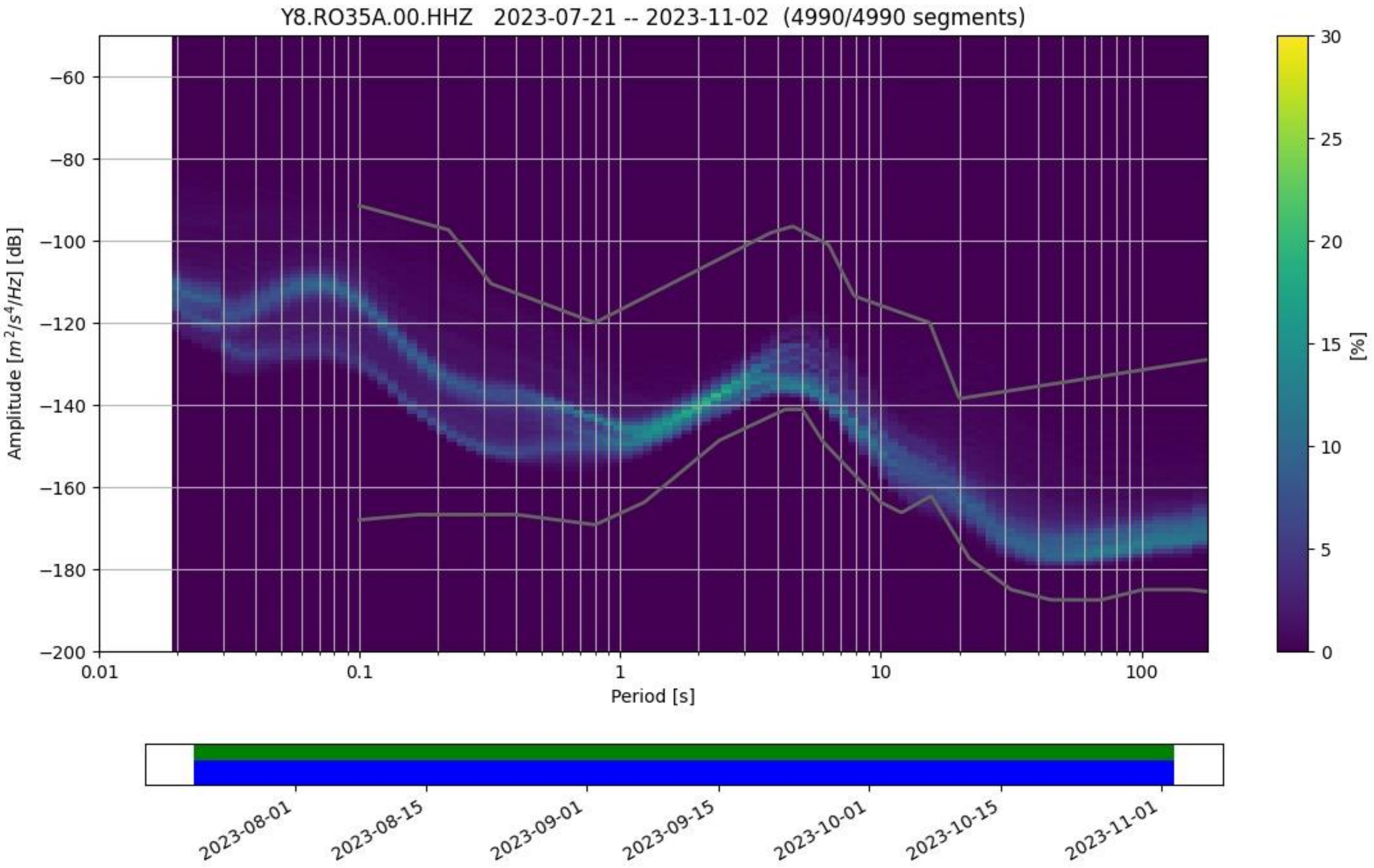


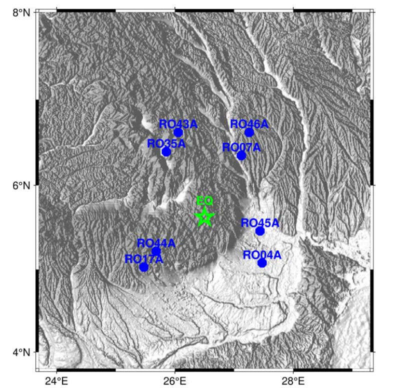
Probabilistic power spectral density (PPSD)



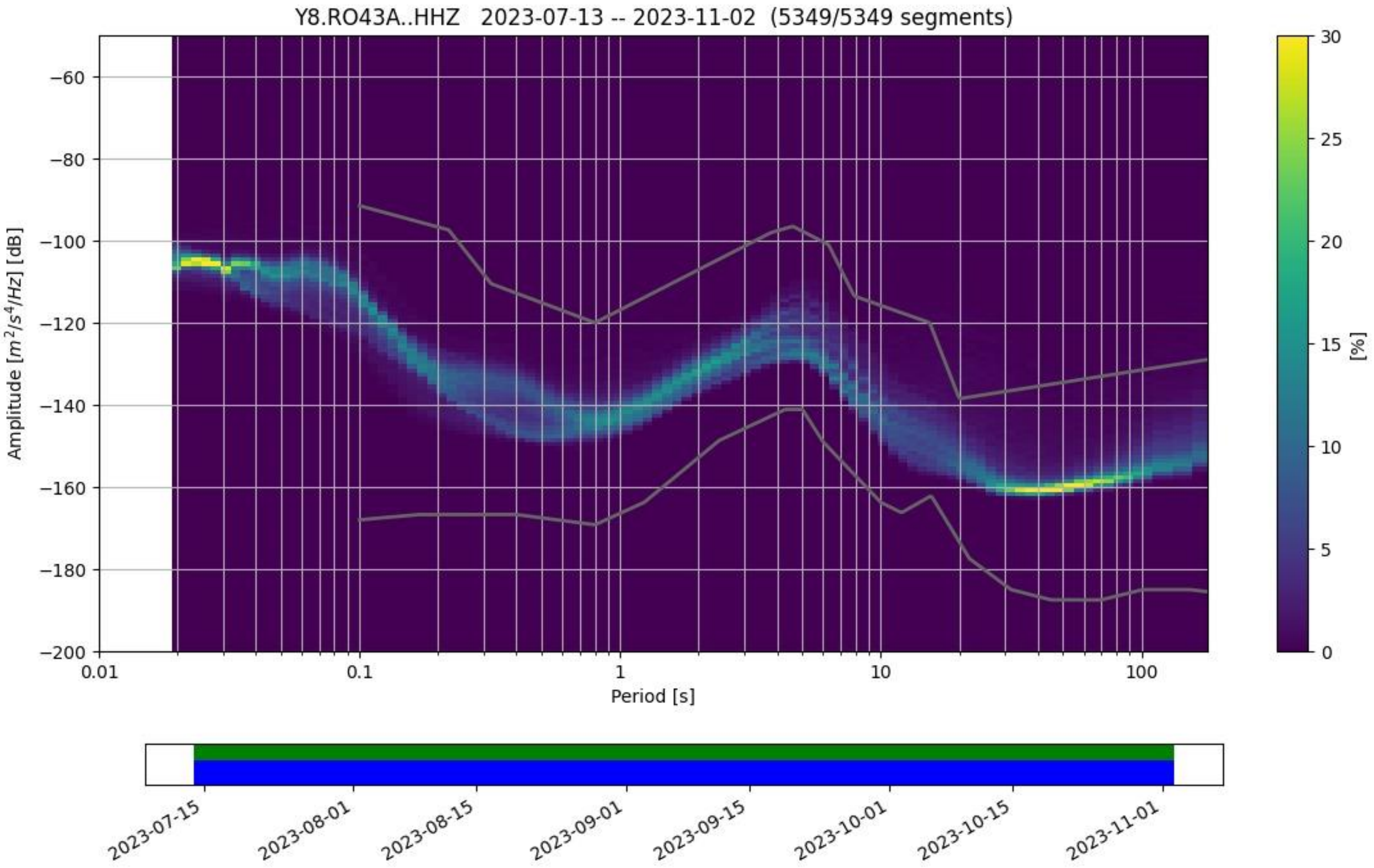


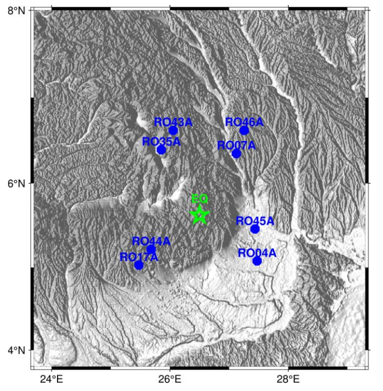
Probabilistic power spectral density (PPSD)

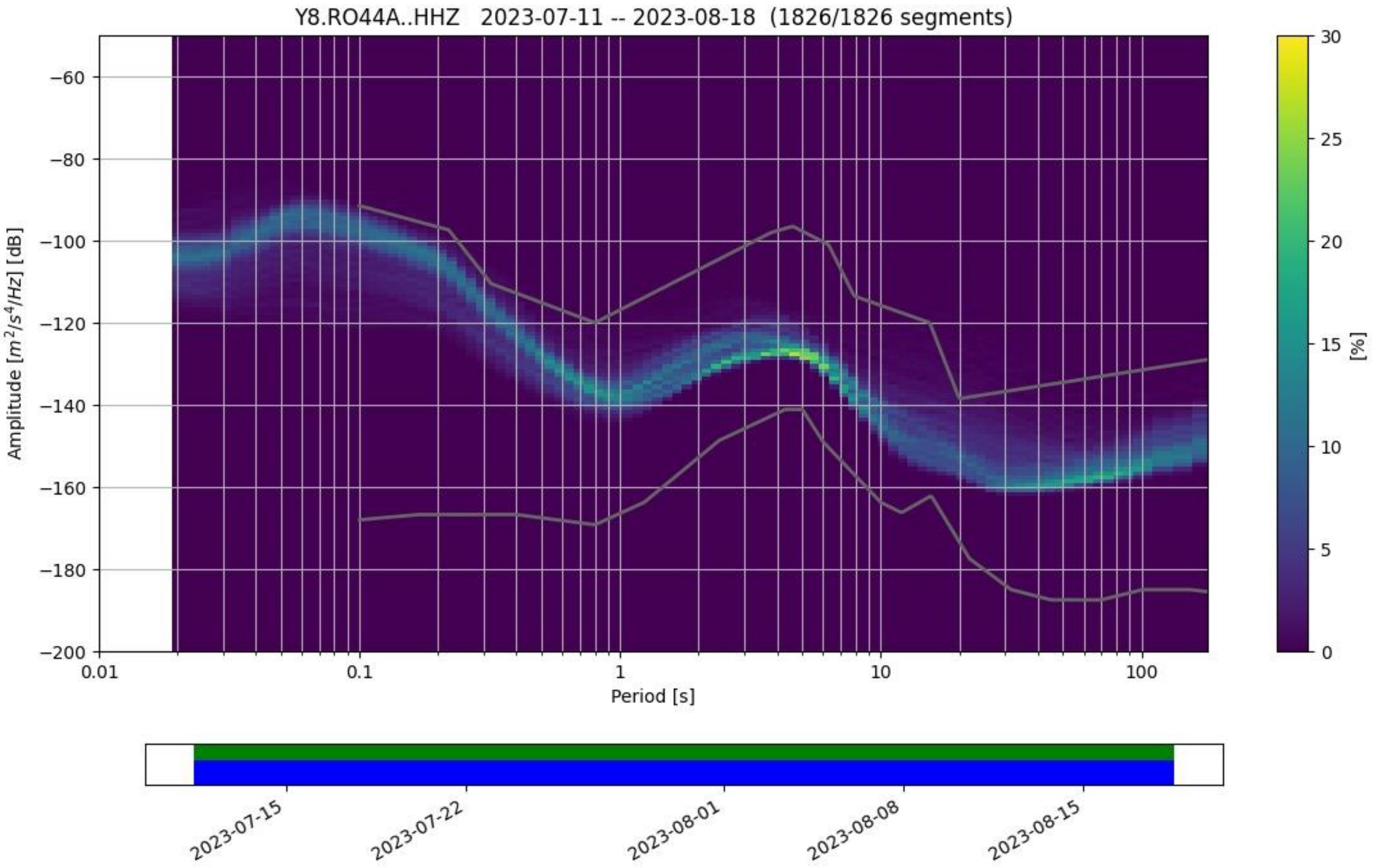




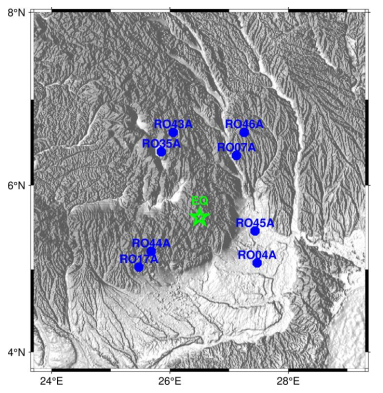
Probabilistic power spectral density (PPSD)





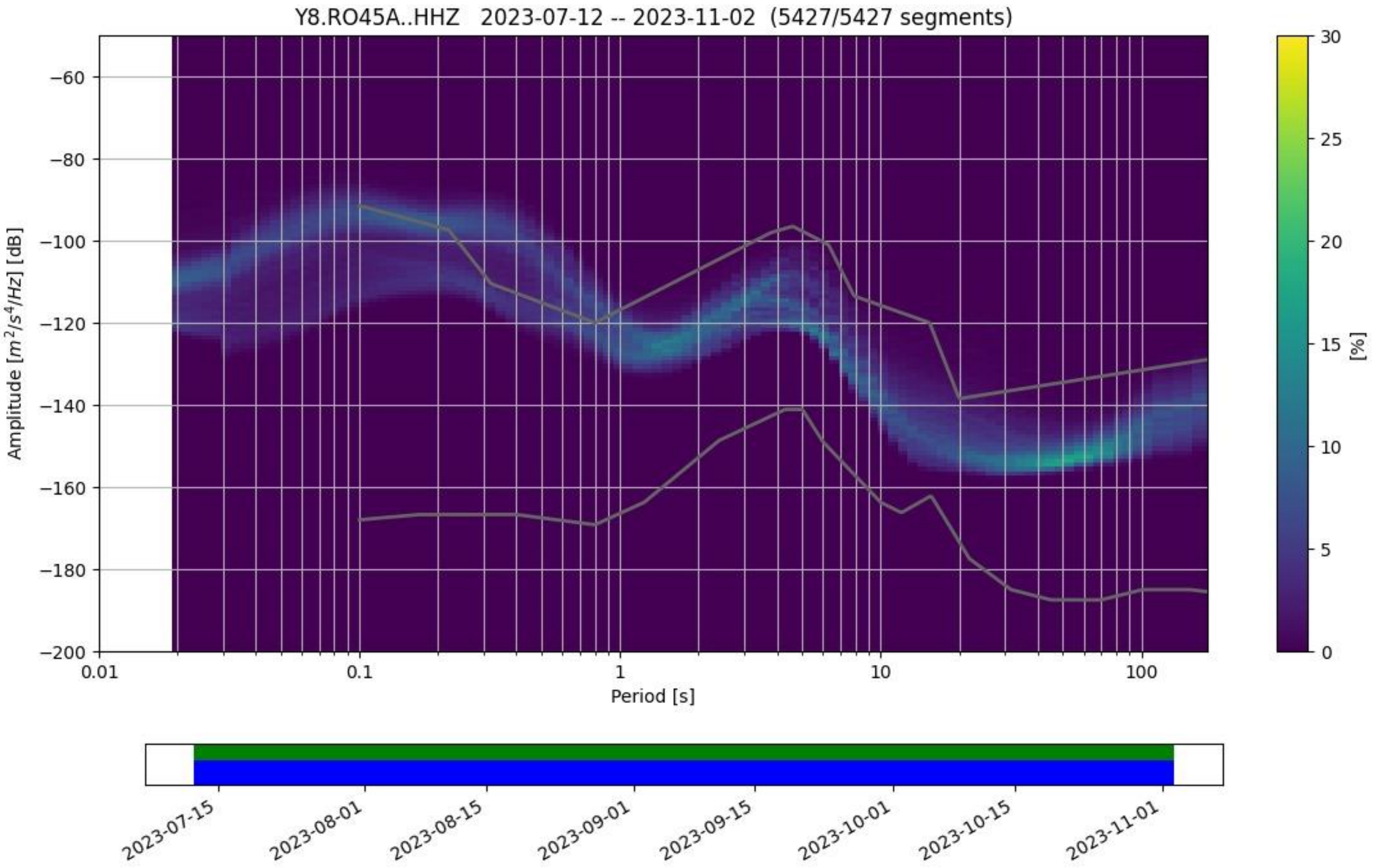


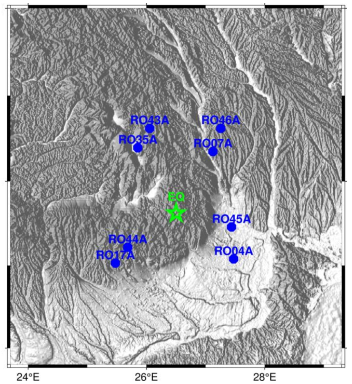
Y8.RO44A..HHZ 2023-07-11 -- 2023-08-18 (1826/1826 segments)
Amplitude [$m^2/s^4/Hz$] [dB]
−60
−80
−100
−120
−140
−160
−180
−200
0.01
0.1
1
10
100
Period [s]
30
25
20
15
10
5
0
[%]
2023-07-15
2023-07-22
2023-08-01
2023-08-08
2023-08-15



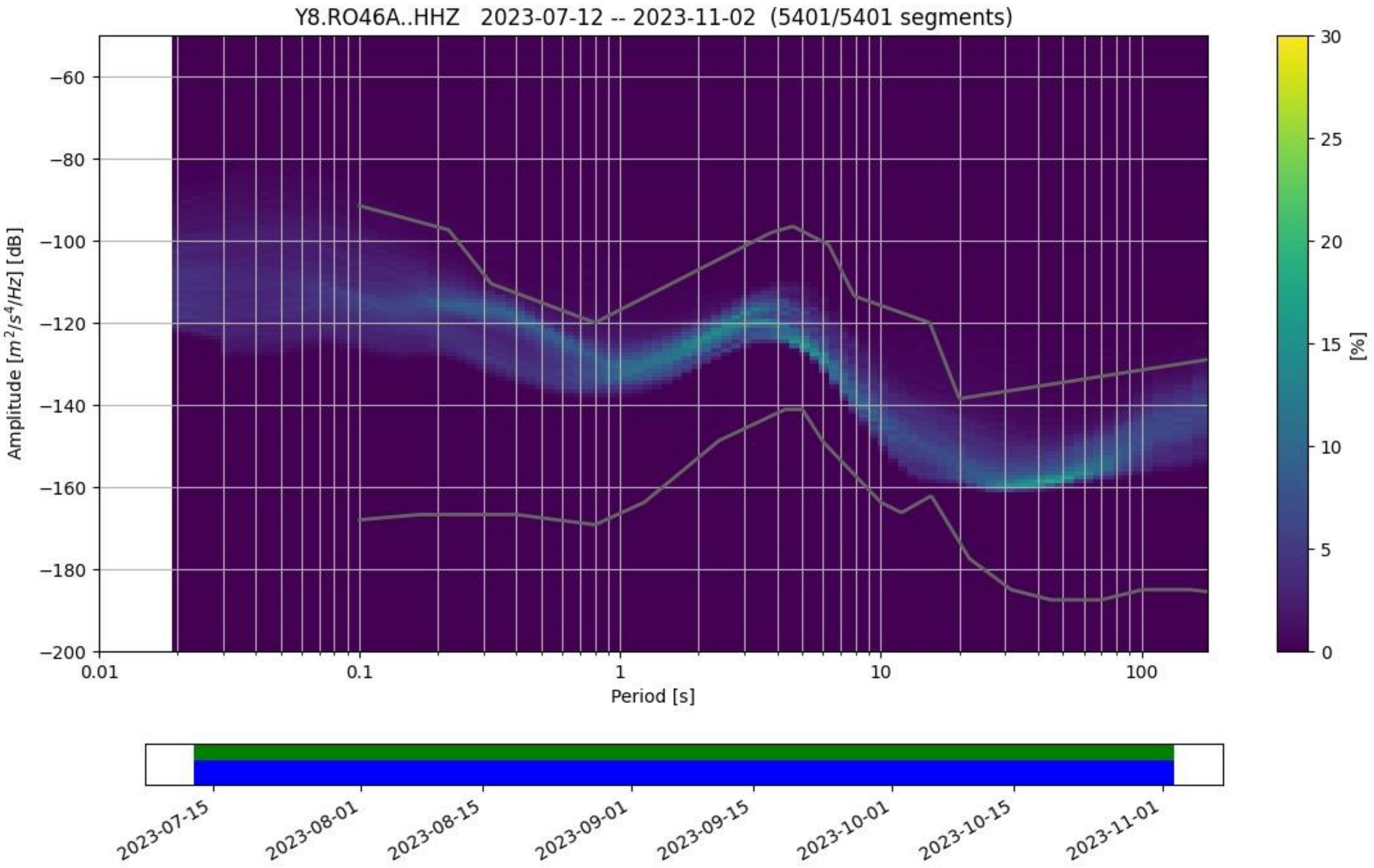
8°N
6°N
4°N
24°E
26°E
28°E
RO43A
RO46A
RO35A
RO07A
EQ
RO45A
RO44A
RO17A
RO04A

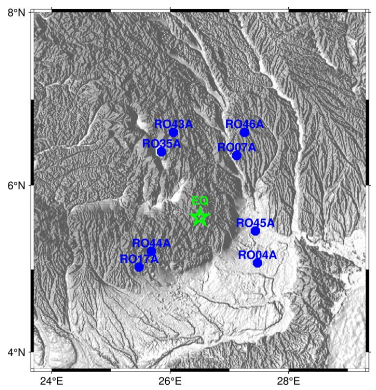
Probabilistic power spectral density (PPSD)





Probabilistic power spectral density (PPSD)





AdriaArray

AdriaArray - Mission

AdriaArray is a multi-national effort to cover the Adriatic Plate and its active margins in the central Mediterranean by a dense regional array of seismic stations to understand the causes of active tectonics and volcanic fields in the region. Plate-scale observations are complemented by local and LargeN experiments in key areas. The AdriaArray region reaches from the Massive Central in the west to the Carpathians in the east, from the Alps in the north to the Calabrian Arc and mainland Greece in the south. The deployment of seismic stations and scientific research is coordinated by the AdriaArray Seismology Group based on FAIR and open data exchange. Analyses of seismicity and multi-scale passive seismic imaging will lay the ground for a physical understanding and modelling of plate deformation and associated geohazards.

AdriaArray - Logo

The logo was discussed at the third AdriaArray international workshop in Dubrovnik, Croatia, on 3-5 April 2023. The logo was approved during the AdriaArray Splinter meeting (EGU General Assembly on April 27th, 2023). Several versions (by Claudia Piromallo and Hana Kampfová Exnerová) are available and can be downloaded from the AdriaArray GitHub repository.

AdriaArray - Current deployment

How to access the data?

Permanent stations, temporary stations with open access as well as metadata (stationXML) are available to AdriaArray members and non members through EIDA nodes.

In order to access the embargoed AdriaArray data, EIDA Token is needed. The token act as login and passwords while requesting waveforms.

EIDA Token

- The seismic data will be available to the participants through EIDA nodes.
- The metadata are openly available, but accessing the embargoed waveforms requires an authentification.

In order to get a token that would give you access to the embargoed AdriaArray data, the procedure is the following:

1. **Register to B2Access**

   If you already have a B2Access account, go to 2) If you do not have a B2Access account, please visit this link

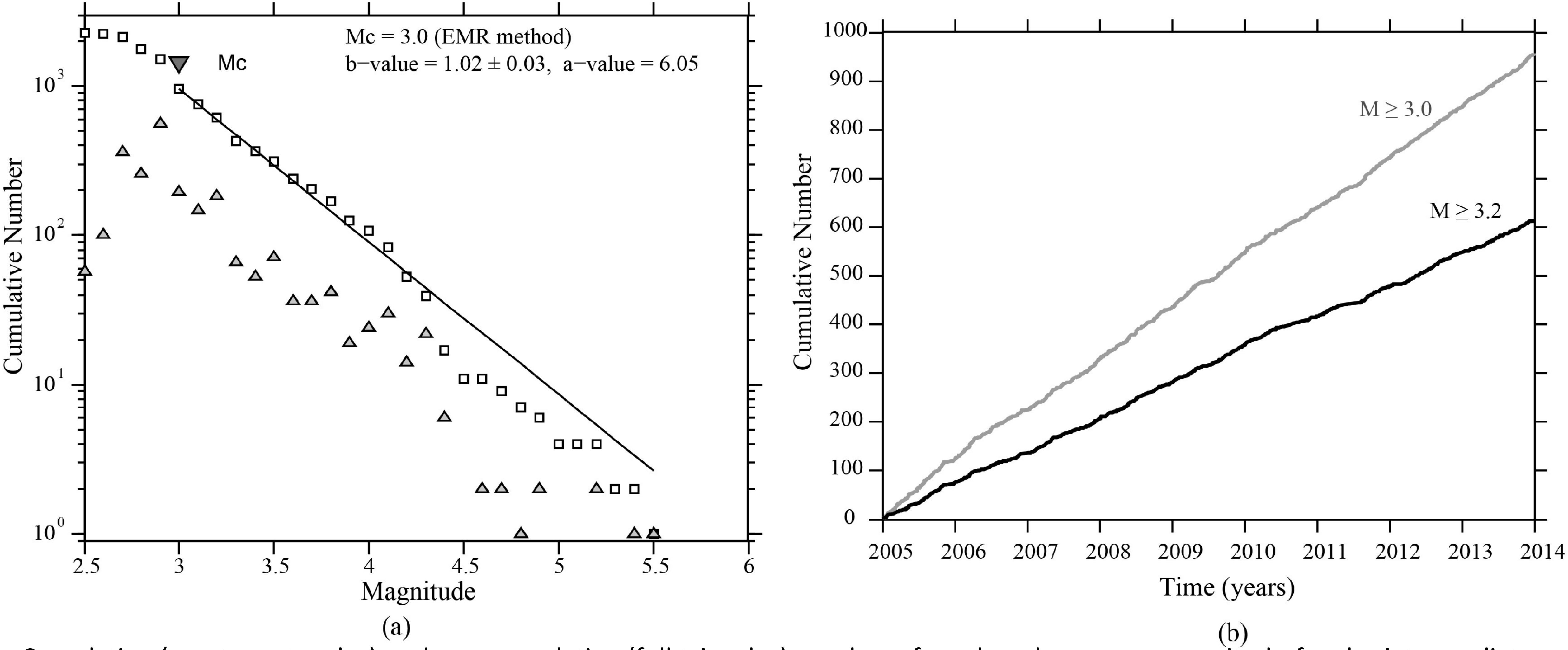
   Please go to the link “No account, sign up”. You need to create a B2Access user account (either with a username or with a certificate, up to you, no difference here). The most important is that you need to click “Select group:” and **request to be part of EPOS**. Otherwise, you won’t be able to access the data.

2. **Granting permission.**

   Then, please let the representative of Working Group ‘Communication and Outreach’ know which email was registered, to be added to the AdriaArray group.

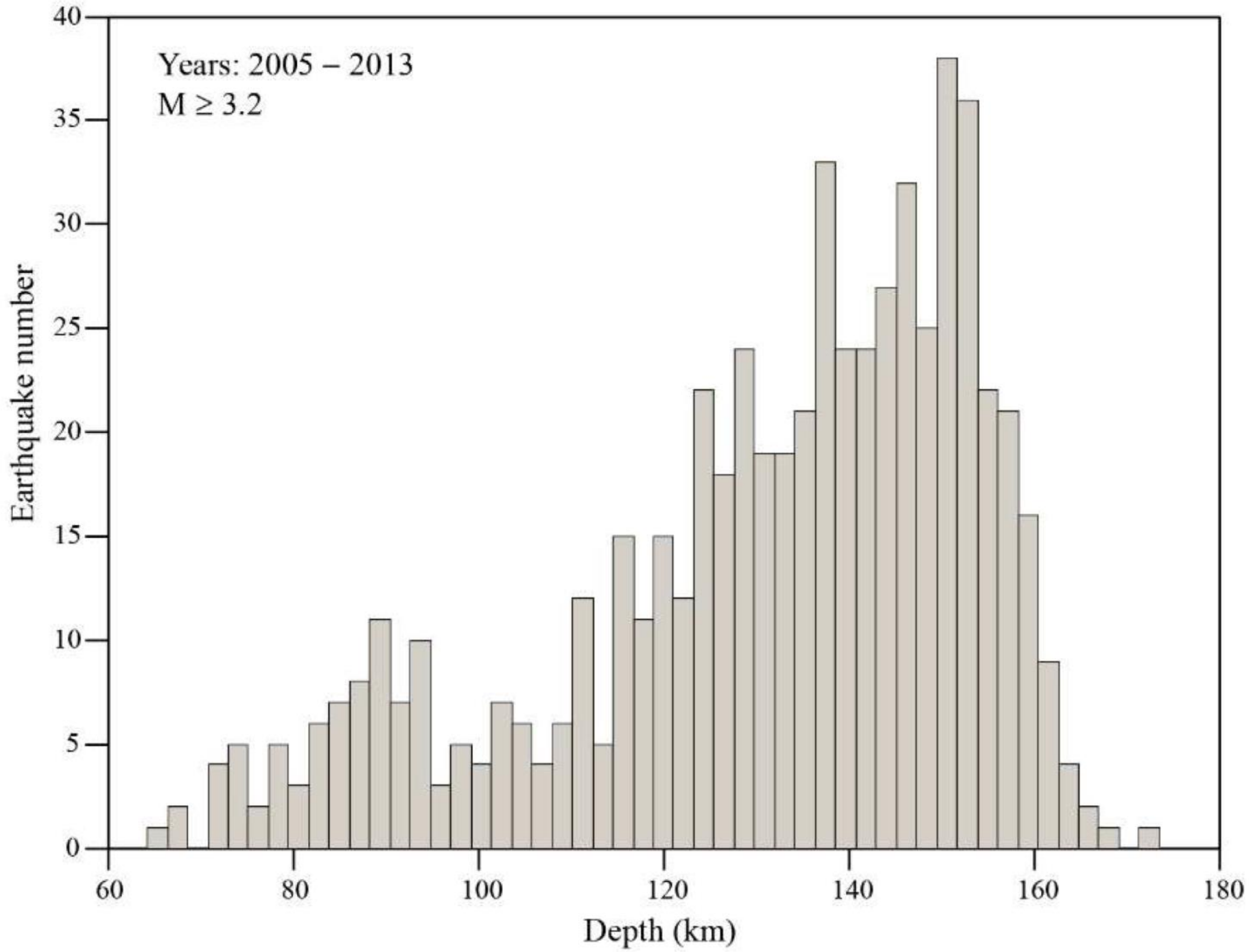
   Some nodes (as NIEP) require a manual update of the email list, and it may take a few more days to access the full database (i.e. Y8 network code).

   With this token, you should have access to all the AdriaArray data that are online. Any token generated before being added to the EPOS group will not give you access to the embargoed data. The representative of Working Group ‘Communication and Outreach



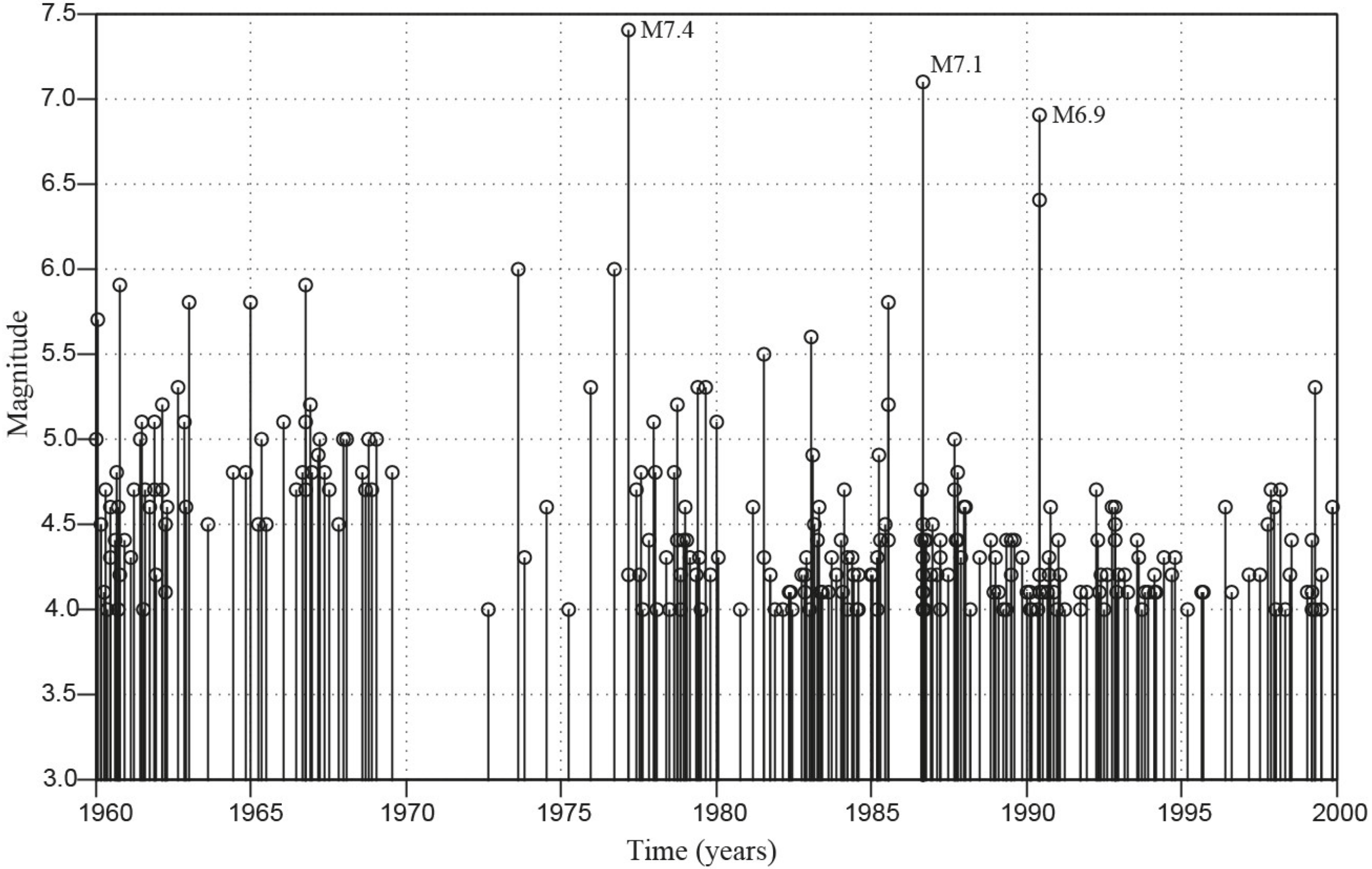
Cumulative (empty rectangles) and non-cumulative (full triangles) number of earthquakes versus magnitude for the intermediate-depth Vrancea earthquakes (ROMPLUS catalog, 60–220 km depth), period **2005–2013**, M ≥ 3.0. The earthquake data are complete above Mc = 3.0 (indicated by an inverted triangle). The black curve is a fit to the data, with the a- and b-values of the frequency-magnitude relation determined using a maximum likelihood procedure. (**b**) Cumulative number of earthquakes with time (years), for two threshold magnitudes (3.0 and 3.2).

Enescu, B.; Ghita, C.; Moldovan, I.-A.; Radulian, M. Revisiting Vrancea (Romania) Intermediate-Depth Seismicity: Some Statistical Characteristics and Seismic Quiescence Testing. Geosciences 2023, 13, 219. https://doi.org/10.3390/geosciences13070219



Histogram of earthquakes (2005–2013, M ≥ 3.2) as a function of depth for Vrancea intermediate-depth earthquakes.

Enescu, B.; Ghita, C.; Moldovan, I.-A.; Radulian, M. Revisiting Vrancea (Romania) Intermediate-Depth Seismicity: Some Statistical Characteristics and Seismic Quiescence Testing. Geosciences 2023, 13, 219. https://doi.org/10.3390/geosciences13070219



Magnitude versus time for the intermediate-depth Vrancea earthquakes, from 1960–1999. The threshold magnitude is M = 4.0. The three largest earthquakes during the studied period are marked in the figure (1977 M7.4, 1986 M7.1, and 1990 M6.9 Vrancea earthquakes).

Team:
Mgr. Lucia Fojtíková, Ph.D.,
Mgr. Renata Lukešová, Ph.D.,
RNDr. Jiří Málek, Ph.D.
RNDr. Václav Vavryčuk, DrSc.,
Mgr. Jan Valenta, Ph.D.,
RNDr. Jiří Vackář, Ph.D.
Mgr. Martin Mazanec - PhD student
Mgr. Milosz Wcislo (Mgr) - PhD student

Methodologies:

Precise location of microearthquakes: For the determination of P and S wave onsets, we will apply recently developed methods, e.g., a normalized cross-correlation of effective functions for clustering different seismic sequences (e.g., Vlček et al., 2018). Microearthquakes will be located using the double-difference technique. The expected number of events is many tens of thousands every year, therefore automated procedures have to be applied.

Methodologies:

Focal mechanisms: Focal mechanisms will be computed using different approaches, e.g., BayesISOLA, which are automated method for determination of the source mechanism with uncertainties described in Bayesian formulation (Vackář et al., 2017) and/or the method: Cyclic Scanning of the Polarity Solutions (CSPS), which can be efficiently adopted where weak events are recorded (Fojtíková and Zahradník, 2014). We will attempt to calculate the full moment tensors even for microearthquakes. The agreement between nodal planes of the individual sources and possible source clustering on planar faults will be investigated. The superior station coverage of the area, providing a reference focal-mechanism solution, is a unique opportunity to investigate and test methodologies for calculating moment tensors in a sparse network (which is modeled as a subset of the reference station network).

Methodologies:

Existence of seismic tremors: Seismic tremors are typical for regions with active volcanic activity. However, non-volcanic tremors were also detected in many regions. For instance, episodic tremors have been correlated with rupture characteristic in subducting oceanic lithosphere (Burlini et al., 2009). The most probable hypothesis is that non-volcanic tremors are connected with movement of crustal fluids. The presence or absence of seismic tremors and their localization can significantly contribute to the debate about nature of the seismicity in the Vrancea region.

Methodologies:

Tomography based on direct P and S waves from local earthquakes: New data obtained from AdriaArray enables one to construct a more precise and reliable model for Vrancea seismic zone from the surface to 180 km depth - the depth range of the hypocenters. Inversion for a velocity model from travel times generated by local microearthquakes needs a special technique because there is a strong trade-off between hypocenter locations and the velocity model. It is a non-linear inverse problem, which is solved iteratively with the relocation of all earthquakes at each iteration (Málek et al. 2005, Málek et al., 2023). A very fast isometric method was developed for this inverse problem which enables one to compute hundreds of parameters of the velocity model while using millions of onset times of direct P and S waves. This method will be enhanced in the scope of our project. We will determine a velocity model that predicts precise travel times. More precise absolute locations of hypocenters can be determined from this model.

Methodologies:

Amplitude tomography and site-specific GMPE dependent on the hypocenter depth:
Isometric inversion method will be used also for amplitude tomography based on amplitudes of direct P and S waves – it will be used for the Vrancea seismic zone though the hypocenters for Vrancea are much deeper than in Iceland. With this approach, we can find a 3D attenuation (Qp and Qs) model of the region. We will be looking closely for low-value anomalies of Qs, which could imply the presence of partially melted rocks or even the presence of magma.
A second objective will be a site-specific Ground Motion Prediction Equation (GMPE) for the region. This is essential for seismic hazard assessment. For the Vrancea region, it is important to find the sensivitive of the GMPE on hypocenter depth because the strong earthquakes have originated at various depths. Analysis of seismic attenuation from seismic body waves will provide additional information about the tectonic structures in the Vrancea region. Varying depths of the hypocenter will allow us to determine Q in the source area (Wcisło et al., 2018). Q anomalies are often significantly stronger than velocity anomalies. Additionally, the increase/decrease in seismic velocities is not necessarily tied to a corresponding change in seismic attenuation (Pham et al., 2002). Therefore, analysis of QP/QS ratio in the region can provide complementary information - particularly in regards to the discussion about possible slab detachment from the crust.

Děkuji za pozornost!
Vă mulțumim pentru atenție!

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