Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

INGV

Local Noise sources at Sos Enattos

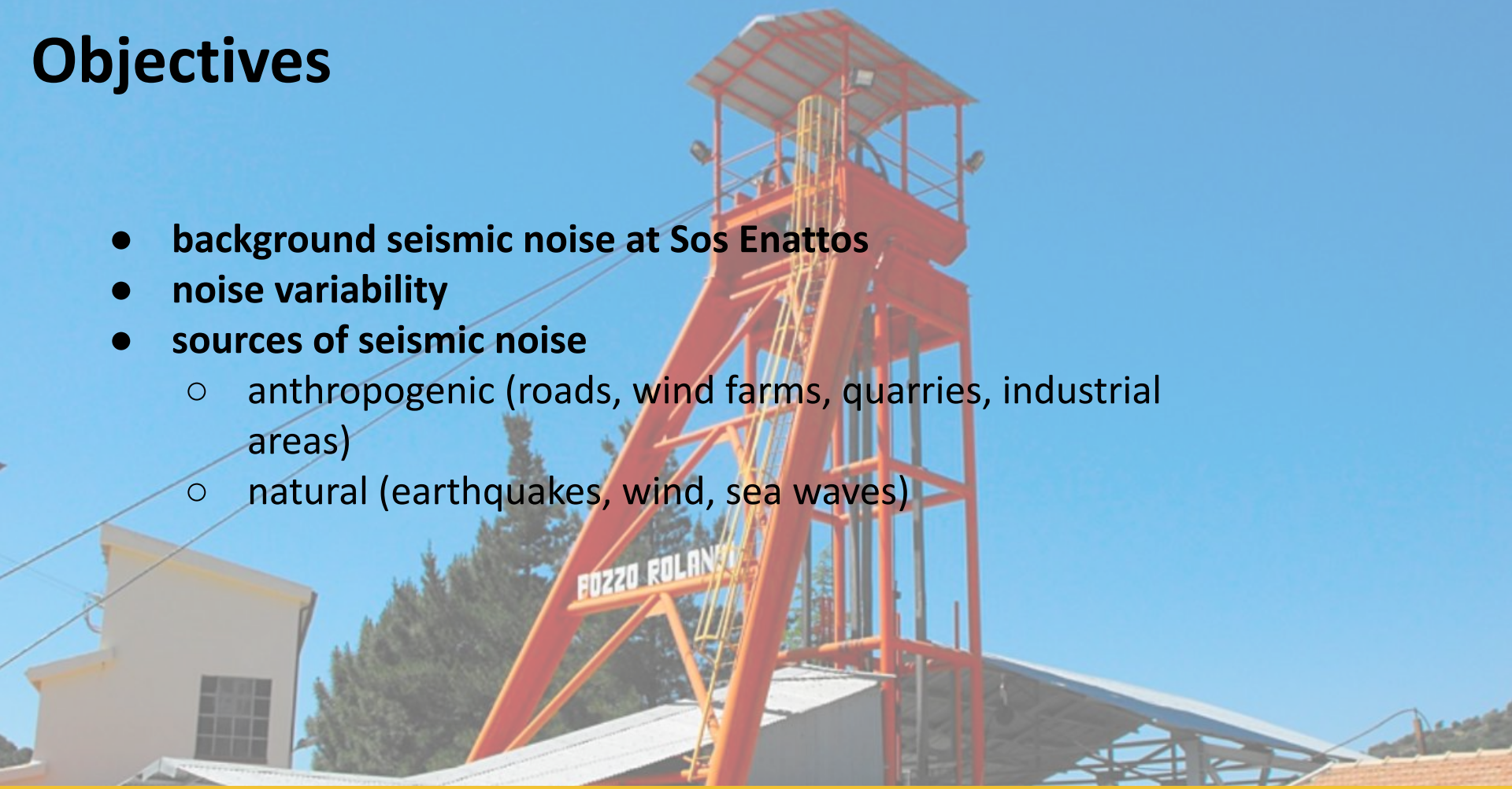
Marco Olivieri
Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Bologna

MEET MONITORING EARTH'S EVOLUTION AND TECTONICS

SARDINIA FABER FAR FAULT OBSERVATORY

ET ITALY Einstein Telescope

Objectives



- **background seismic noise at Sos Enattos**
- **noise variability**
- **sources of seismic noise**
  - anthropogenic (roads, wind farms, quarries, industrial areas)
  - natural (earthquakes, wind, sea waves)

Long-lasting collaborative action (since 2019)

INGV

Carlo Giunchi, Gilberto Saccorotti, Marco Olivieri, Spina Cianetti, Irene Molinari, Giovanni Diaferia, Gennaro Sepede, Fabio Di Felice, Mario Anselmi, Stefano Marino, Damiano Biagini, Sonja Gaviano, Michele D'Ambrosio, Andrea Berbellini,

INFN

Luca Naticchioni, Matteo Di Giovanni, Fulvio Ricci, Rosario de Rosa, Enrico Calloni,

GSSI

Soumen Koley, Jan Harms

UniCagliari

Alessandro Cardini, Andrea Contu

UniSassari

Domenico D'Urso, Davide Rozza, Luca Cardello

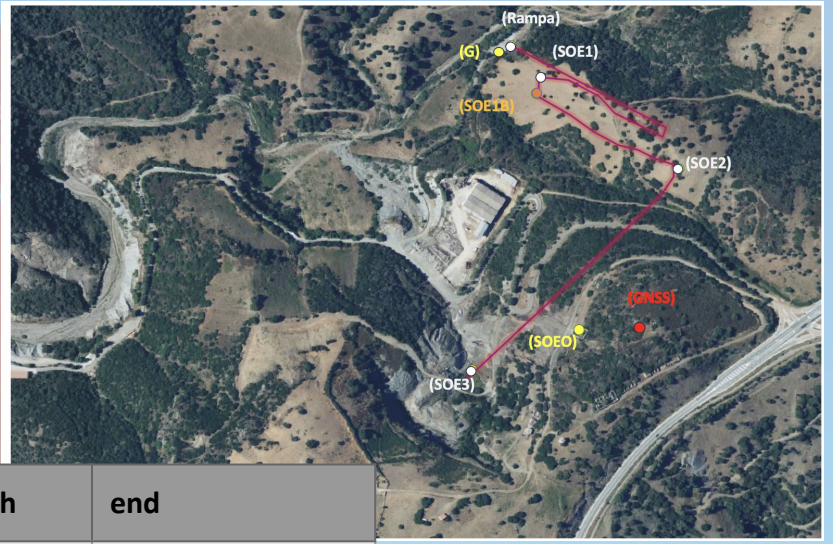
KIT

Andreas Rietbrock

UniPD

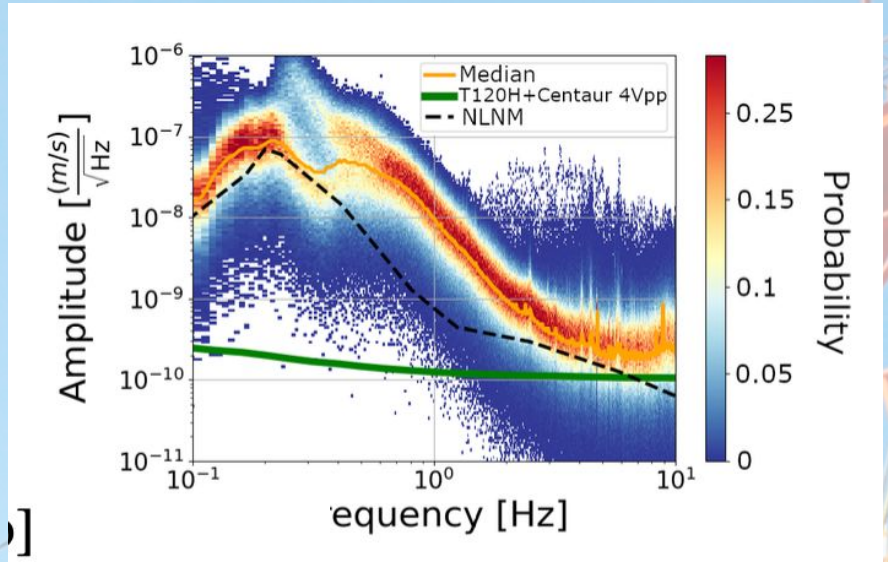
Lapo Boschi

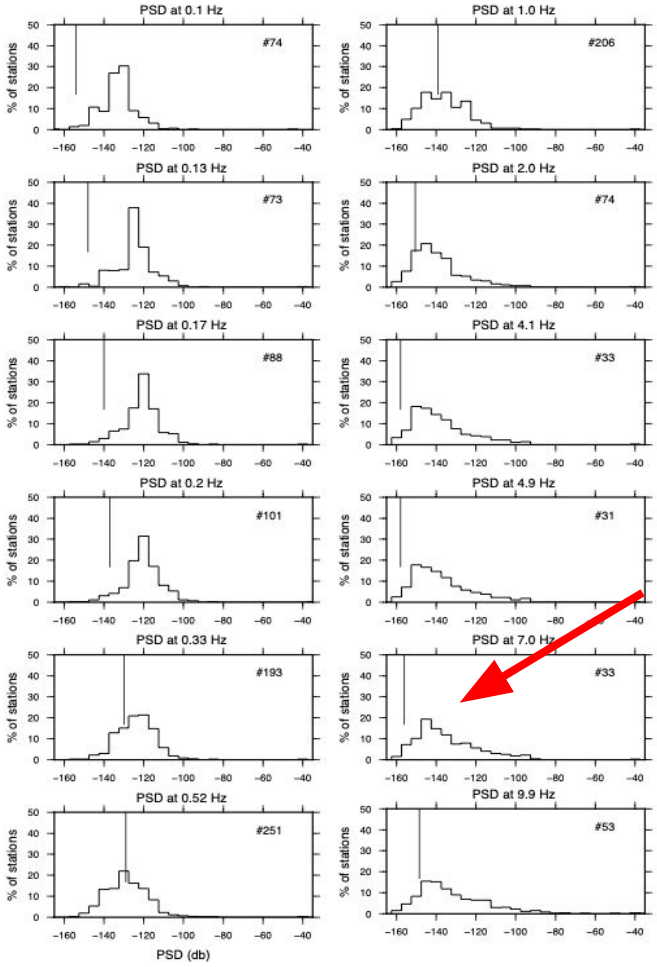
Permanent stations



Name	Sensor	period	starting epoch	end
SOE0	Guralp CMG-3T Trillium 120	360s 120s	2019.081 2021.173	2021.172 -
SOE1	Trillium 240 Trillium Horizon 120	240s 120s	2019.083 2020.183	2020.182 -
SOE2/SENA	Trillium 240 Trillium 360 GSN	240s 360s	2019.086 2021.172	2021.172 -
SOE3	Trillium 240	240s	2020.230	-

Long term noise analysis





Seismic noise recorded in the mine (above) and a comparison with that of the Global Seismic Network (right)

Sos Enattos is the 31st less noisy site at 4.9 Hz

Long term noise

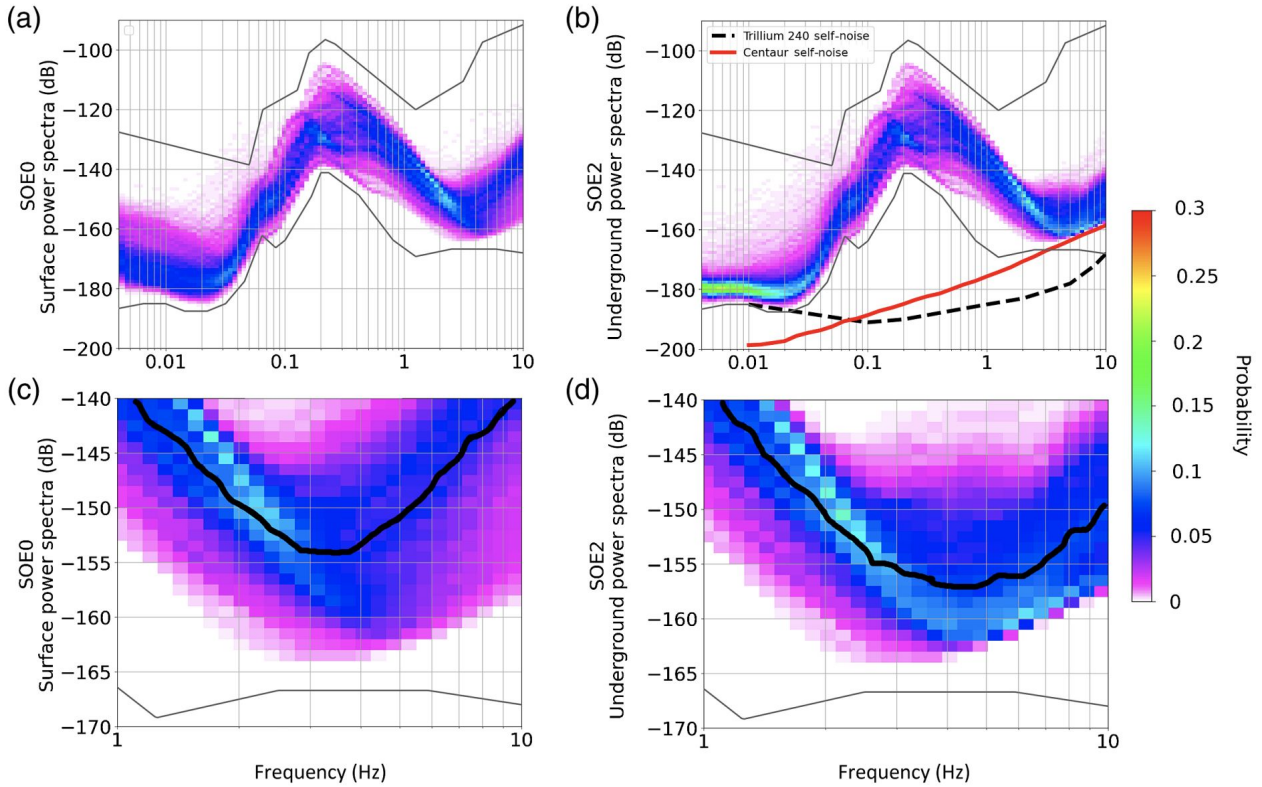
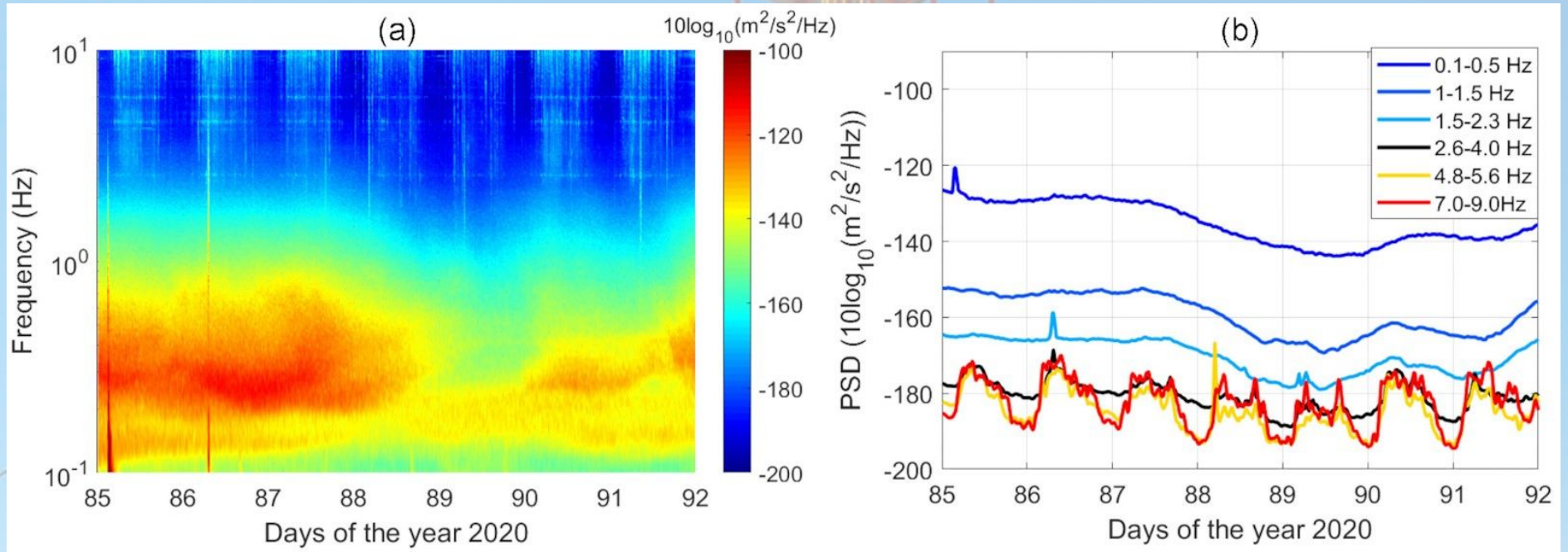


Figure 2. Probabilistic power spectral densities (PPSDs) of the vertical channels for (a) SOE0 and (b) SOE2 during 2020. The frequency ranges from 0.02 Hz (240 s) to 50 Hz (0.02 s). The new low-noise model (NLNM), new high-noise model (NHNM), and detector noise curves are also shown. (c,d) Zoom of (a,b) in the [1,10] Hz band including the median of the PPSD (black line). The color version of this figure is available only in the electronic edition.

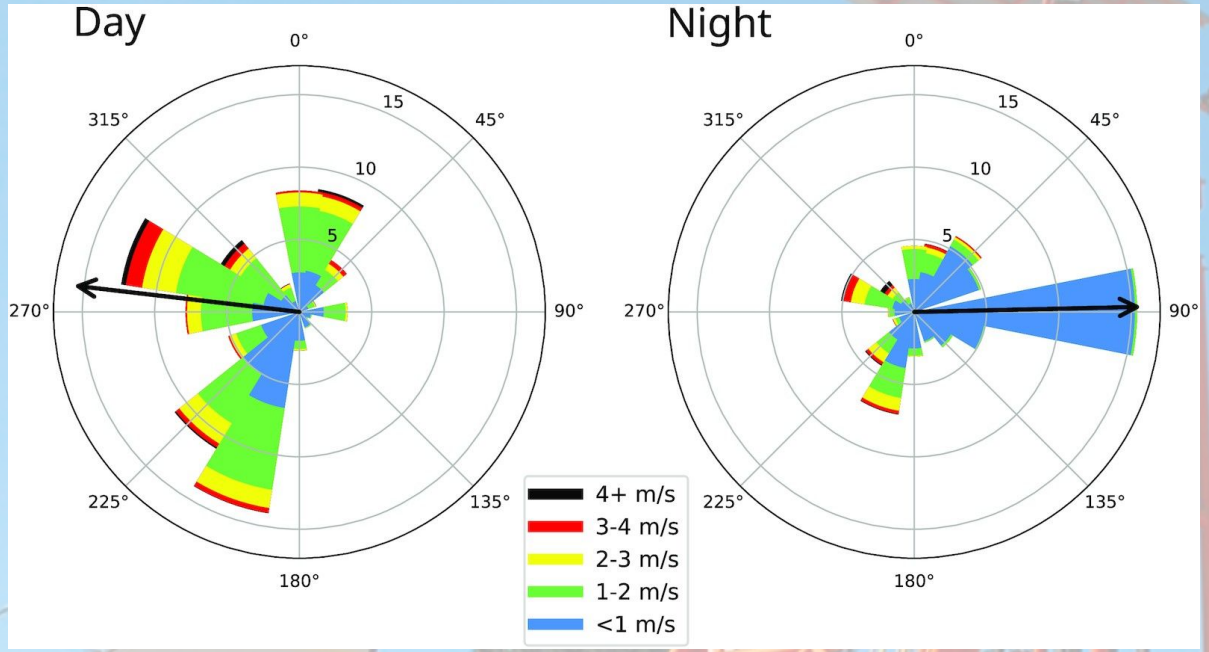
REF: Di Giovanni et al., 2021
doi: 10.1785/ 0220200186.

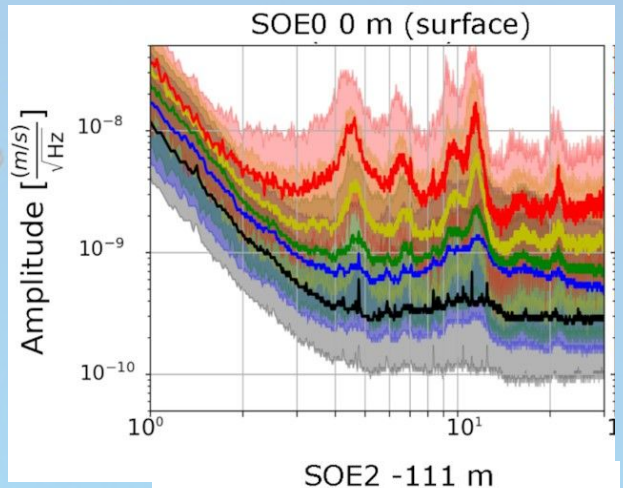
Anthropogenic noise @ Sos Enattos

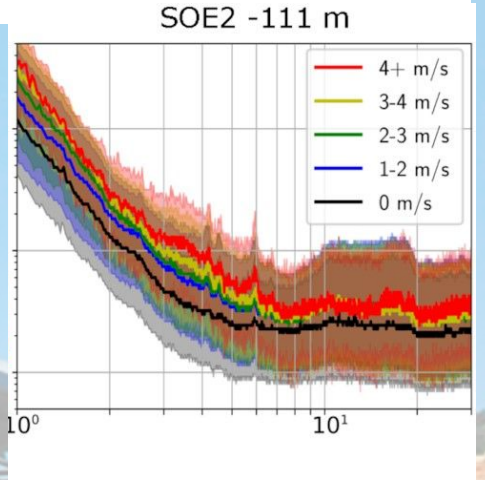


REF: Di Giovanni et al., 2021
doi: 10.1093/gji/ggad178.

Wind generated noise

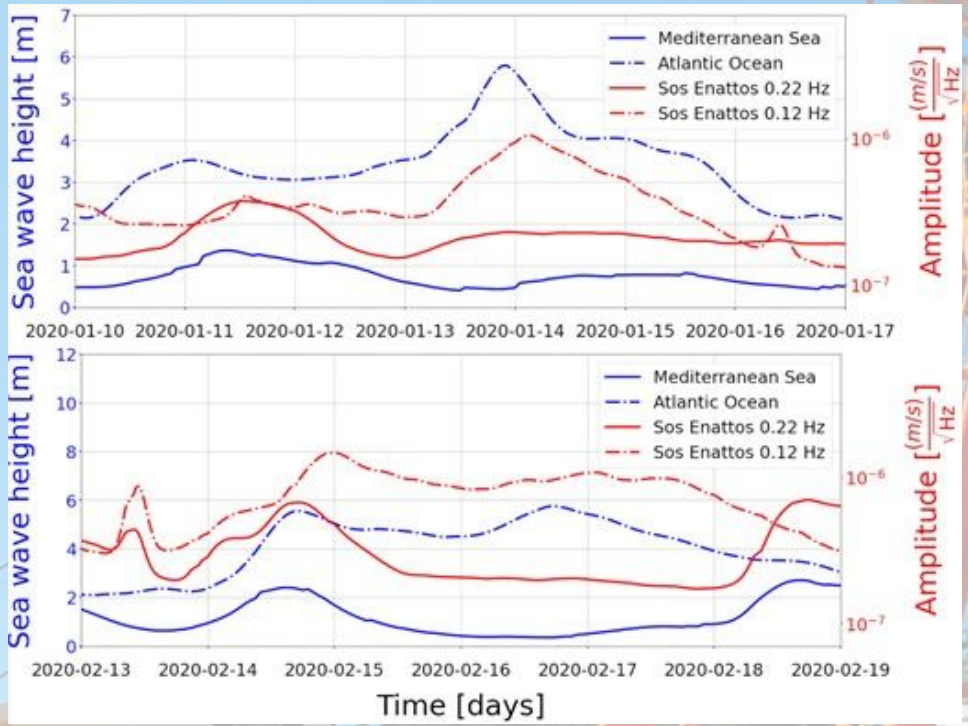






REF: Di Giovanni et al., 2021
doi: 10.1093/gji/ggad178.

Sea waves and seismic noise correlation



Evolution of seismic noise at SOE2 at 0.22Hz (4.5 s) and 0.12 Hz (8.3 s) and evolution of sea-wave height during Storm Brendan (2020 January 10–19).

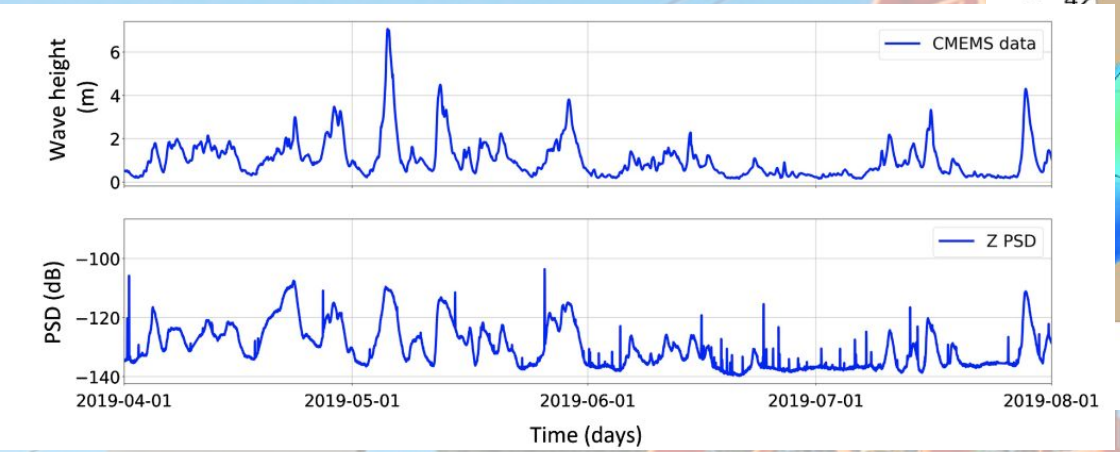
Evolution of seismic noise at SOE2 at 0.22 and 0.12 Hz and evolution of sea-wave height during Storm Dennis (2020 February 11–18).

the time-series of sea-wave height is obtained by averaging wave heights in the areas where correlation is maximized.

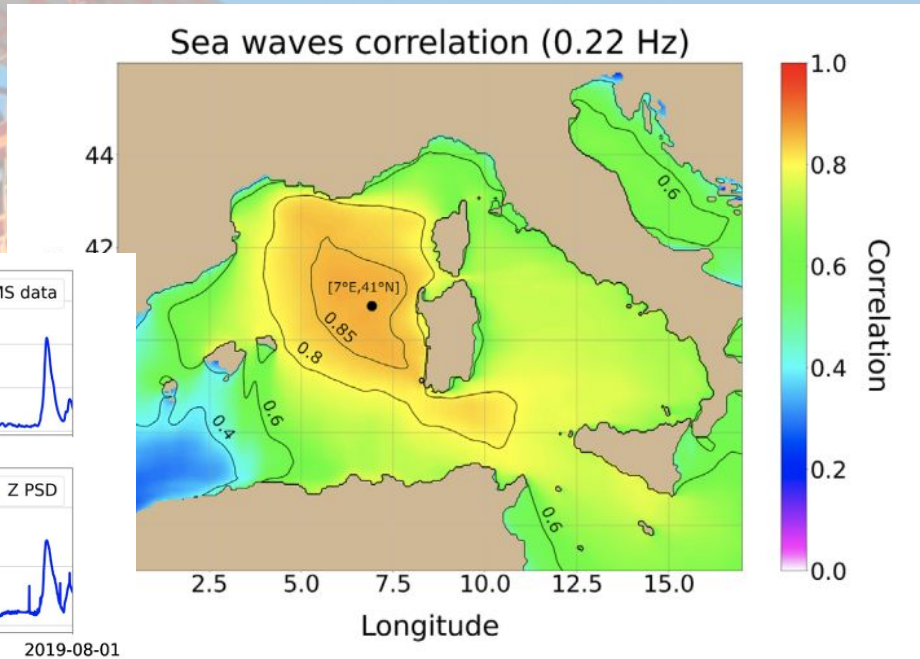
REF: Di Giovanni et al., 2021
doi: 10.1093/gji/ggad178.

Sea waves and seismic noise correlation

Correlation between the average sea wave height and seismic noise at Sos Enattos corresponding to the PSD period that maximizes the correlation.

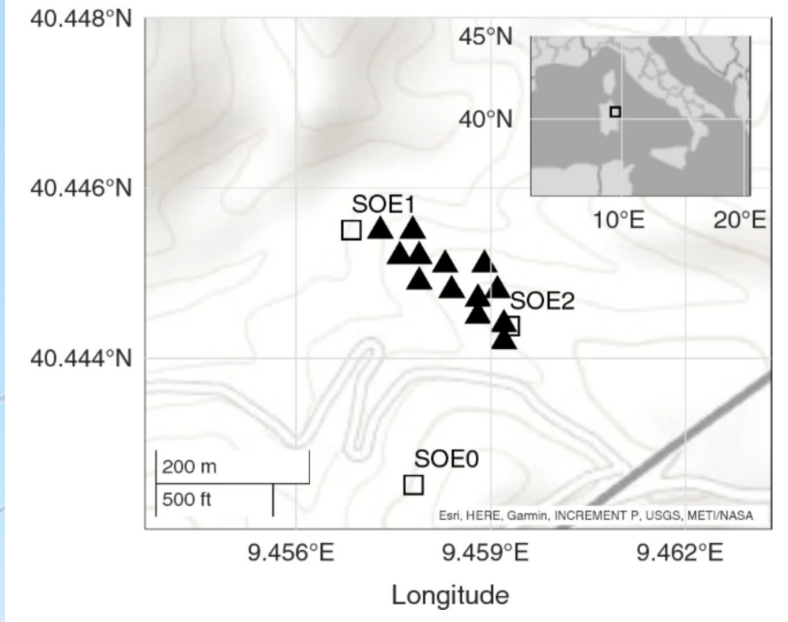


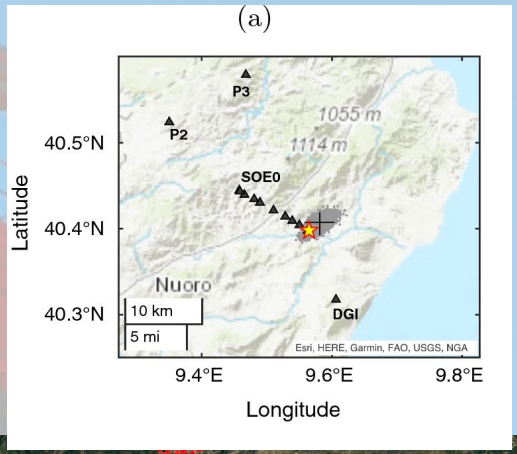
Time evolution of wave height (Copernicus Marine Environment Monitoring Service [CMEMS] data) extracted at the point in the grid identified by the black dot and of the microseism noise with period equal to 4.5 s,

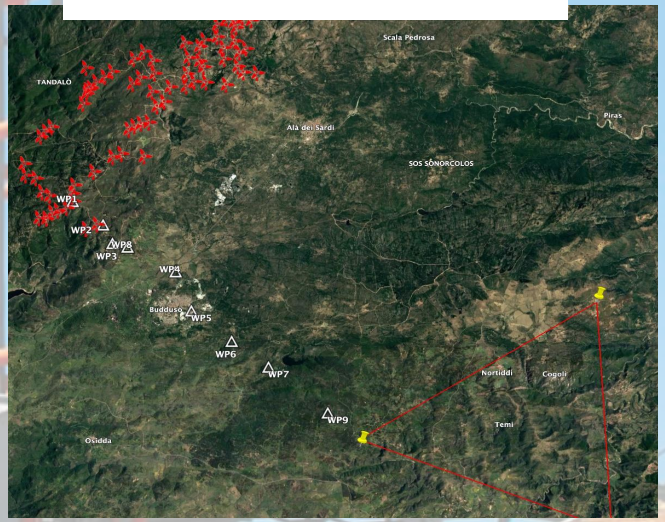


Di Giovanni et al., 2021
doi: 10.1785/ 0220200186.

Temporary deployments

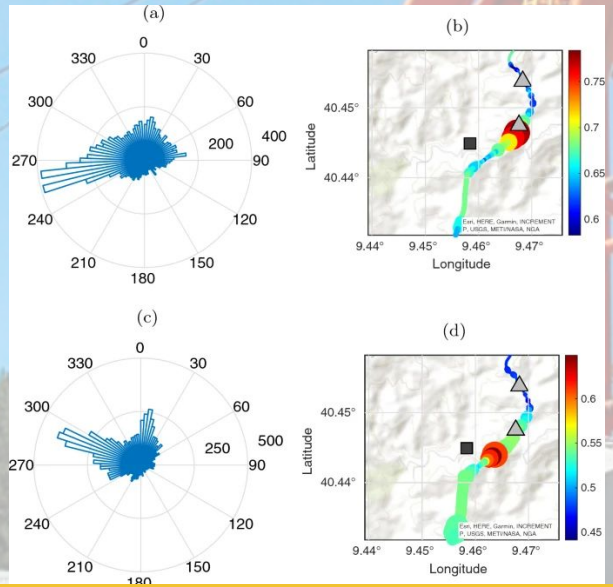


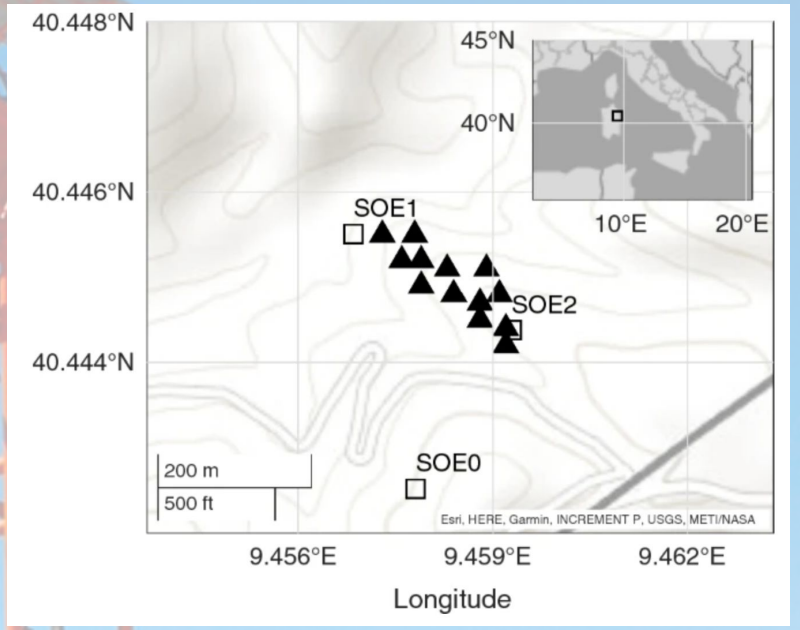




Array analysis at Sos Enattos (even cars count..)

Small aperture array of 15 broadband sensors, sampling at 200 Hz to catch high frequency signals. Cross-correlation analysis and back propagation of slowness allow to detect and locate single car passages along the SP73. gray triangles indicate the two existing bridges.





Saccorotti et al., 2023
doi:10.1140/epjp/s13360-023-04395-2

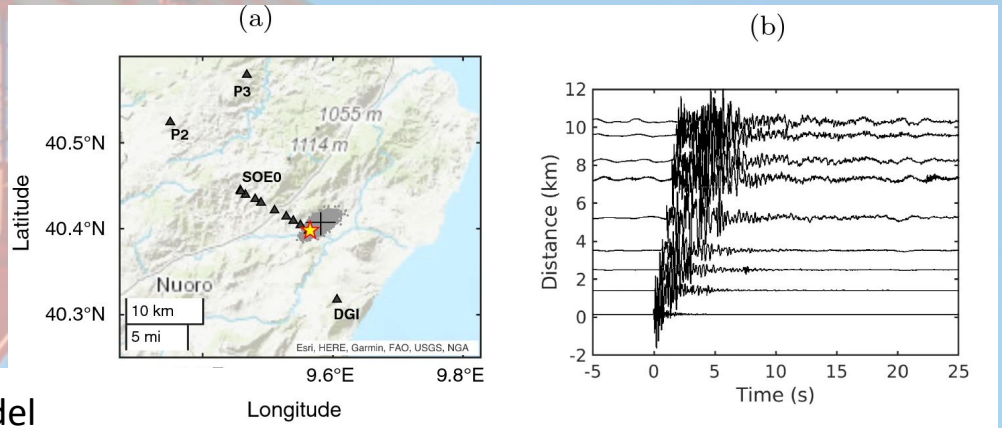
Array analysis at Sos Enattos (quarry blasts)

9 stations along a linear profile,

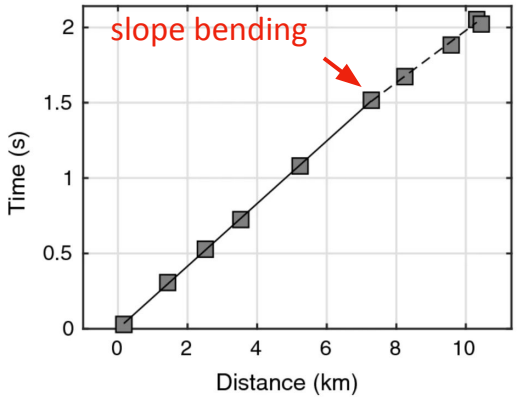
inter-station spacings 750 - 2000 m

record the quarry blast on Jan 20, 2022

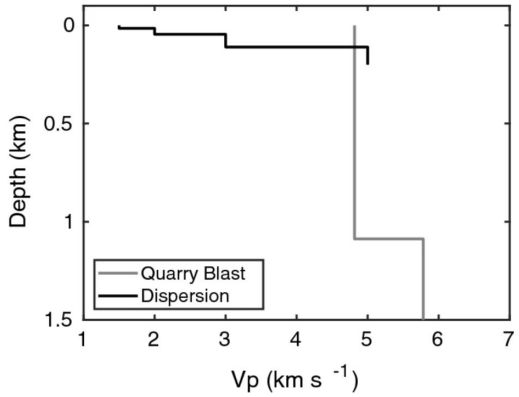
objective of studying the wave propagation and the shallow crustal velocity model.



P-wave arrival times vs. distance

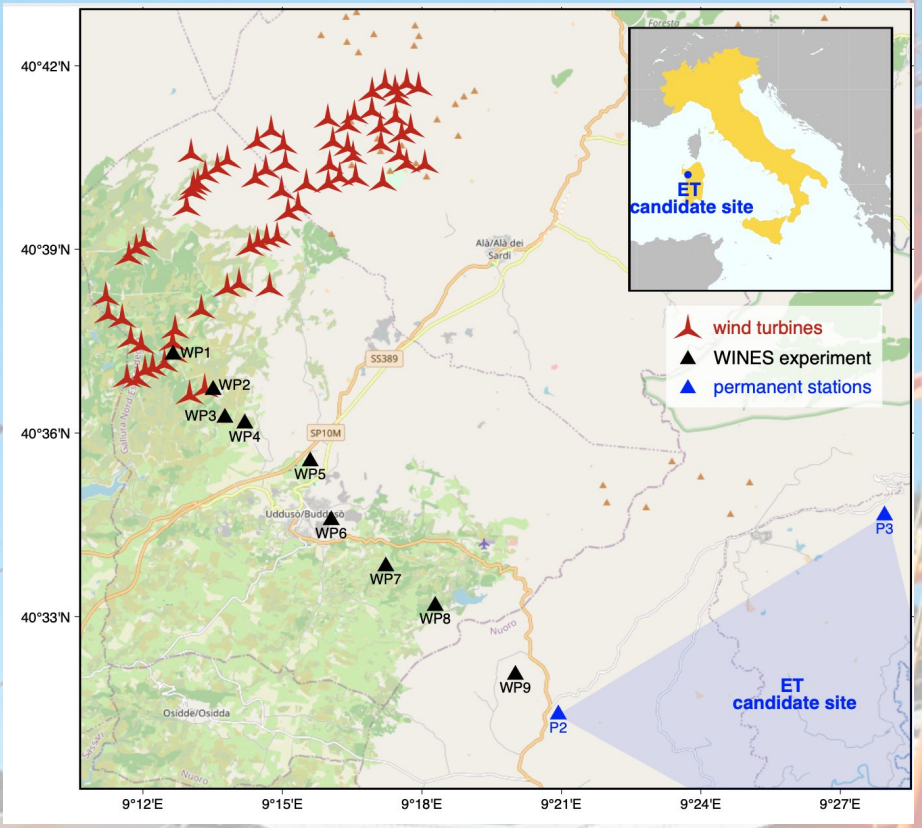


velocity model

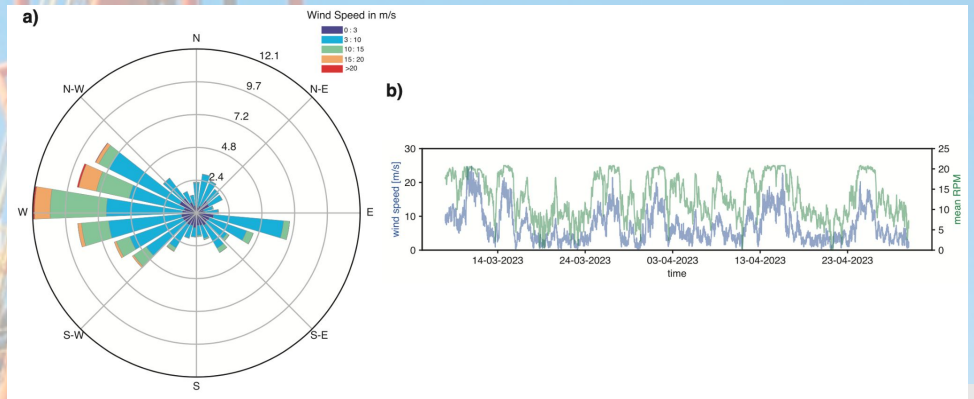


REF: Saccorotti et al., 2023
doi:10.1140/epjp/s13360-023-04395-2

WINES, Wind Park Experiment

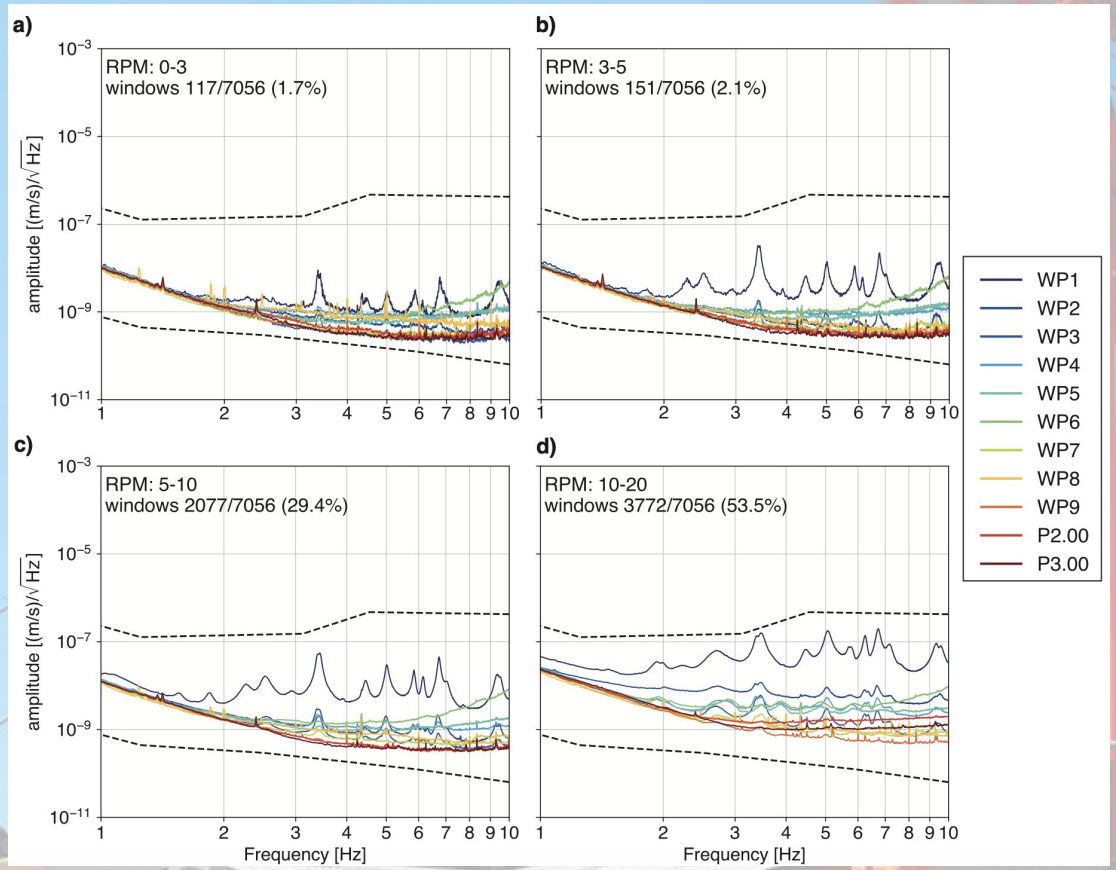


- Linear array of 9 broadband seismic stations
- 15 km total length
- Station interdistance from 600 to 3000 m
- Operation: 08/03/2023 - 30/04/2023



Diaferia et al., 2024
in preparation

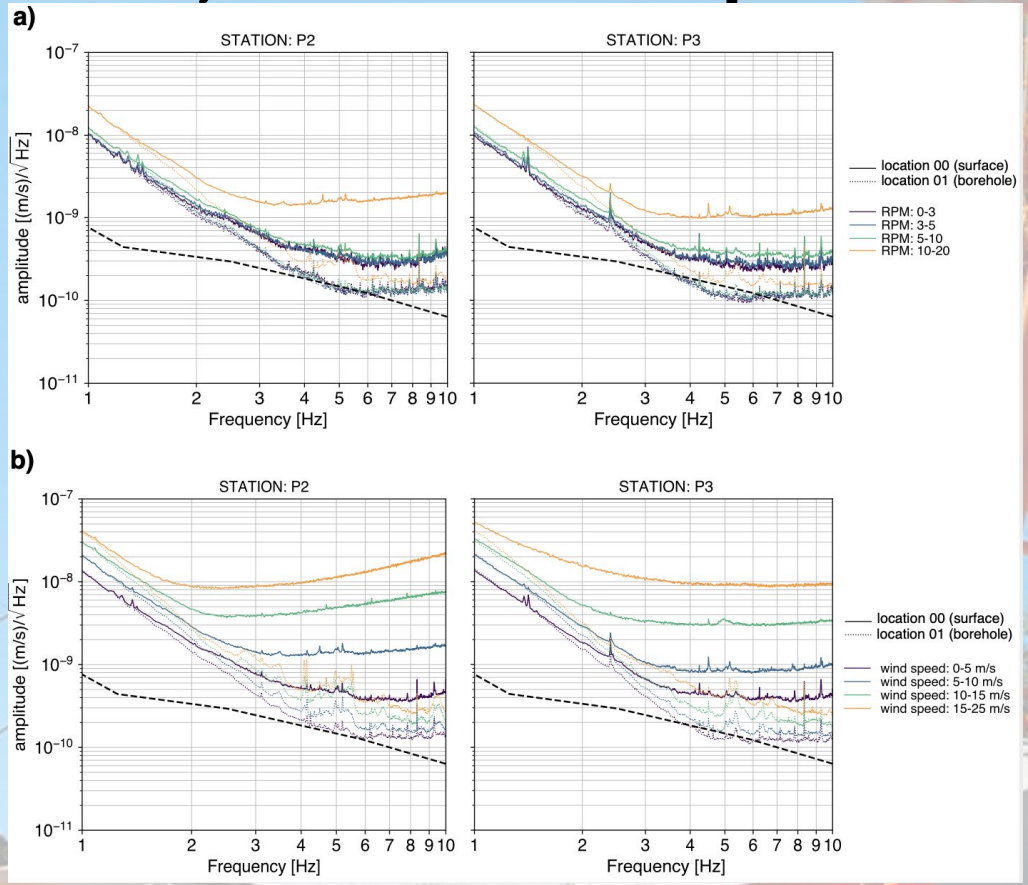
WINES, Wind Park Experiment



- WP1-WP9 + P2 and P3
- spectrum for various classes of turbines RPM
- range 1-10Hz

Diaferia et al., 2024
in preparation

WINE, Wind Park Experiment



Test to discriminate between the wind effect at P2-P3 and the noise generated by the wind turbines at distance.

Diaferia et al., 2024
in preparation

Conclusions

- **Low noise above 1Hz**
  - at ~5Hz the site spectrum lies on the NLNM
  - one of the quietest site in the World;
- **Small or far sources perturb the quietness of the site**
  - car traffic
  - wind turbines
  - quarry blasts;
- **array analyses provide accurate model for the elastic properties of the rock materials at the candidate site**

Ongoing and planned activities

- **AdriaArray network in Sardinia:**
  - part of a broad project to study the crust and tectonics in the Adria plate, it will bring N broadband stations in Sardinia for ~2 years;
  - to model the crust and below;
  - to detect small magnitude seismicity in the region

- **Wind turbine effects:**
  - paper in preparation
  - deployment of a seismic network in Sicily to evaluate the noise generated by larger wind turbines (proposed for deployment in Sardinia)