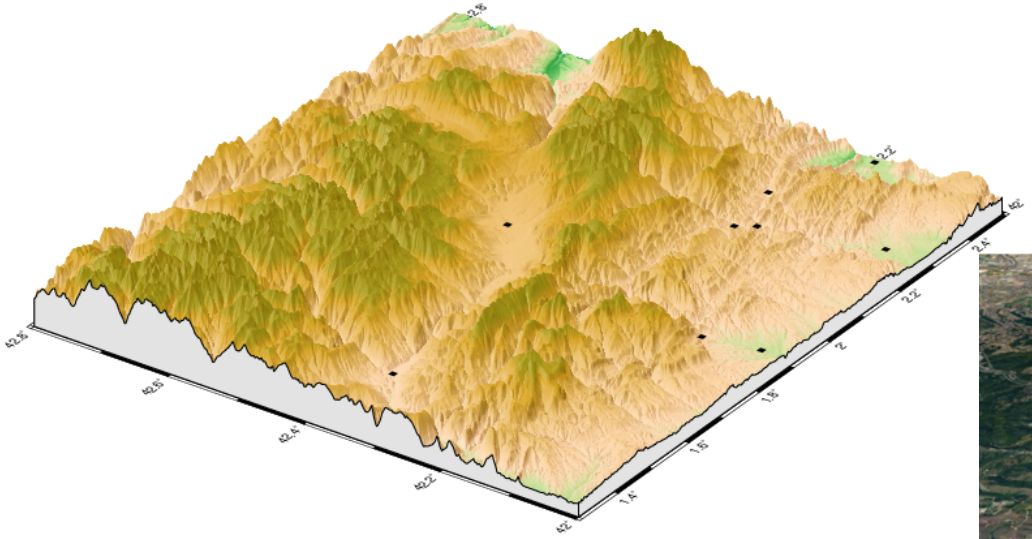
Testing the applicability of ambient noise methods in zones with different degree of anthropogenic sources.

J. Diaz, M. Schimmel, M. Ruiz, R. Carbonell
Institute of Earth Sciences Jaume Almera, ICTJA-CSIC, Barcelona, Spain



The SANIMS project (Spanish M. of Science, Research and Innovation, Ref.: RTI2018-095594-B-I00) is focused into the application and development of methods based on ambient noise seismic data to image and monitor natural and human-altered environments.

To achieve this objective, temporal seismic networks have been installed since late 2019 in two different settings;

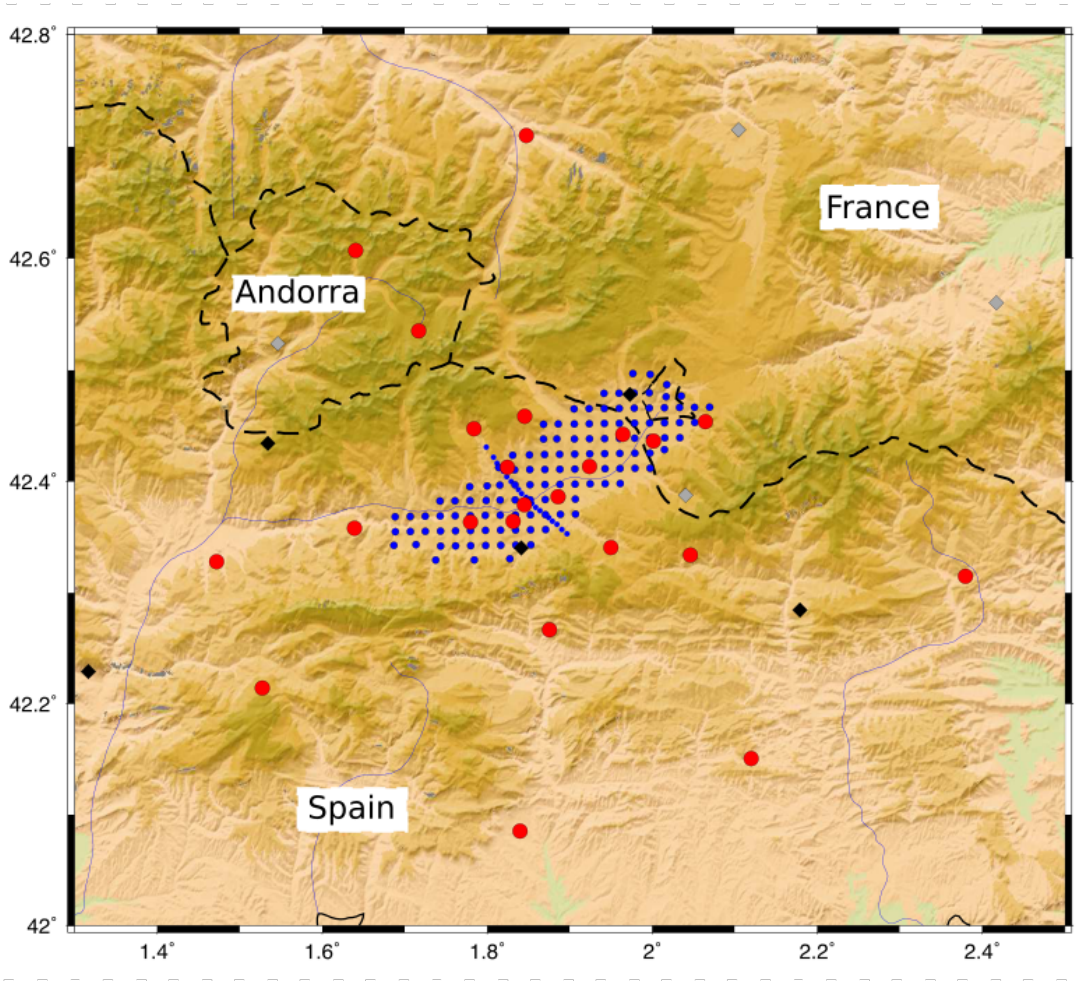
- The Cerdanya Basin, a sedimentary basin located in the eastern Pyrenees

- Barcelona city center.

Eastern Pyrenees deployment:

- 24 broad-band period stations deployed in September/October 2019 and active during one year

- High resolution seismic nodes deployment, scheduled for Fall 2020

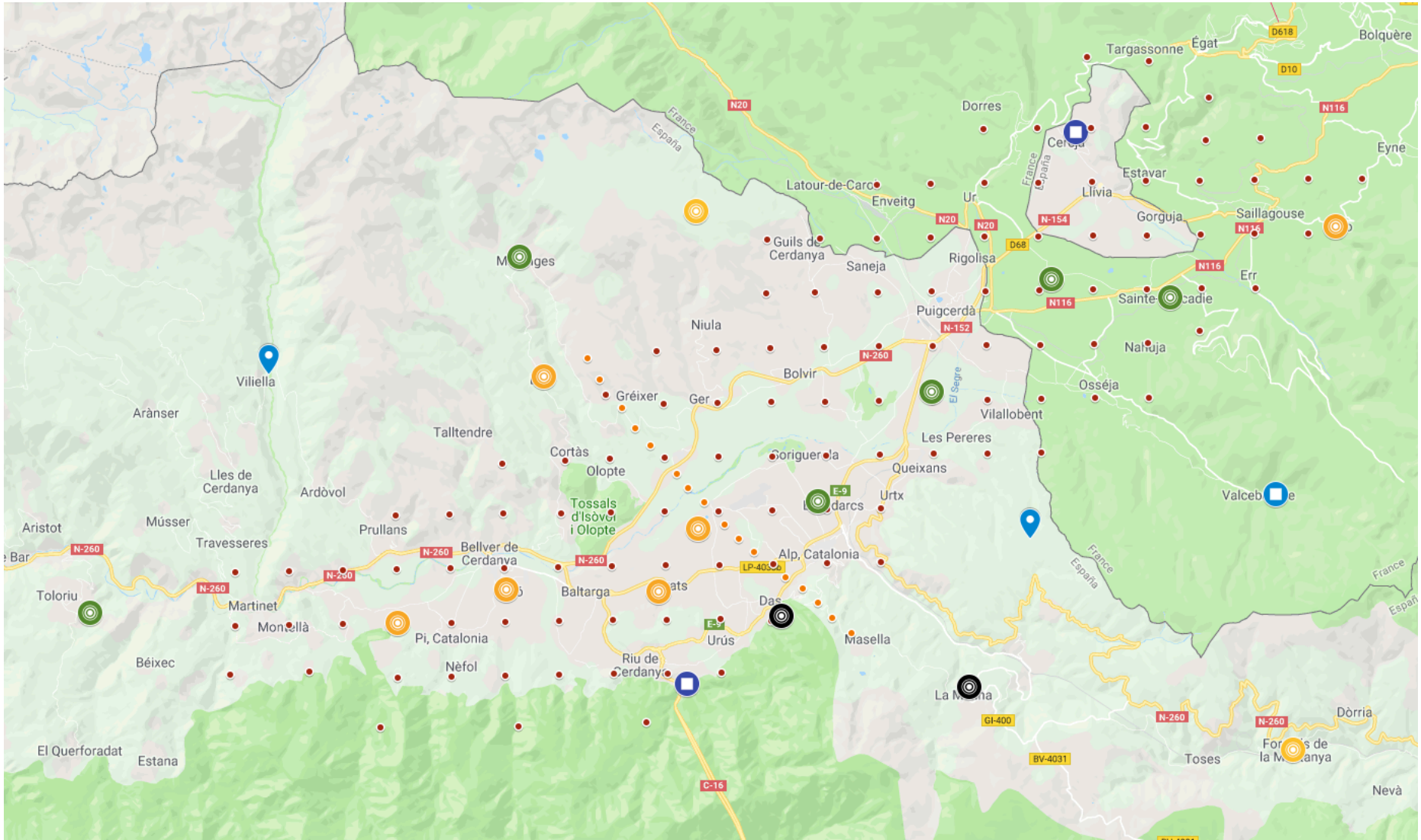


Eastern Pyrenees deployment: (Cerdanya basin)

- 3D bedrock mapping using HVSR and Rayleigh wave ellipticity inversion
- Ambient Noise Tomography
- Crustal scale structure from noise autocorrelation and receiver functions

Eastern Pyrenees deployment:

Area: 30x10 km aprox. Nodes grid spacing 1.5 km
High resolution node profile across the basin (700 m)
Along and across-basin BB profiles (4-6 km spacing 6 km)



Eastern Pyrenees deployment:

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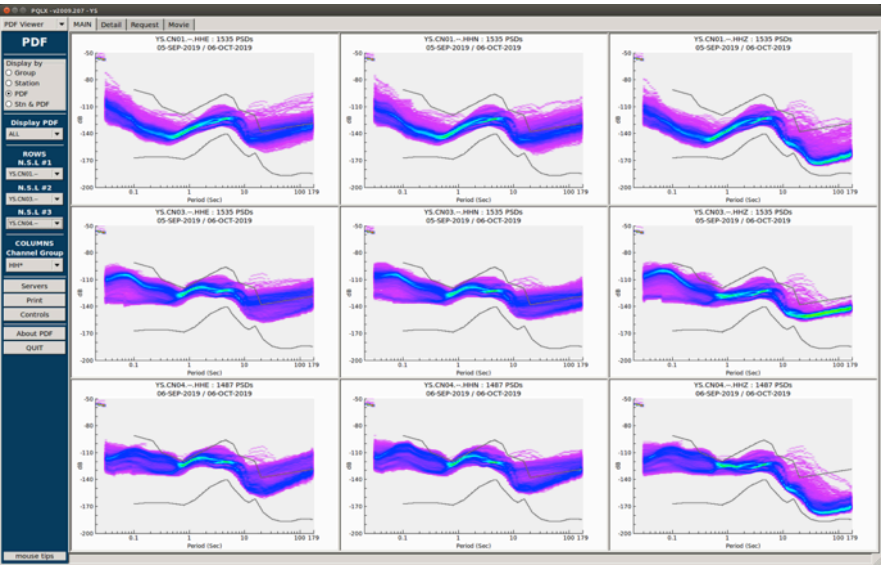
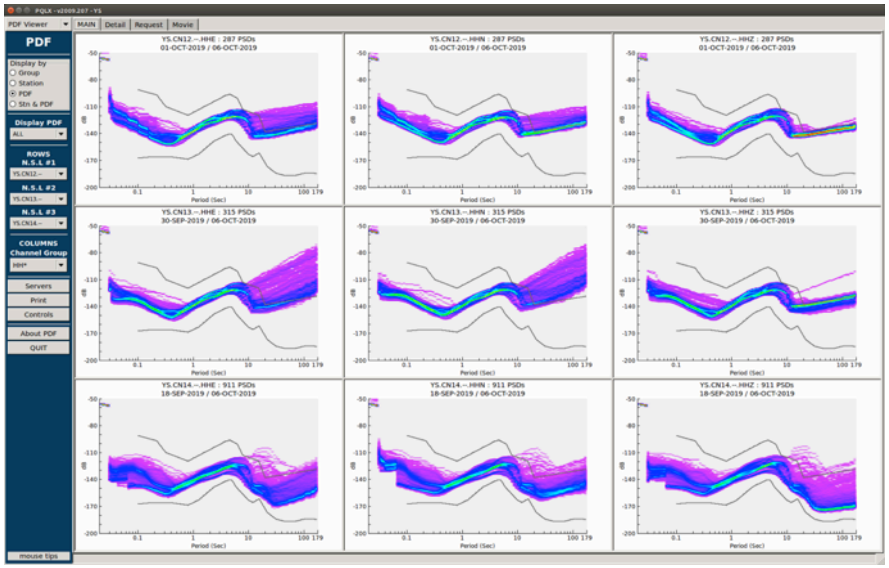
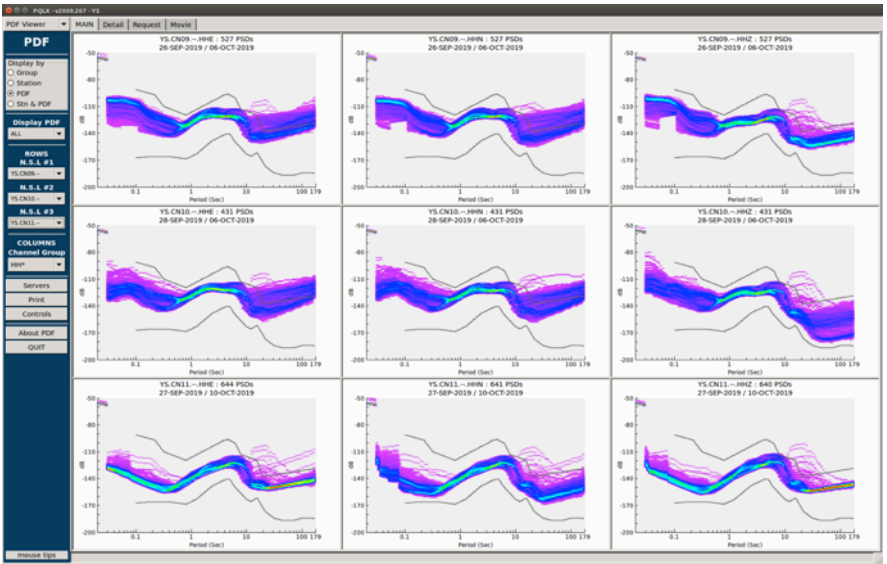
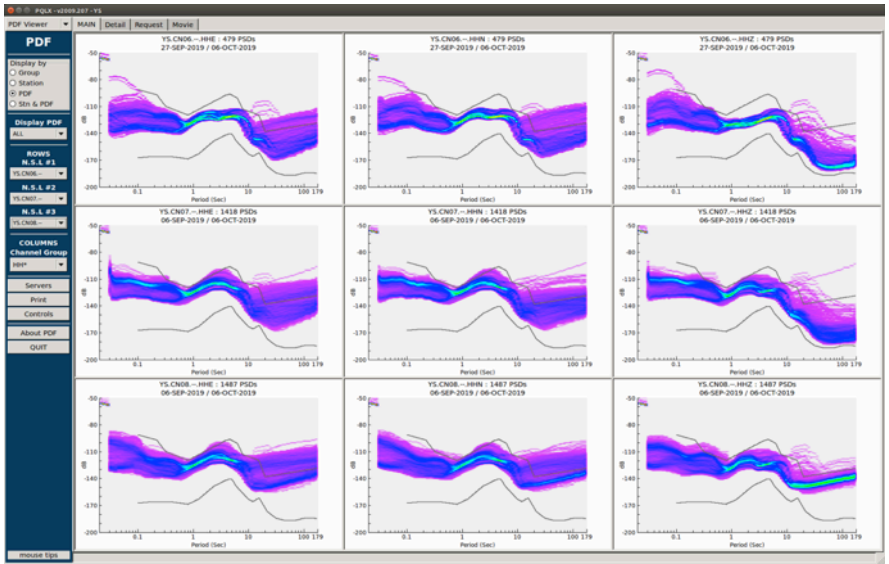
Quality check









Eastern Pyrenees deployment:

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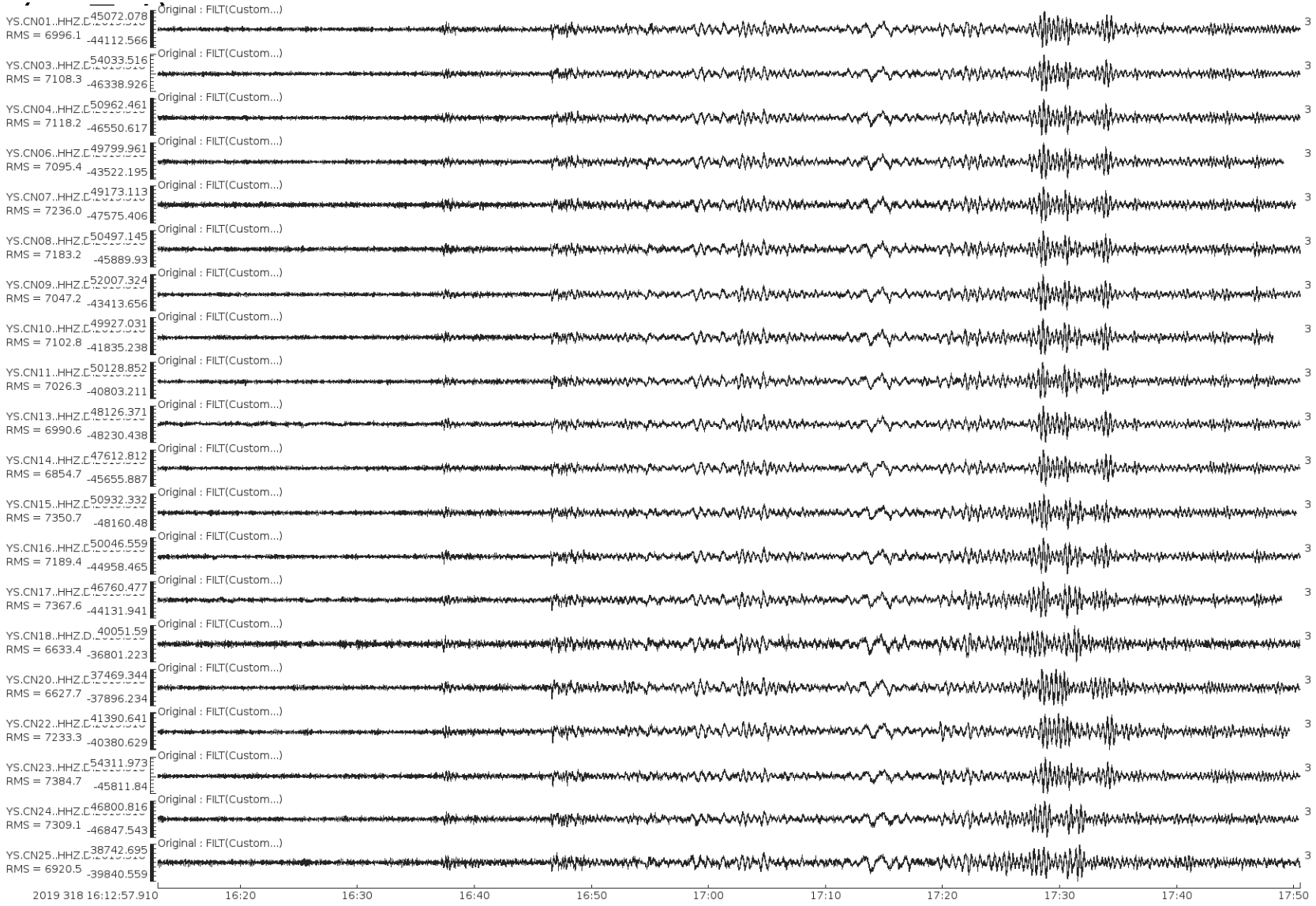
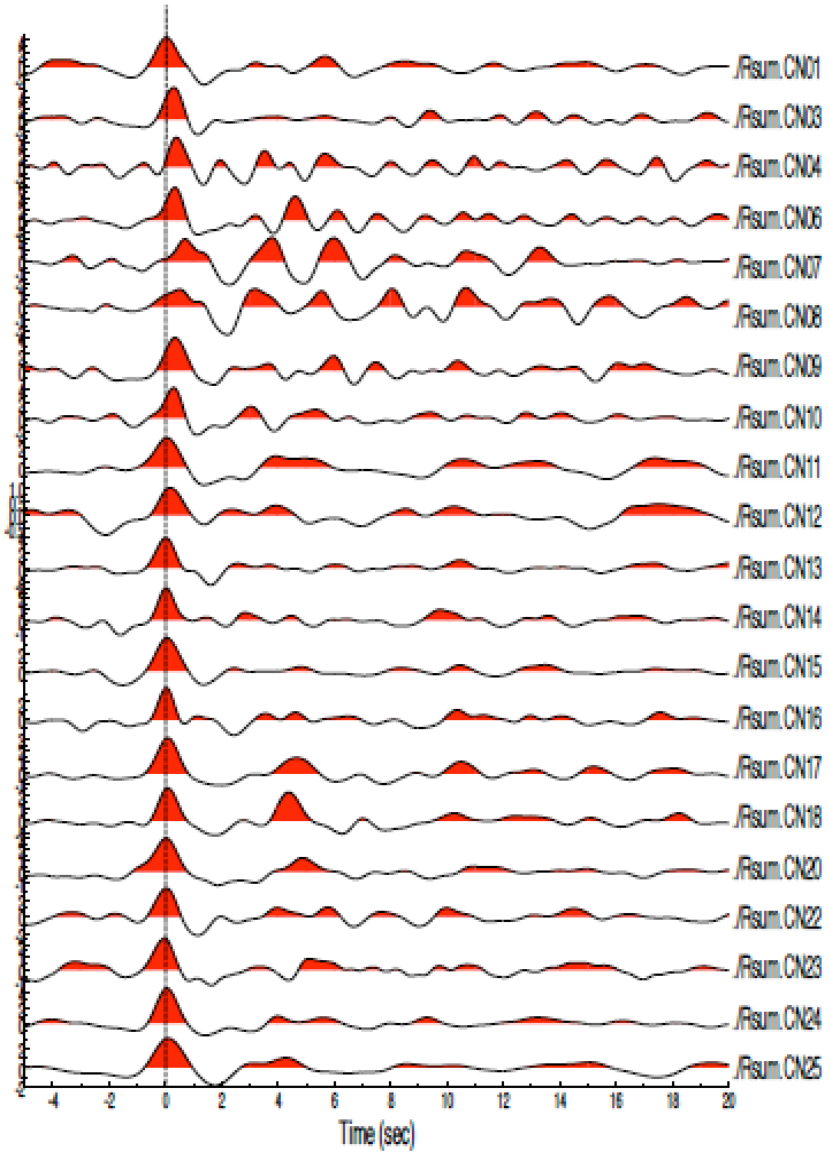
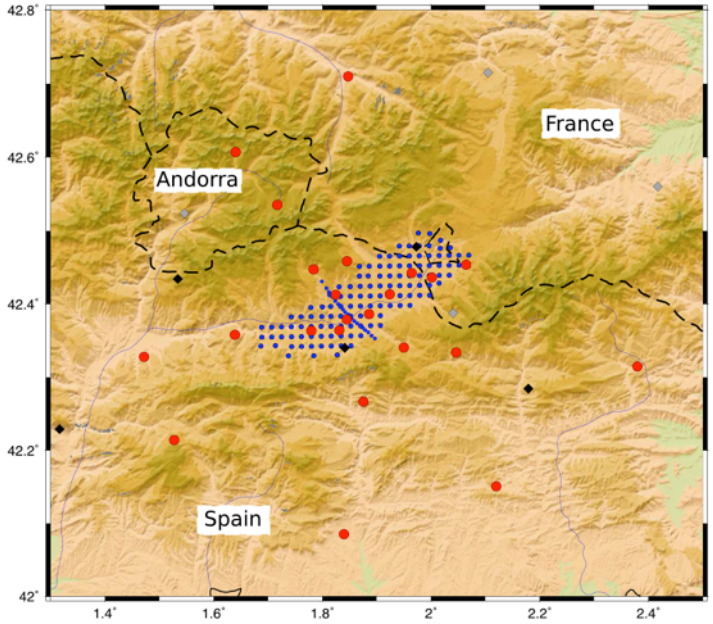
Example of recorded data: Indonesia 2019/11/14 event



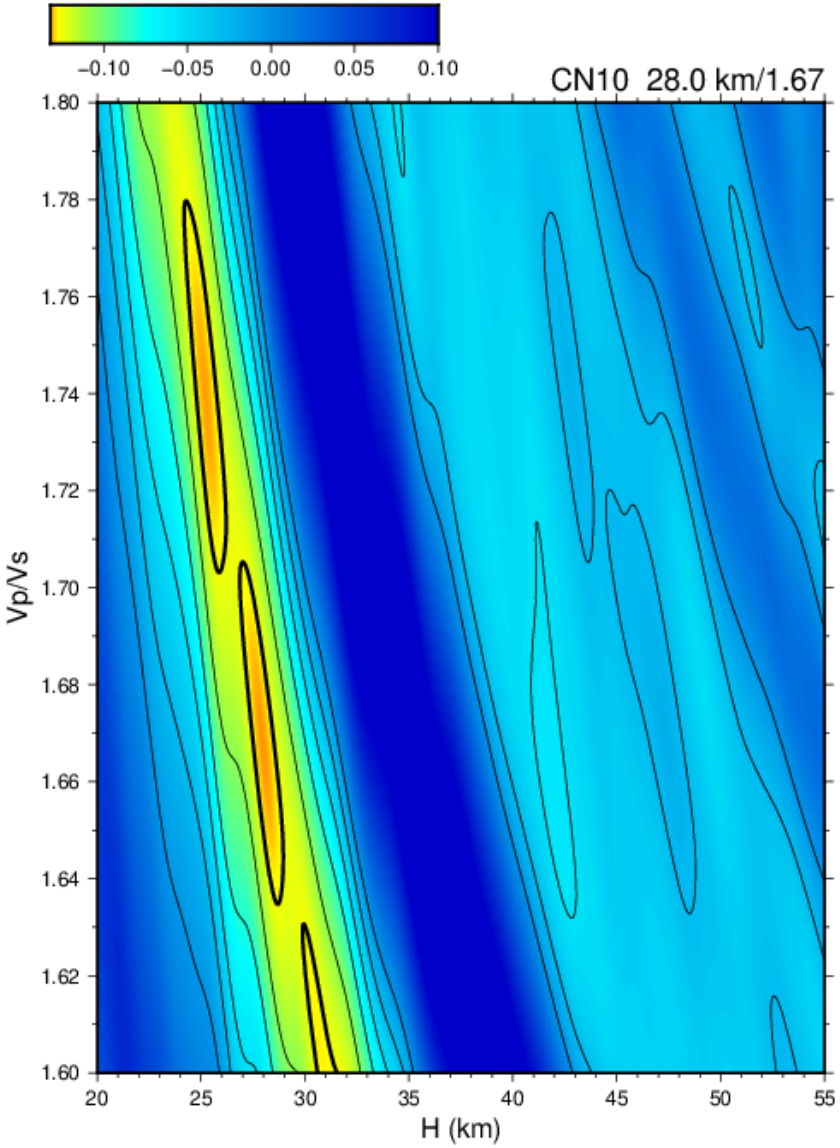
Eastern Pyrenees deployment:

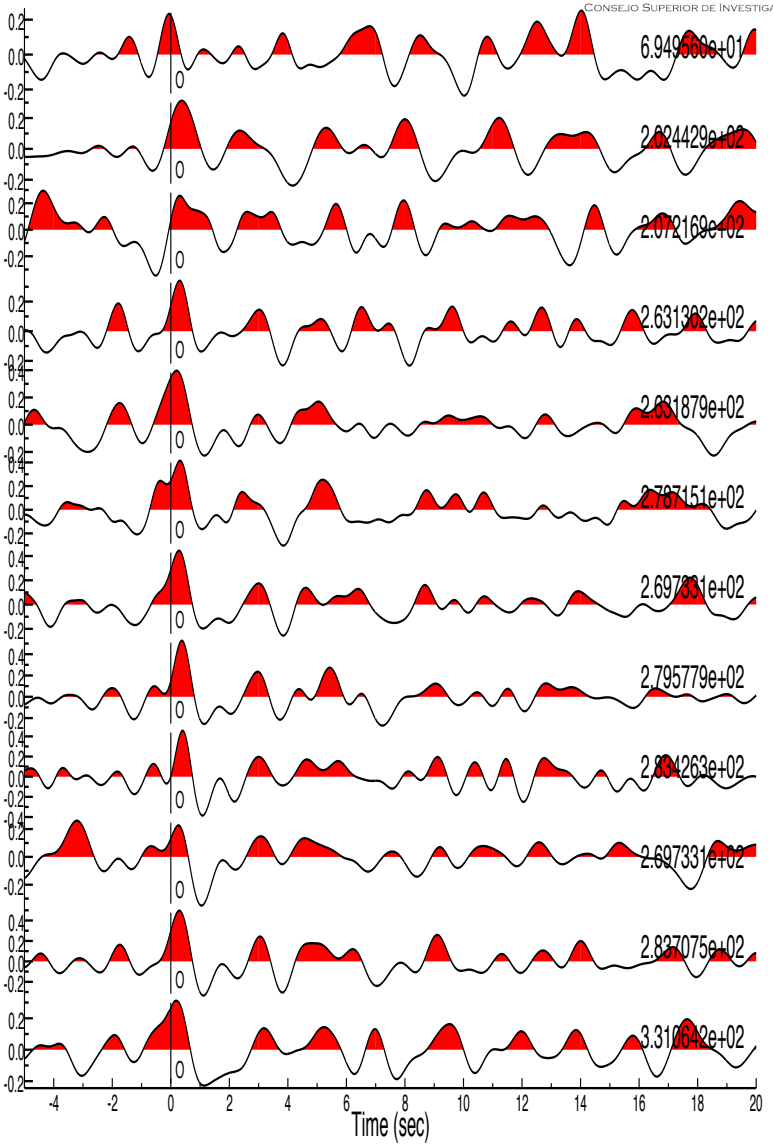




Preliminary RFs results: Stacks for all the stations

Eastern Pyrenees deployment:

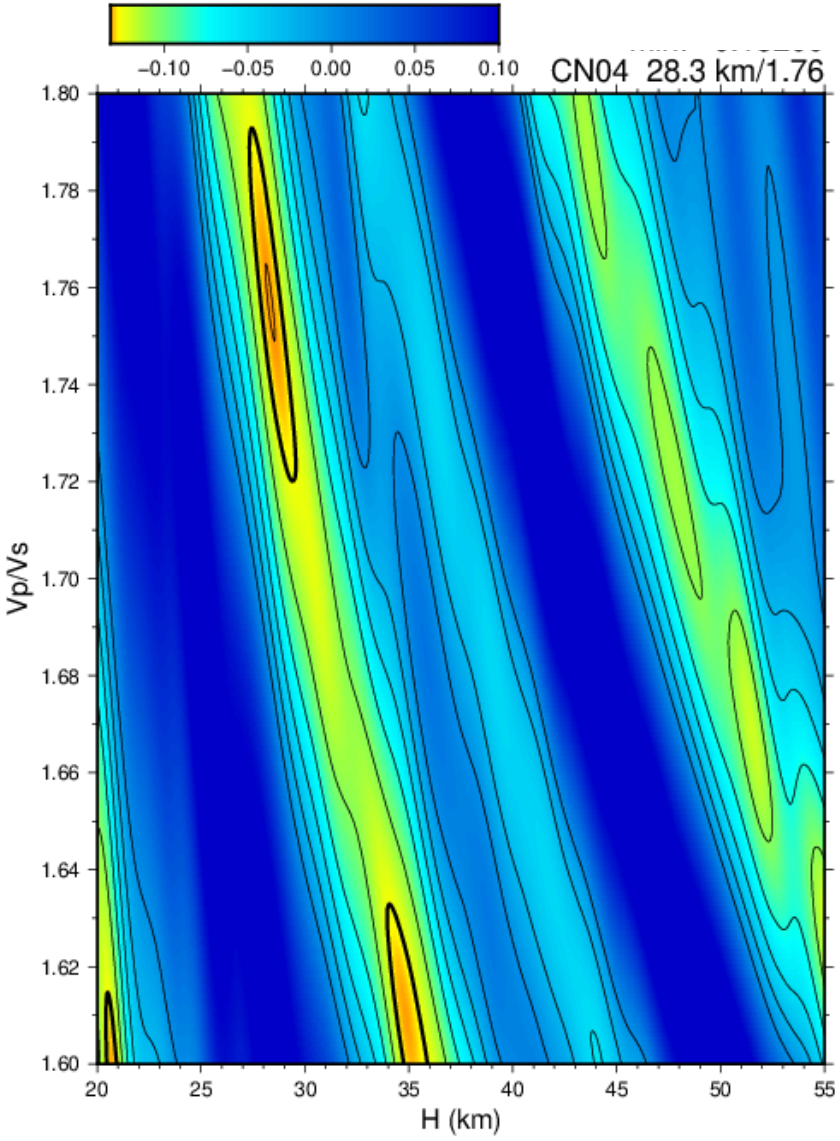


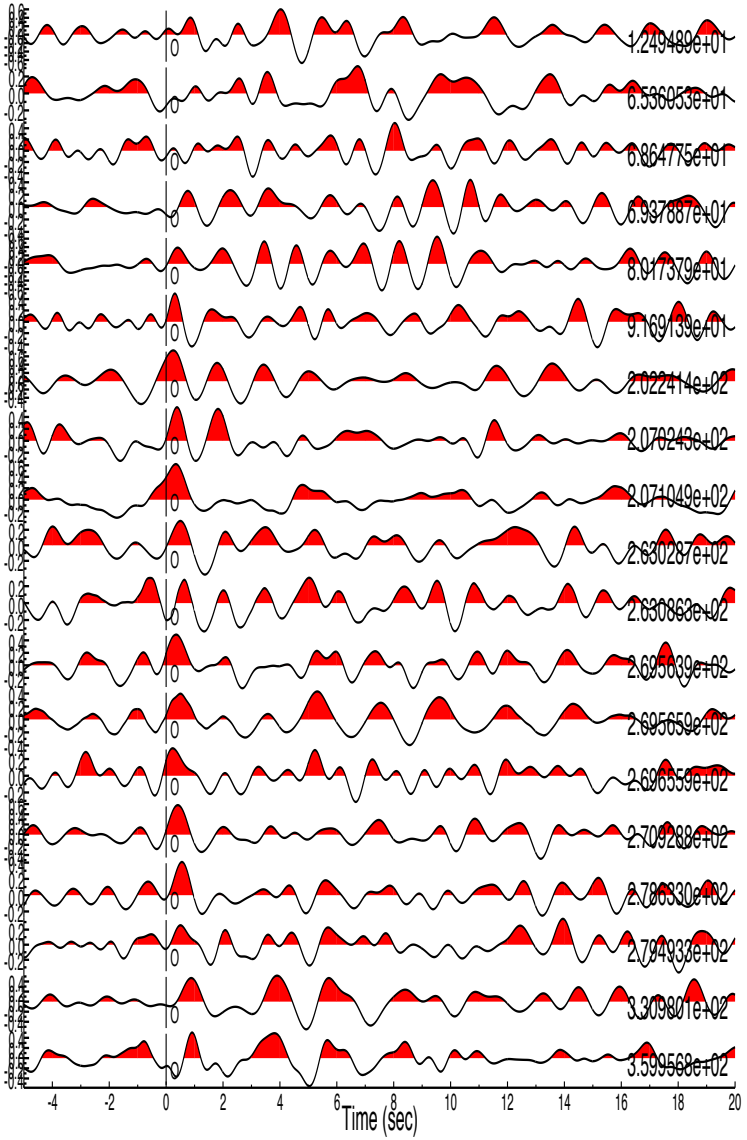


Preliminary RFs results:

CN10: European Crust ??

Eastern Pyrenees deployment:

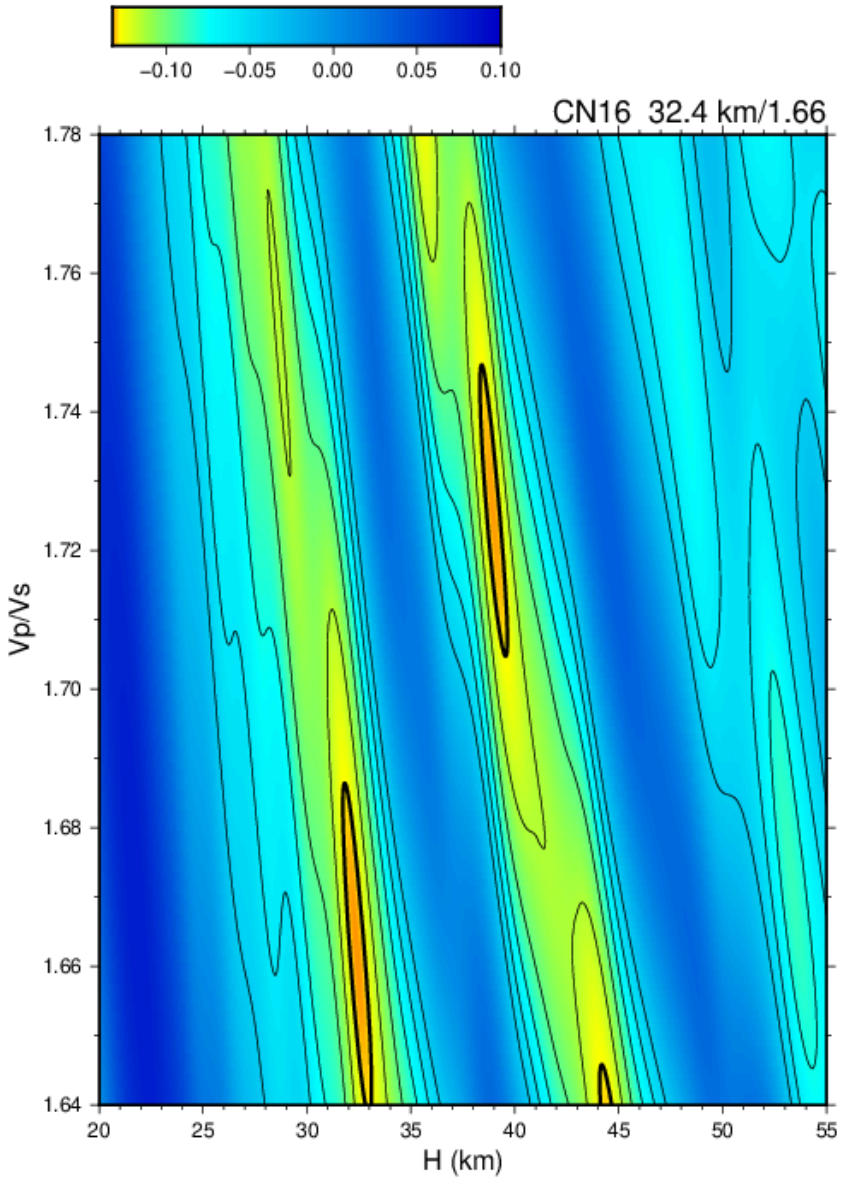


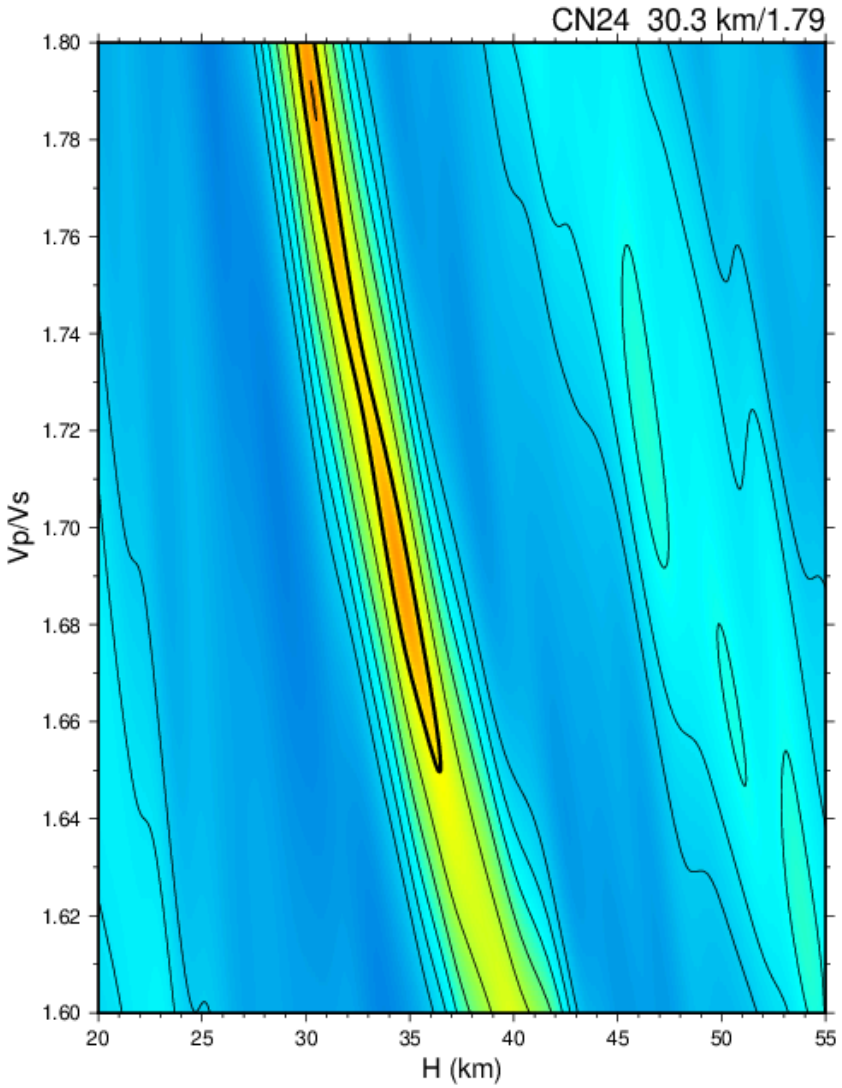


Preliminary RFs results:

CN04: Double Moho?? Azimuthal variation

Eastern Pyrenees deployment:

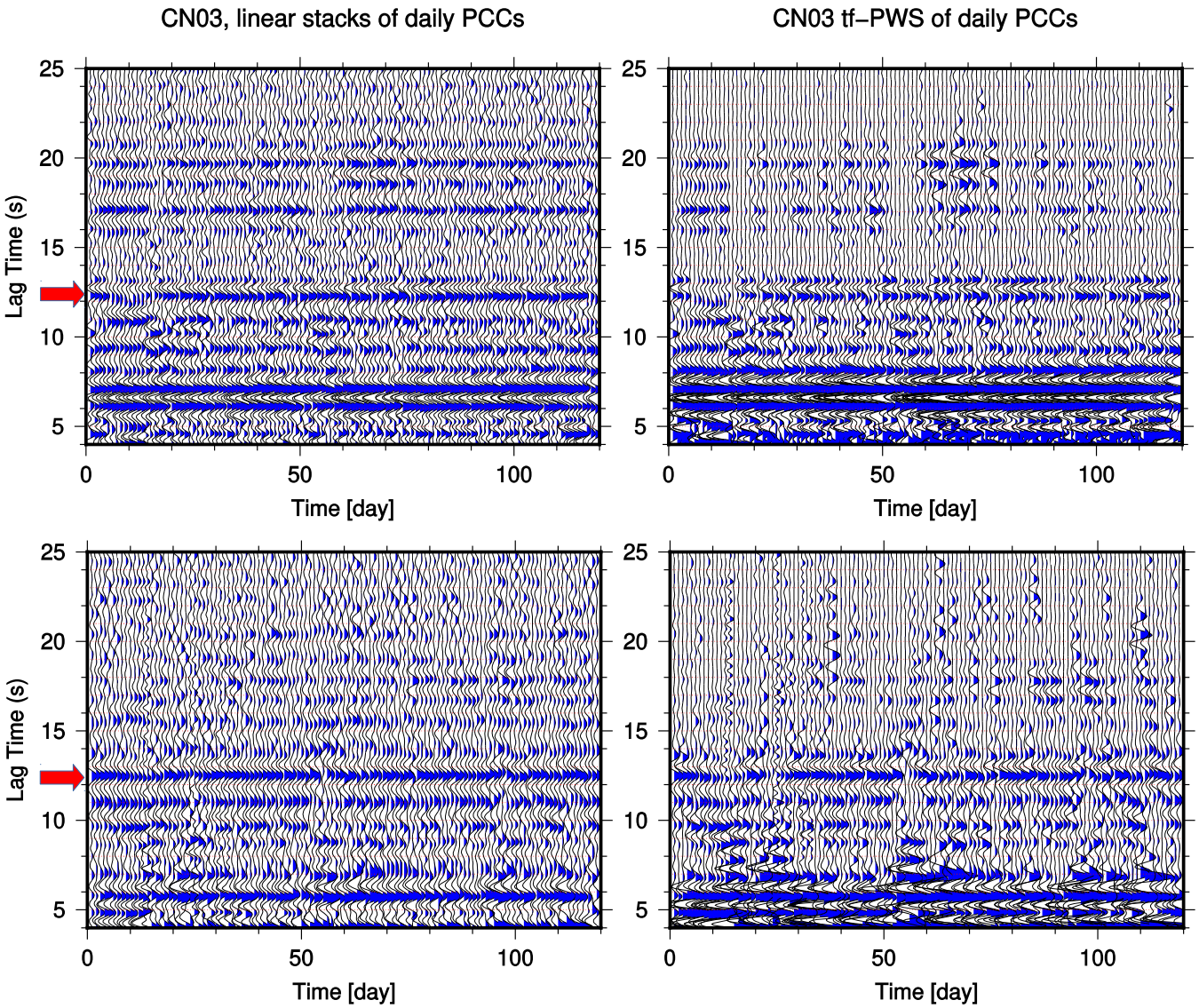




Preliminary RFs results:

Left: CN16 Complex structure, with eventual double Moho
Right: CN24: Simple structure outside of the thickened area

Eastern Pyrenees deployment:

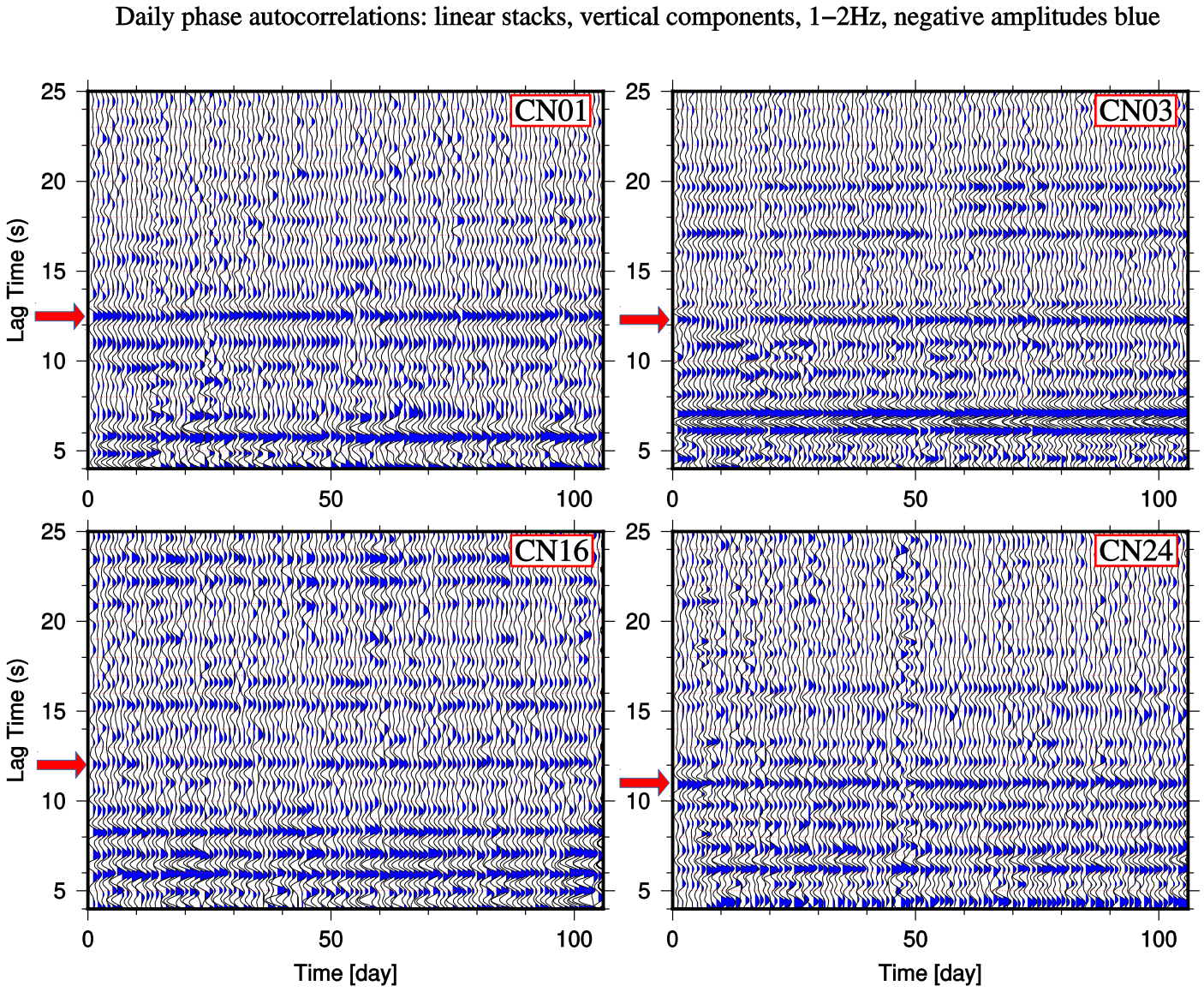


Improvement using PWS stacks

Preliminary Autocorrelations:

Red arrows show the reflection related to Moho

Eastern Pyrenees deployment:



Moho depth assuming Vp=6.2km/s:

38.8km (CN01),
38.1km (CN03),
37.8km (CN16),
34.1km (CN24)

Preliminary Autocorrelations:

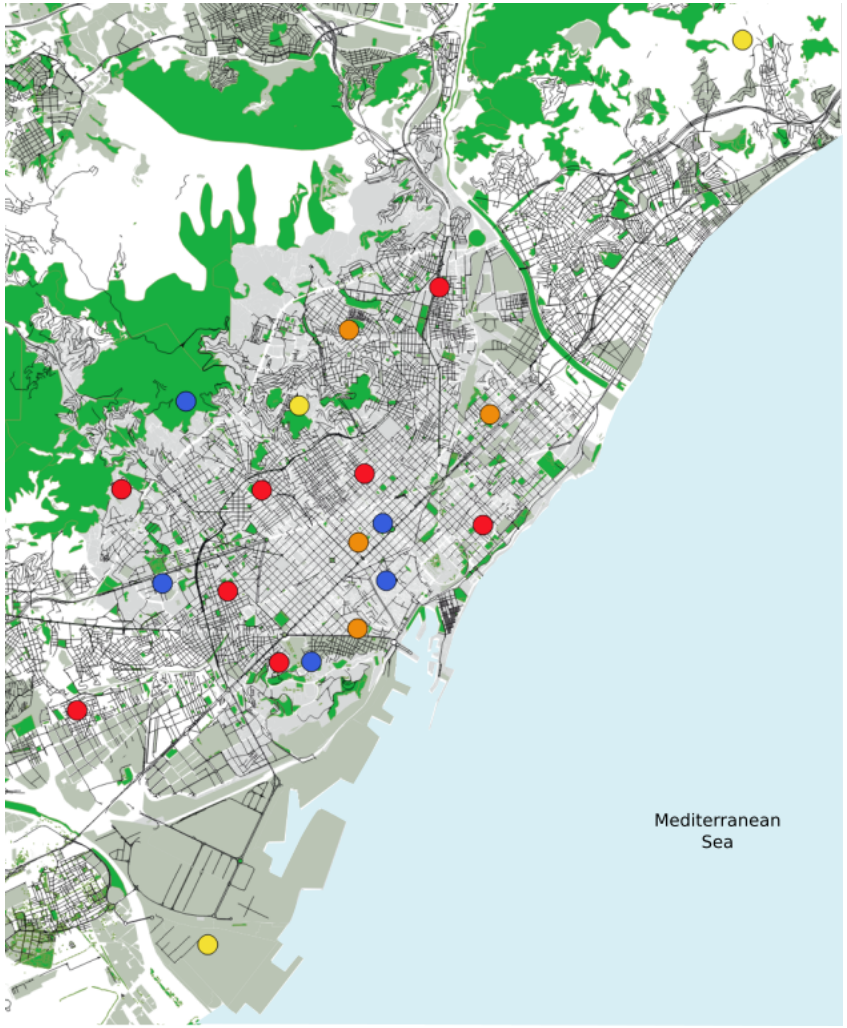
Red arrows show the reflection related to Moho

Barcelona city deployment:

15 short period temporary stations deployed within the city, most of them in the basement of secondary schools, for a duration of 9-12 months.

Two-fold objective:

- acquire new data relative to the characterization of uppermost crust using ambient background vibrations.
- introduce secondary school students in a Earth Science research project.



Barcelona city deployment:

- Characterization of the sources of background vibrations in urban environments
- Testing the applicability of subsurface imaging within urban environments
- Outreach and dissemination activities

Barcelona city deployment:

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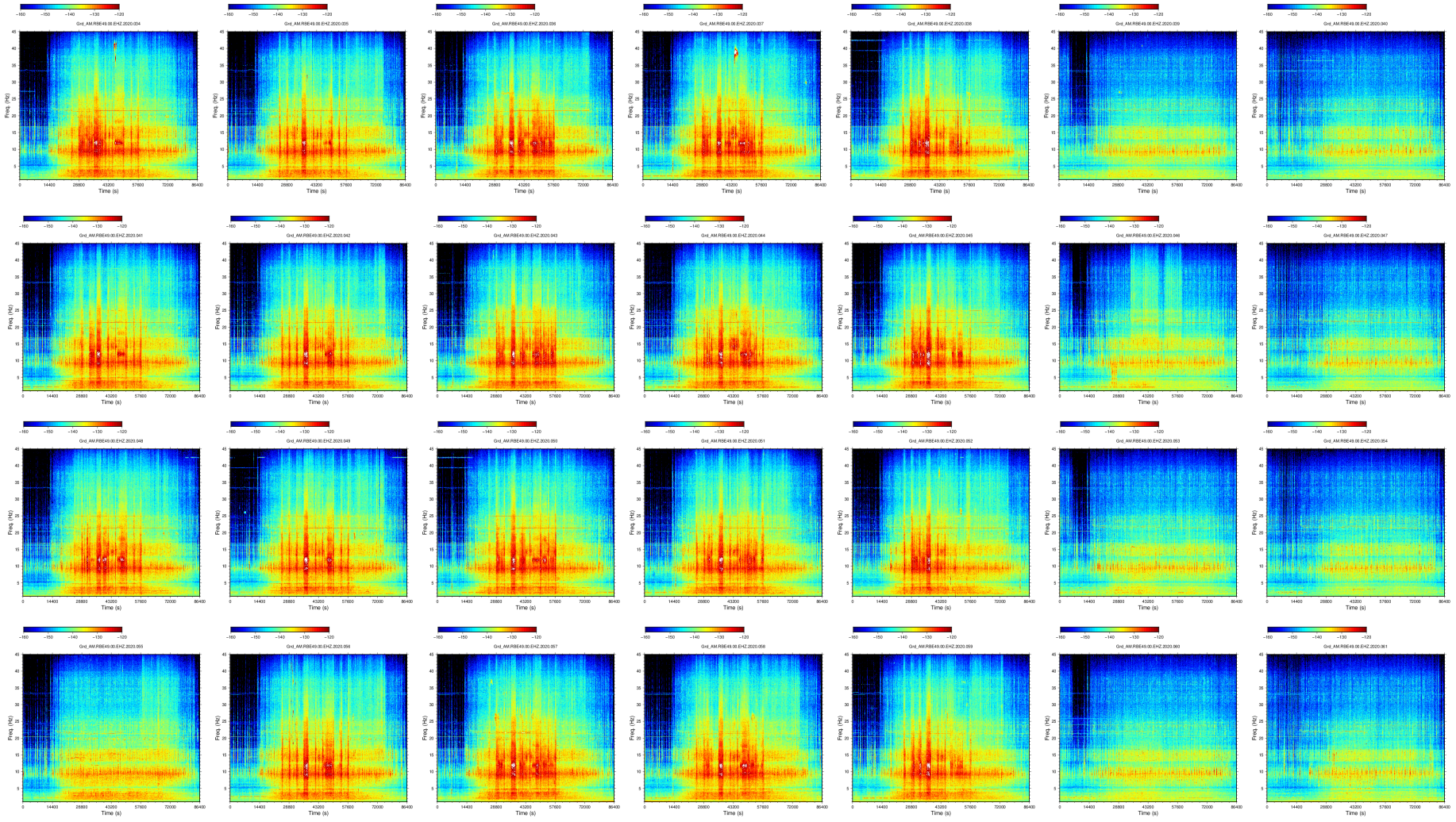
Background noise variations related to man-made activity

Tecla Sala - RBE49
2020/02/03 - 2020/03/01

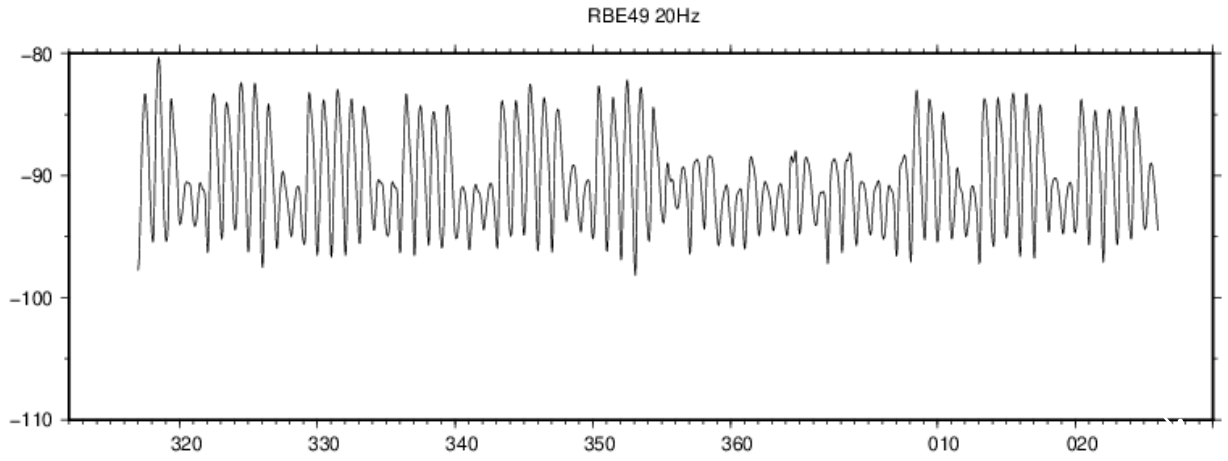


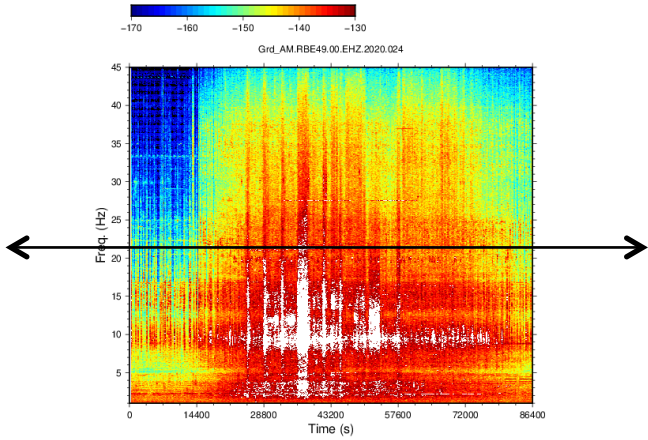
Weekly variations in the seismic spectra

Barcelona city deployment:

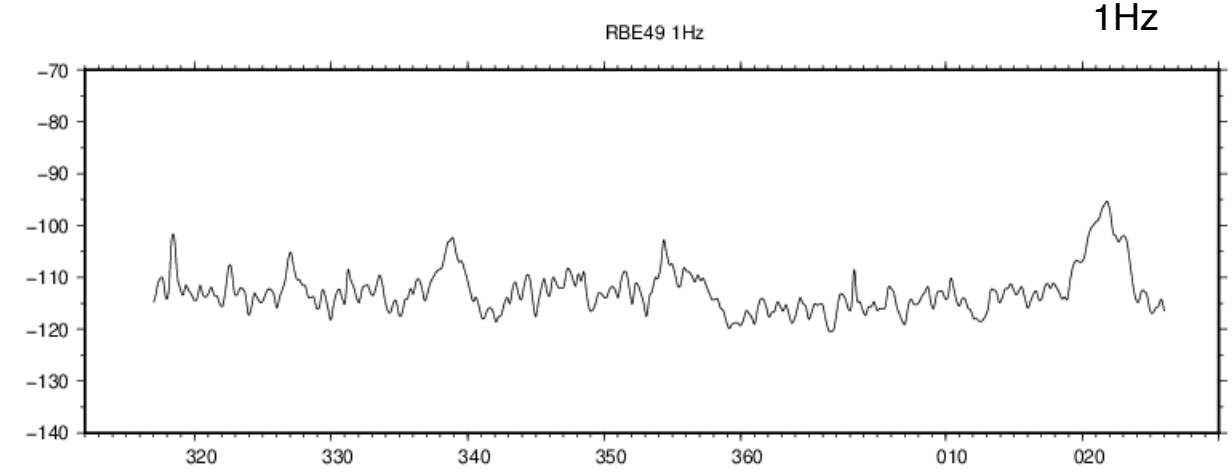
Anthropogenic vs Oceanic sources

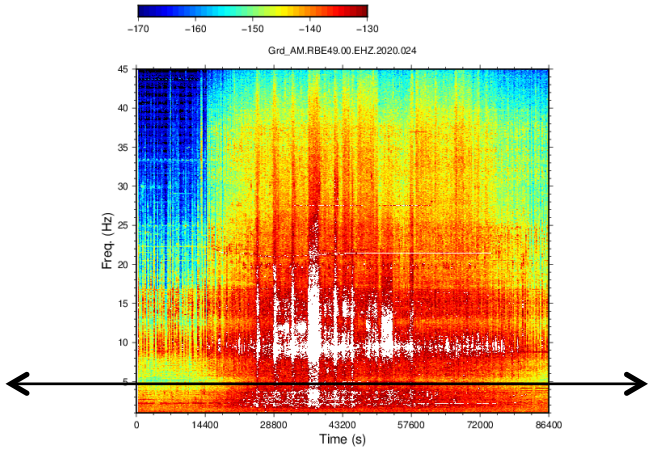
20 Hz





1Hz





Barcelona city deployment:

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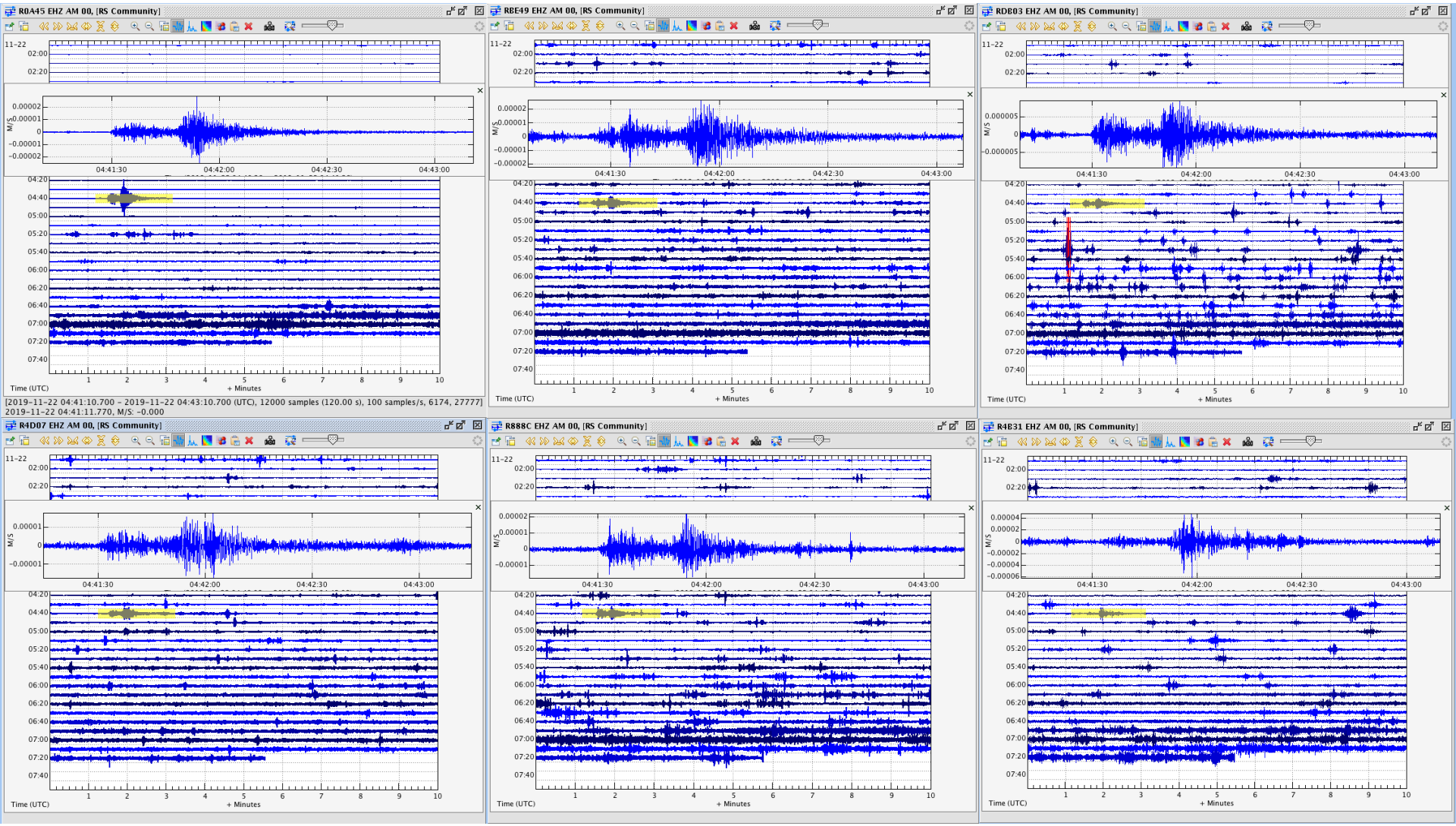
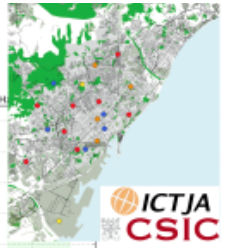
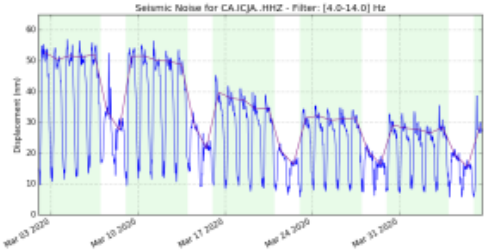
Regional earthquakes
2019-12-08 04:08 – m 2.8 La Torre de Cabdella (E Pyrenees)

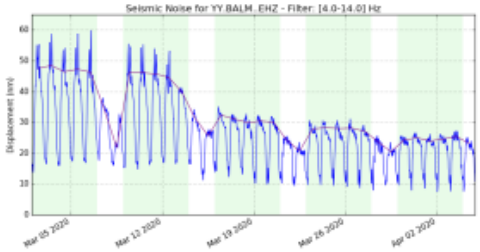


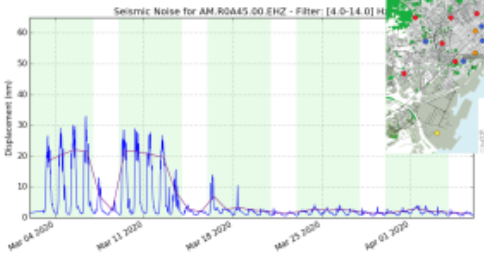
Barcelona city deployment:

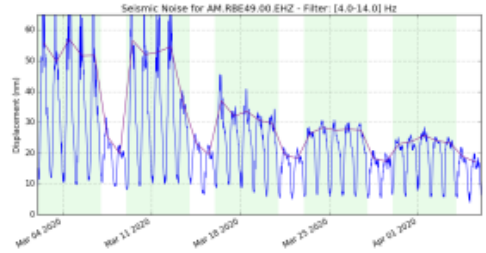
… and the effect of the Covid-19 lockdown

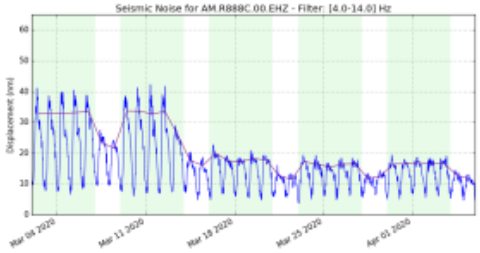


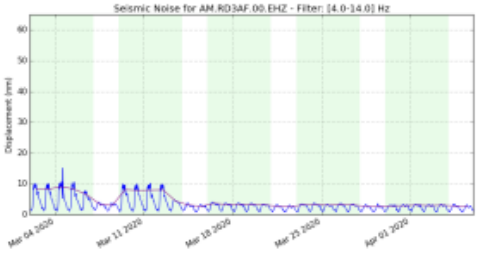


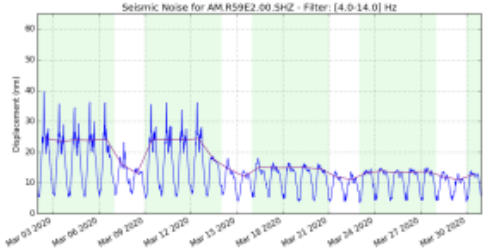


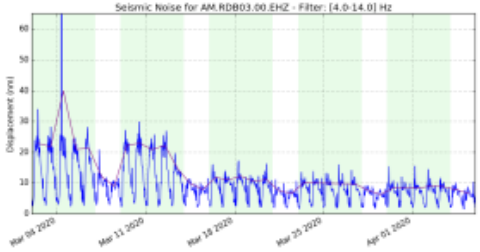


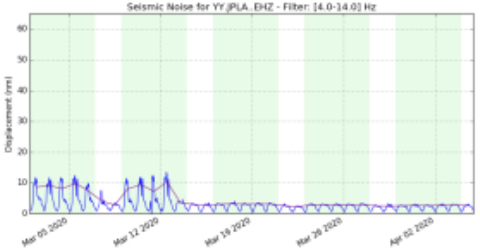


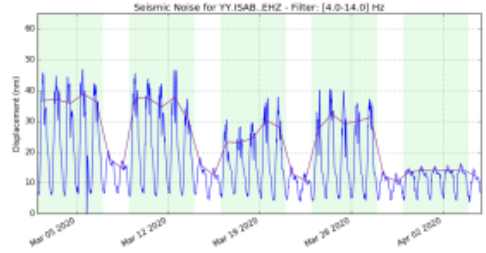


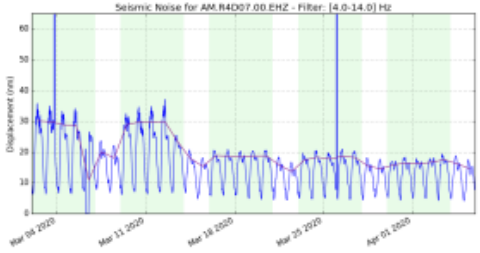


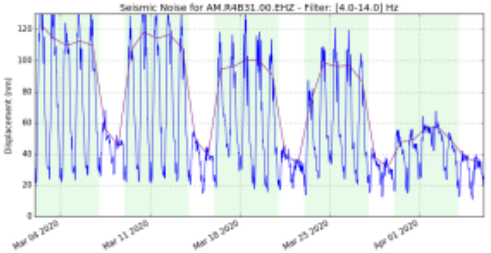








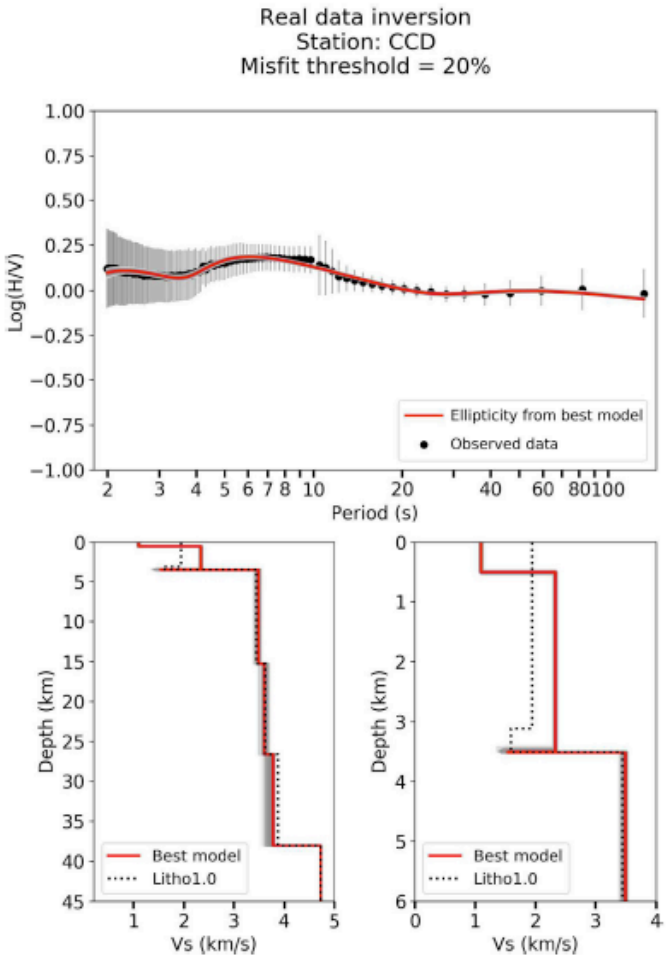




Work in progress:

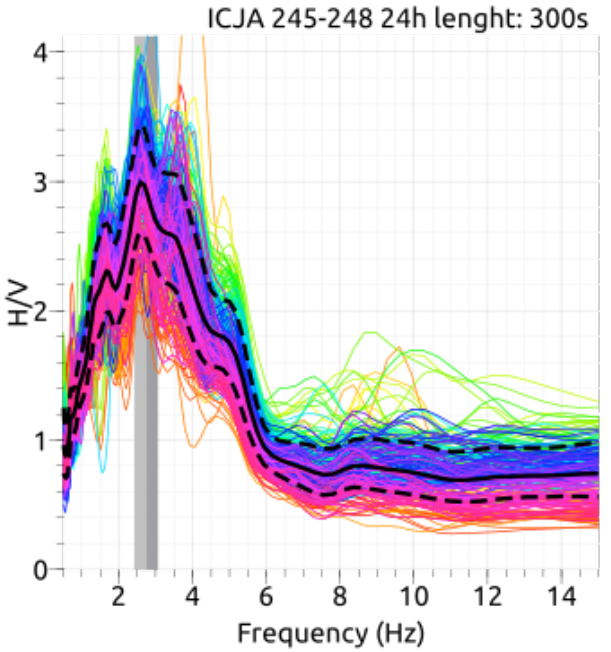
Eastern Pyrenees:

- Extraction of the fundamental mode of Rayleigh waves to measure inter-station group and phase velocity dispersion curves.
- Inversion of the dispersion curves using the Fast Marching Surface Tomography method.
- Joint inversion of Love and Rayleigh to constrain radial anisotropy and/or the application of new strategies to perform attenuation tomography.
- Receiver Functions to constrain crustal structure
- Anisotropy measurements based on SKS splitting and, eventually, local earthquakes
- Relocation of local, low magnitude earthquake activity



Inversion results at station CCD (Antarctica) from both ambient and earthquakes. Berbellini et al 2018

Work in progress:



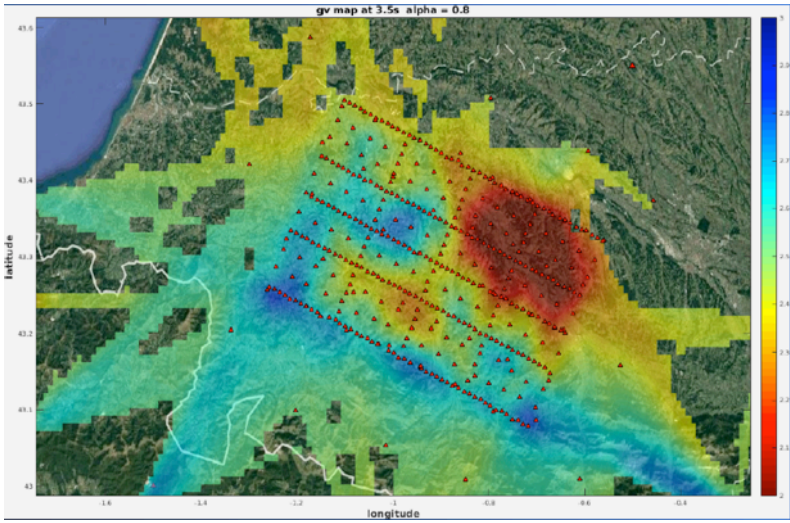
Barcelona city:

- Expand the available MHVSR measurements dataset and analyze its eventual the time variability.
- Analyze the applicability of the methods based on Rayleigh wave ellipticity inversion of ambient noise and earthquake data to provide S-velocity depth profiles
- Outreach talks at secondary schools
- Supervision of research projects of secondary school students

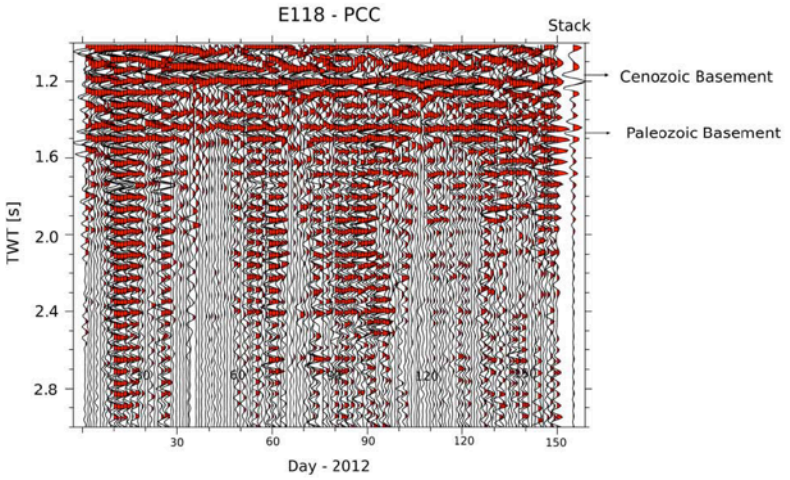
Work in progress:

We expect that the project will allow us to:

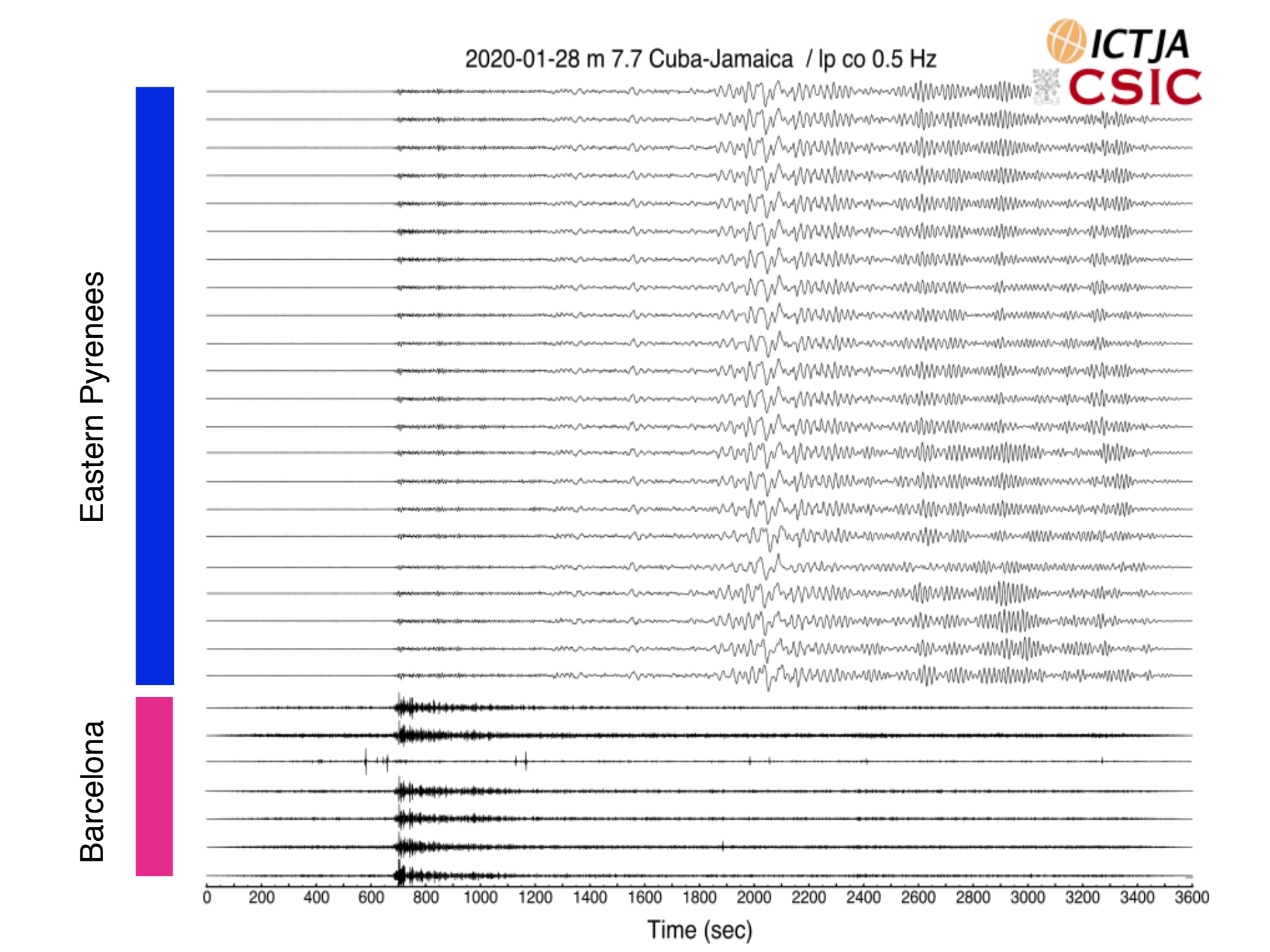
- Map the basement and to obtain new higher resolution ambient noise tomographic images of the upper crust in the Cerdanya Basin.
- Enlarge the crustal structure knowledge of this area, a relevant issue to understand the connection between the Pyrenean orogenic belt and the thinned areas of the Gulf of Lion
- Better constrain the subsoil properties of Barcelona, hence improving the existing seismic hazard maps.
- Compare the performance of the different methods based on ambient noise in quiet and noisy areas.



Ambient noise tomography using the Maupassacq data set
L. Stehly, (pers. com)



Upper crust structure from noise autocorrelations.
Romero and Schimmel, 2018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ICTJA
CSIC
Eastern Pyrenees
Barcelona
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