

Earthquake monitoring in Italy: integration of a temporary seismic experiment into national real-time surveillance, the example of FocusX temporary land-network.

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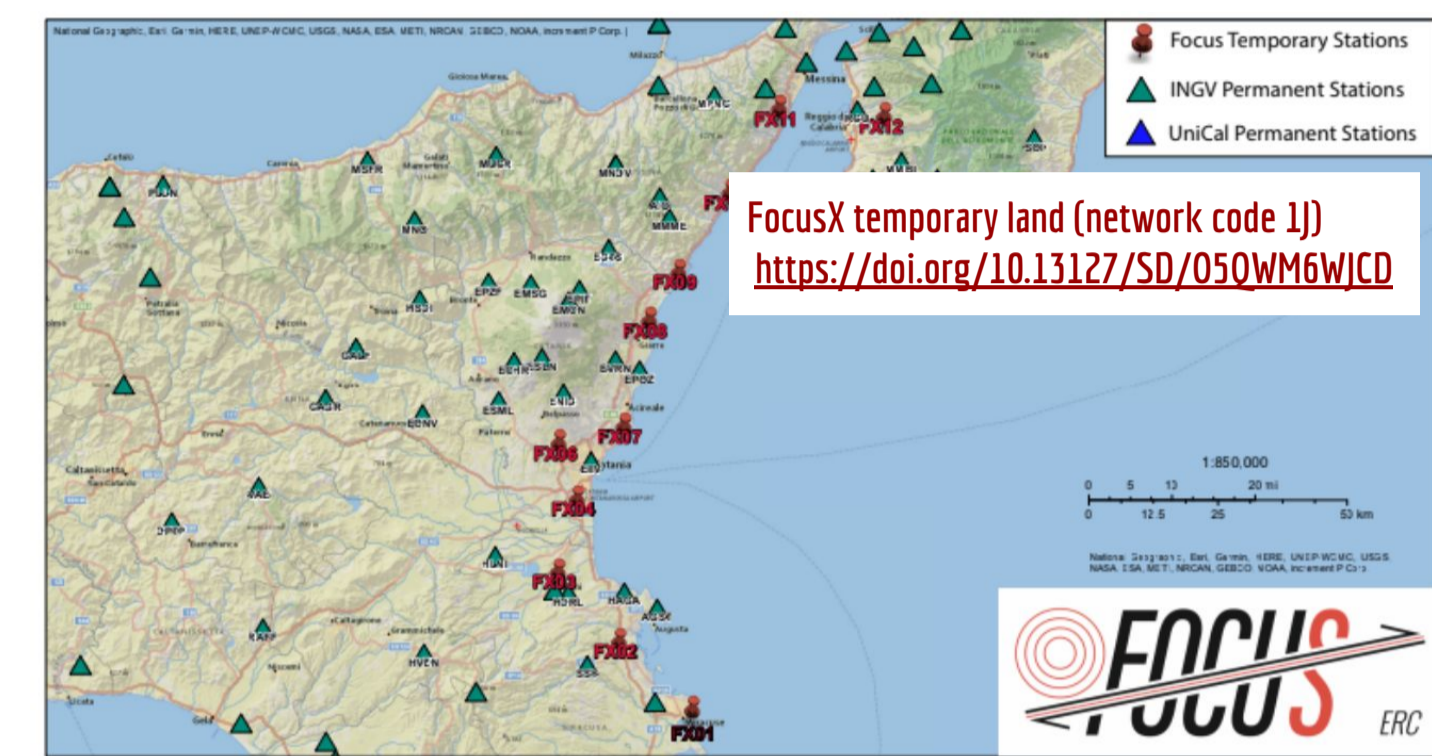


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Introduction

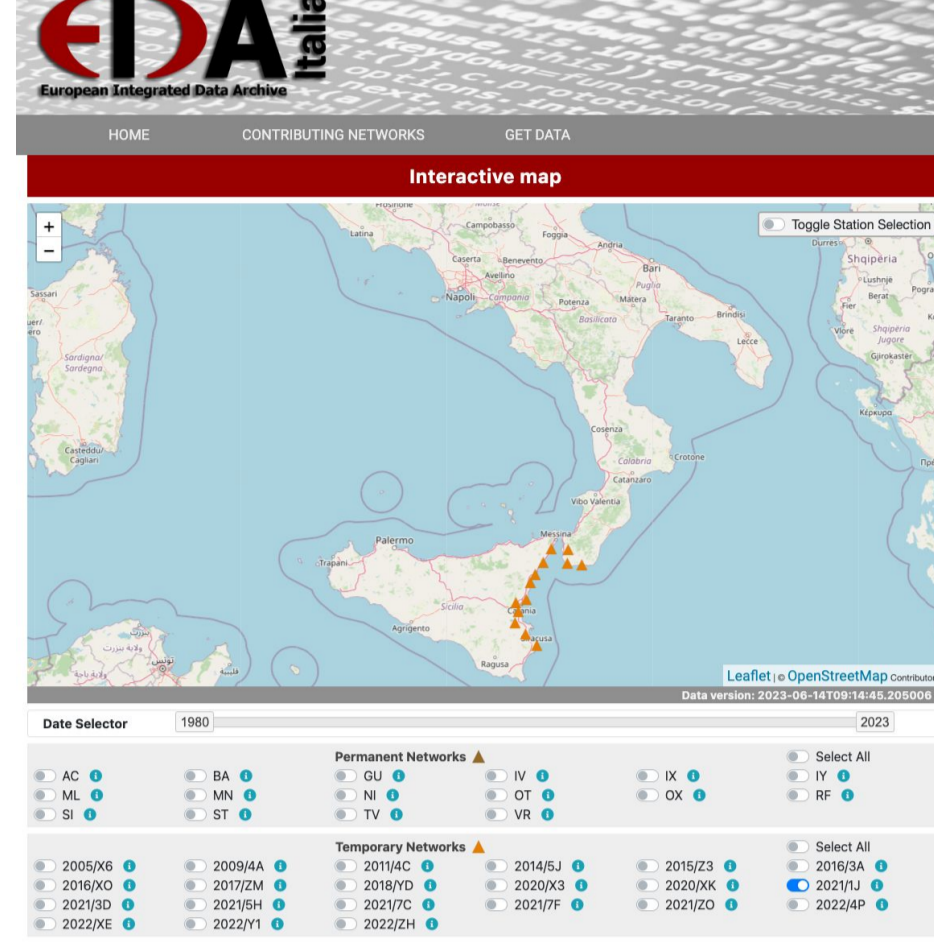
The **INGV** is the operational center for earthquake monitoring in Italy, <https://www.ingv.it/en/monitoraggio-e-infrastrutture/sorveglianza/servizio-di-sorveglianza-sismica>, it operates the Italian National Seismic Network and other networks at different scales and is a primary node of EIDA for archiving and distributing seismic recordings. INGV provides earthquake information to the Department of Civil Protection and to the public. In the frame of the **FOCUS (Fiber Optic Cable Use for seafloor studies of earthquake hazard and deformation) project**, <https://www.geo-ocean.fr/Recherche/Projets-de-Recherche/ERC-FOCUS>, we deployed a temporary seismic network, **FXLand (1J)**, for a passive seismological experiment to record regional seismicity and teleseismic events. This experiment aims to improve the detection of seismicity; the accuracy of earthquake locations, and to define the crustal structure of the region. The seismicity in the Ionian area is possibly the result of two types of tectonic activity at different depths: a gently NW dipping subduction interface of the Calabrian subduction zone, and the strike-slip fault systems in the Ionian Sea, well expressed in the morpho-bathymetry and observed in previous seismic profiles.

The FXLand network*



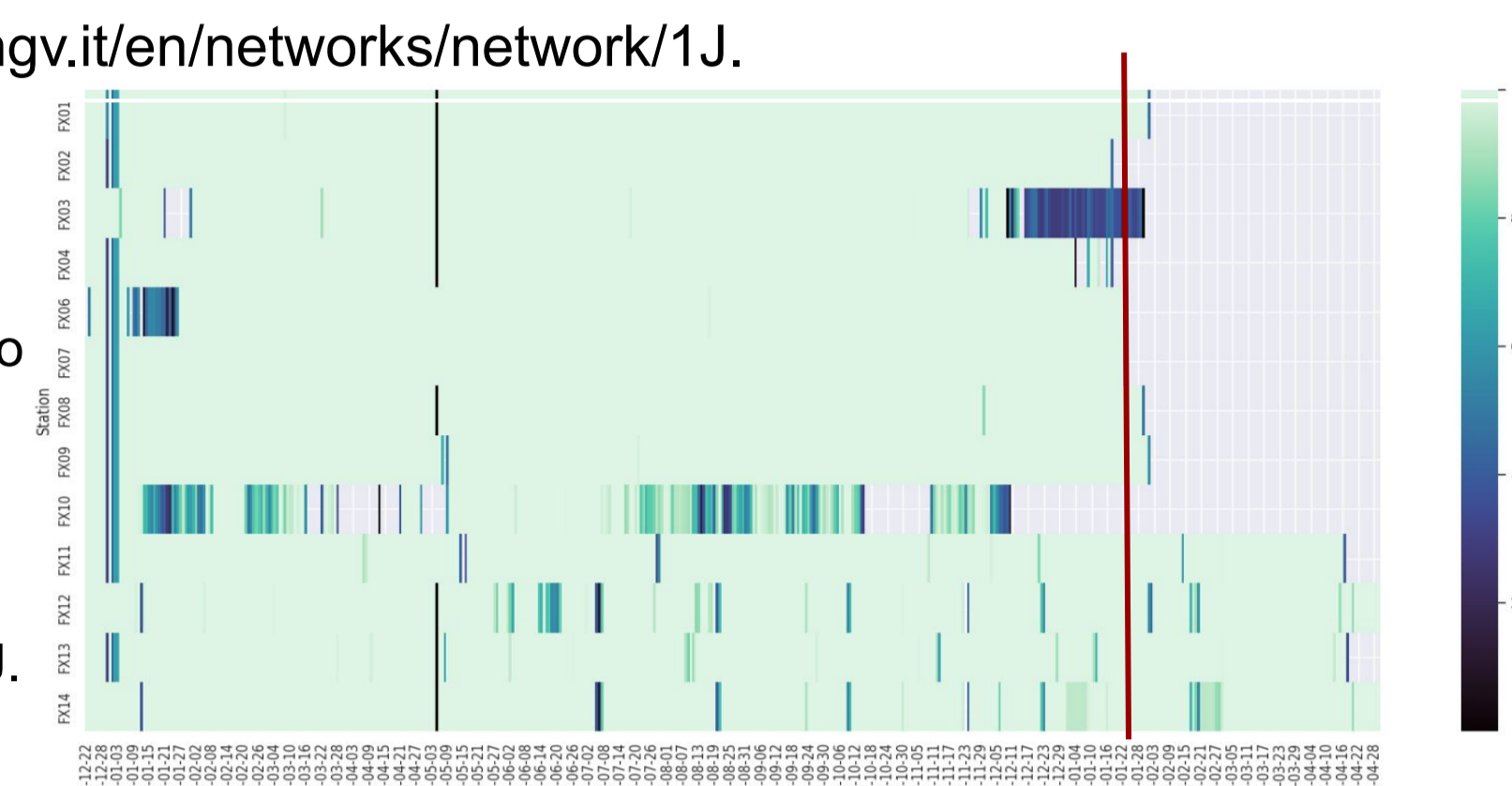
In the frame of FocusX project INGV (Osservatorio Nazionale Terremoti and Osservatorio Etno) and UniCal (Laboratorio di Sismologia) deployed, from 22nd December 2021 - 2nd February 2023, a **temporary seismic network**. The temporary seismic network **FXLand** FDNS code **1J** is integrated with permanent seismic stations (INGV network codes: IV, MN and Unical network code: IY) to record regional and global seismicity in the Ionian Sea. The deployment consists of **13 temporary land stations** and of the acquisition of **one new station IY**; in the same period OBS stations are deployed at sea: FocusX temporary OBS-network (network code **XH**).

DATA archiving



Continuous data are archived and distributed in EIDA <https://eida.rm.ingv.it/en/networks/network/1J>.

The station CDFN network **IY** of UniCal (Laboratorio di Sismologia) started to be archived in EIDA together with the network **FXLand 1J**.



<https://eida.ingv.it/>

DATA archiving percentage per day

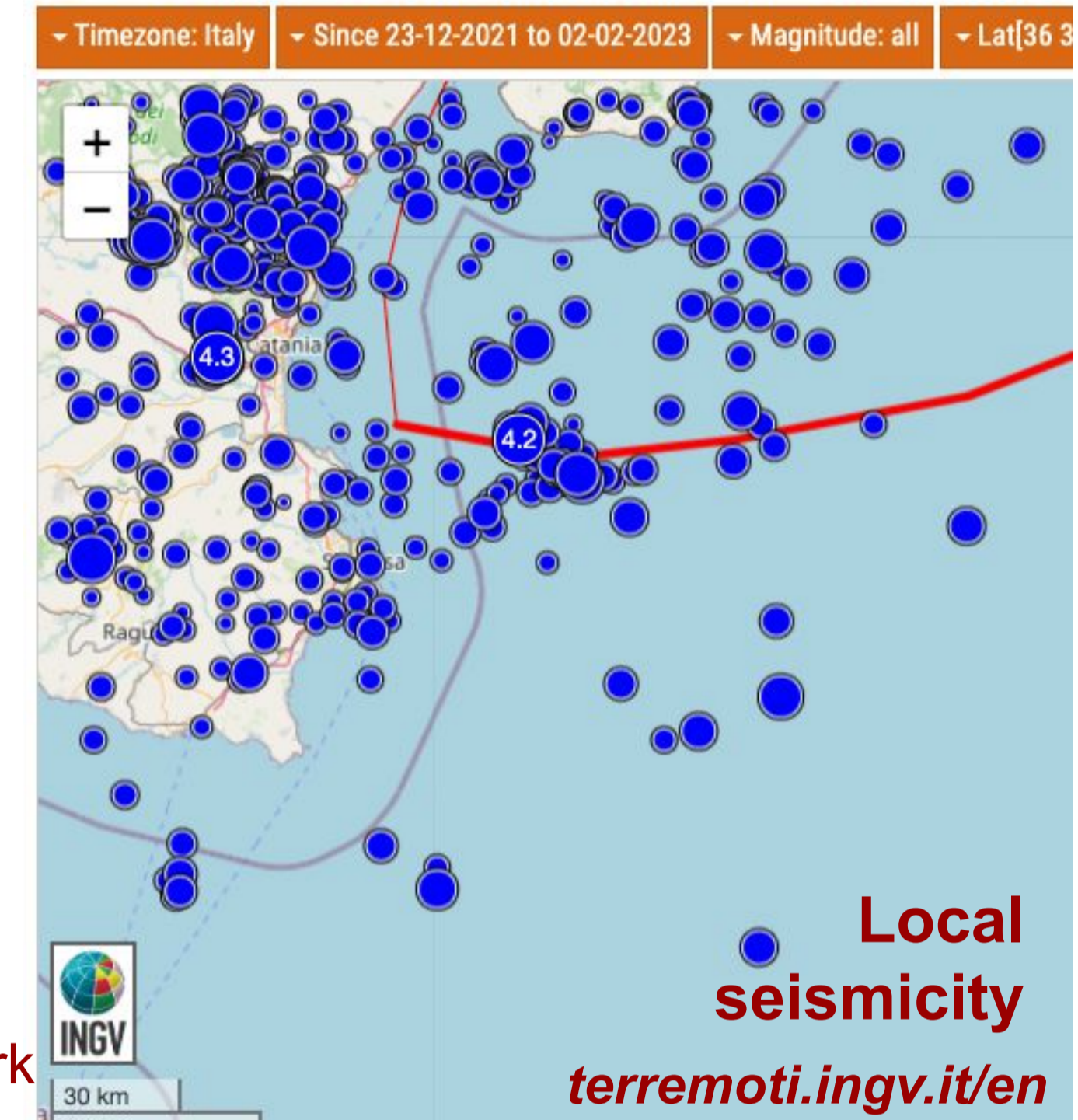
MAP of the stations in the frame of the permanent INGV network

* <https://progetti.ingv.it/it/focus#project-informations>

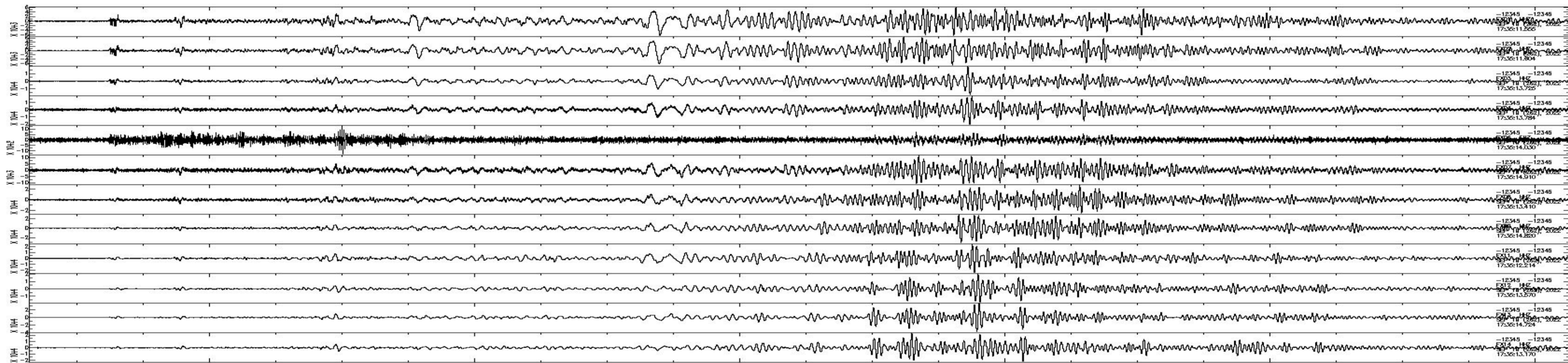
Integration of FXLand into the real time seismic surveillance and in the Italian Seismic Bulletin BSI



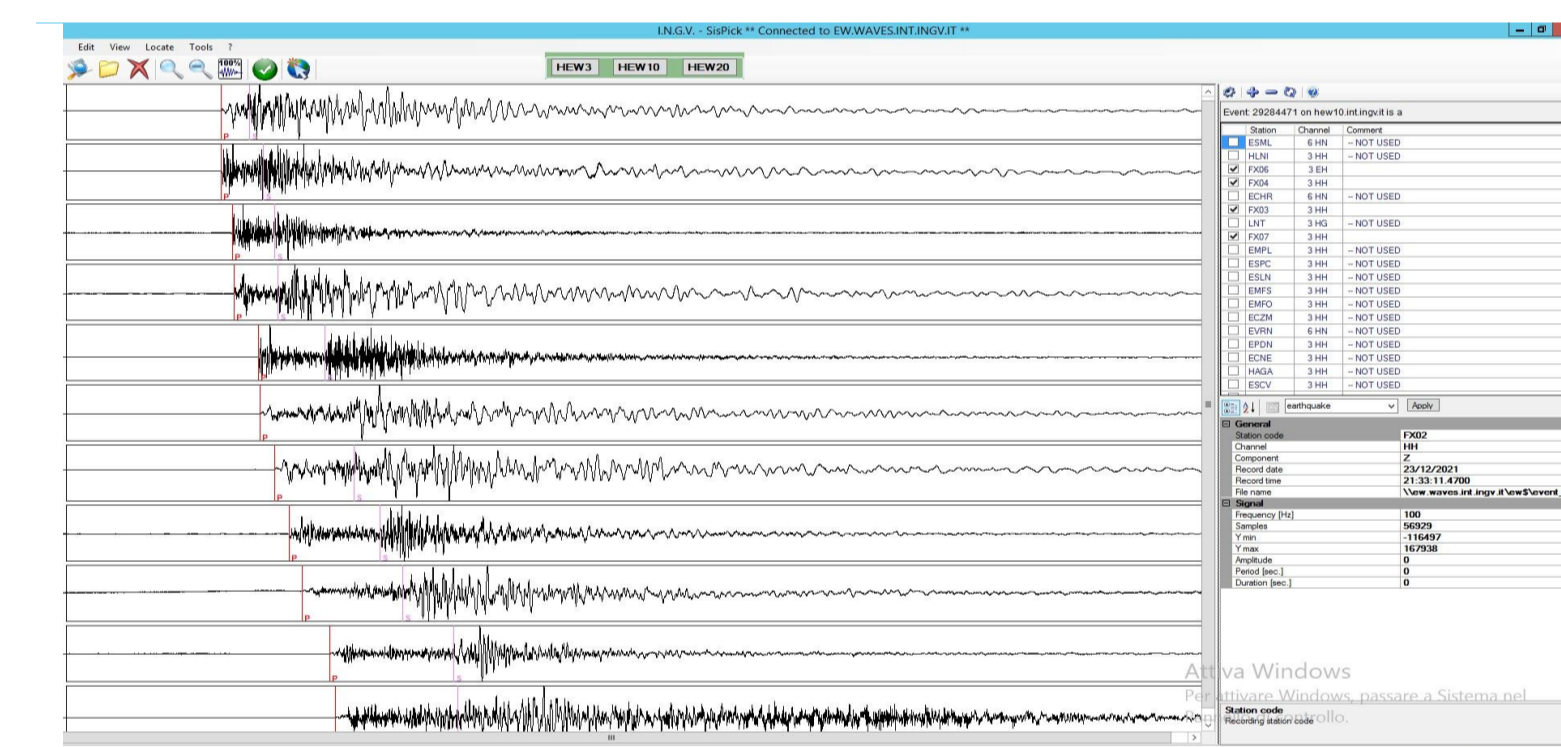
Continuous data are transmitted in real time at the INGV Rome acquisition system, used in the seismic surveillance. In the deployment period 22nd December 2021 - 2nd February 2023, were located by the INGV Control room for the seismic surveillance and the tsunami alert in Rome 153 of magnitude 6+ teleseismic earthquakes and 886 local events (area between Lat 36-38 Lon 14.5-17.0), two of them with magnitude larger than 4.0. The two local events with $M > 4.0$ and some other events were analyzed by the analysts of the Italian Seismic Bulletin including all the stations of the FXland 1J network. The stations were all used by the analysts of the BSI during the period 22-12-2021 02-02-2023. **In the INGV Database we have more than 1000 P and 650 S arrival times at stations FX.**



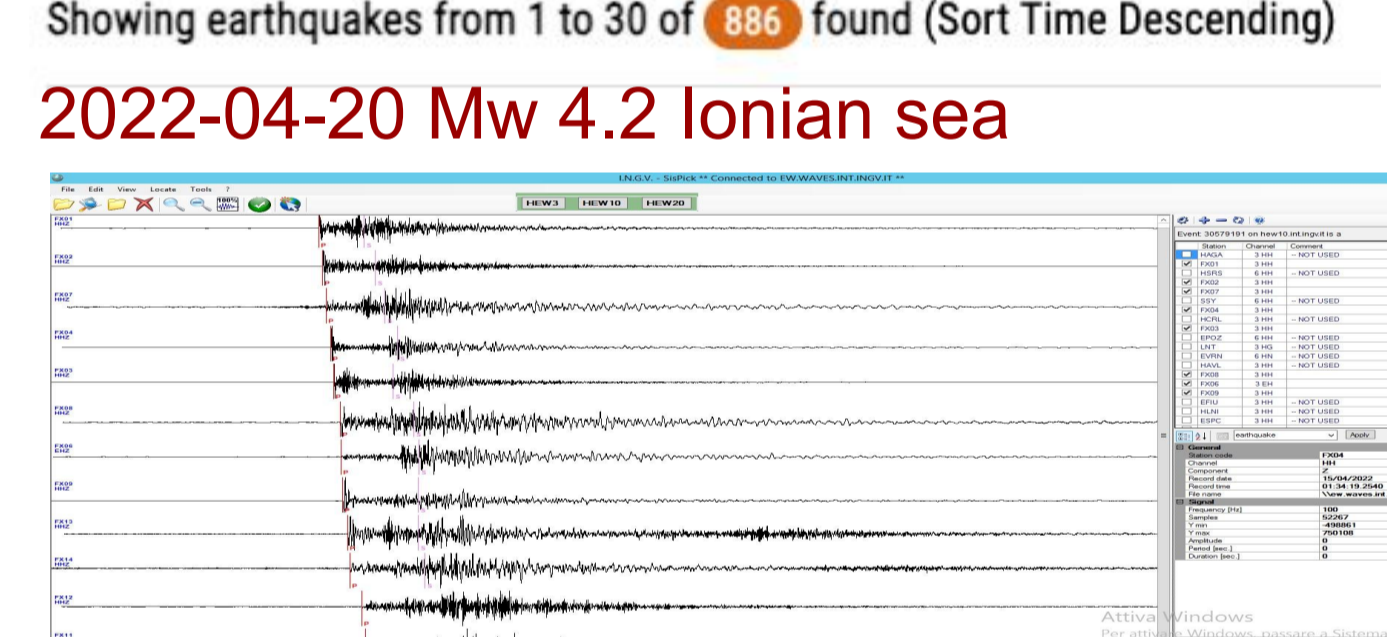
2022-09-19 18:05:15 Mw 7.5 Michoacan, Mexico recorded at 1J Network



2021-12-23 Mw 4.3 Motta - CT recorded at 1J Network



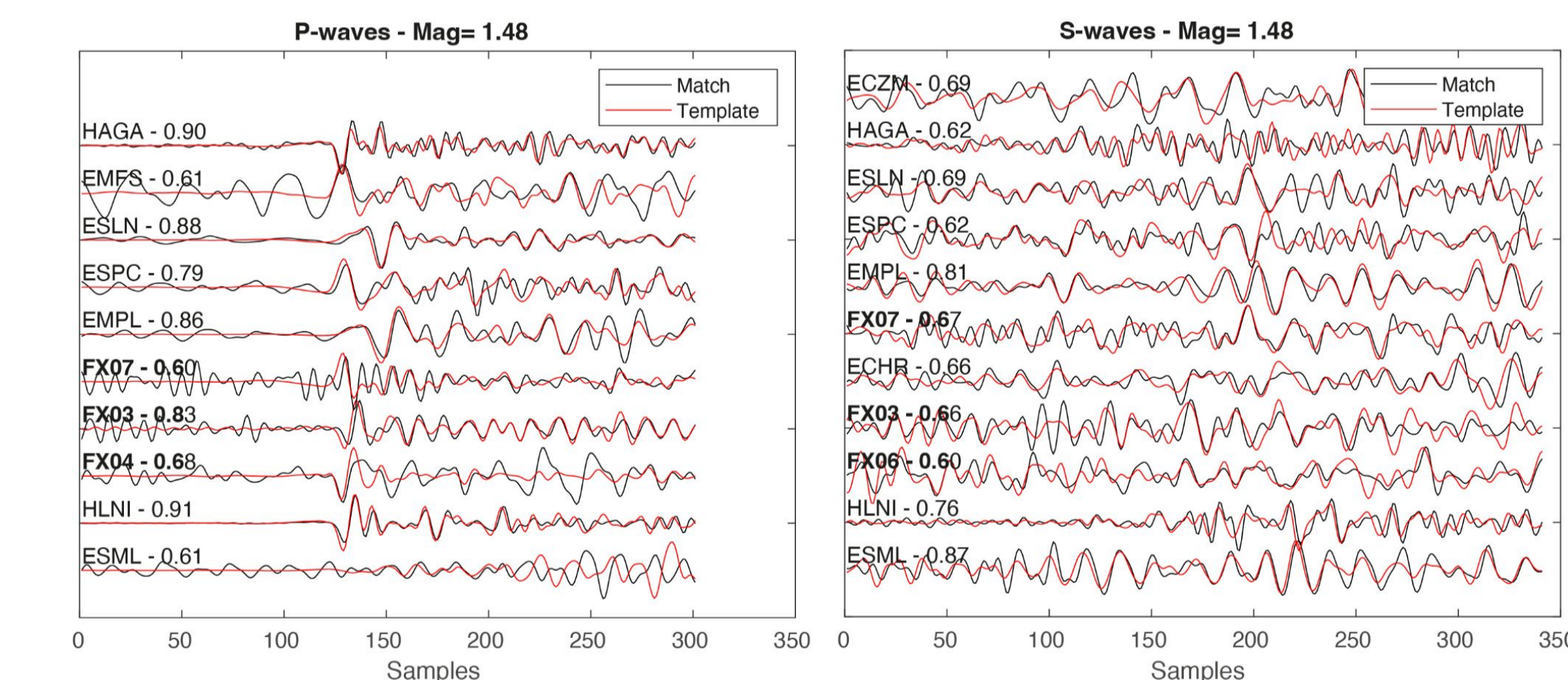
2022-04-20 Mw 4.2 Ionian sea



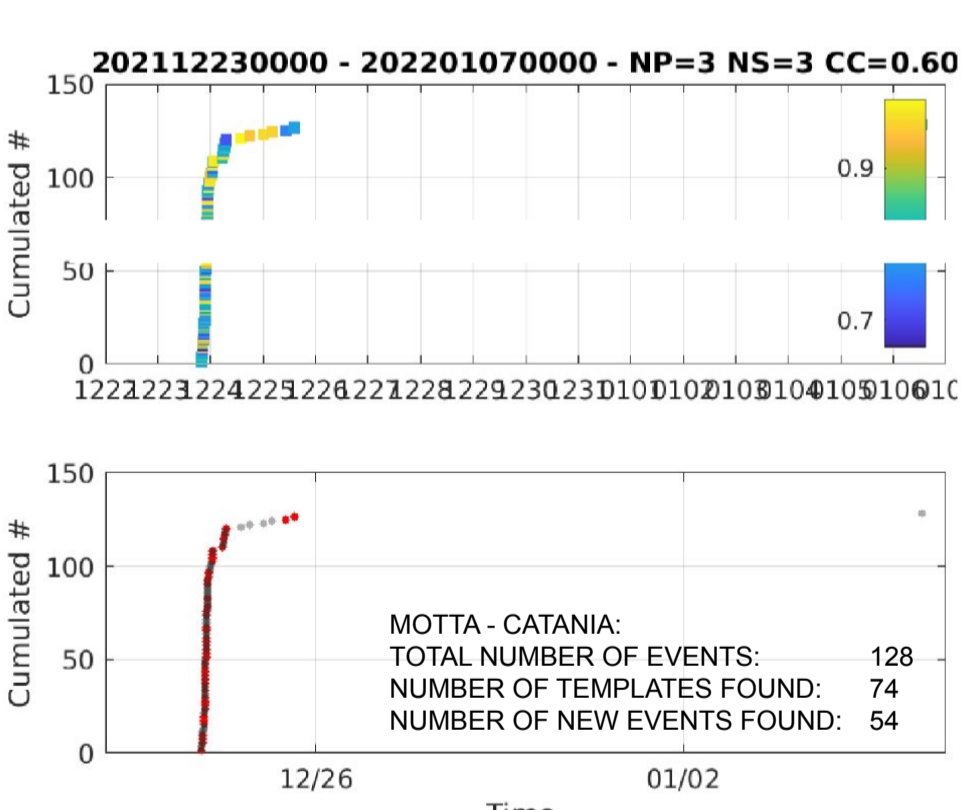
The goal of this experiment is to improve the detection of seismicity in the Ionian Sea area and the accuracy of the locations; to better define the crustal structure of the region and find patterns related to fault systems. Here we present the **analysis of three seismic sequences**: one starting on December 23rd 2021 with a magnitude 4.3 at Motta near Catania lasting about three days (we analysed 10 days of data), one occurred in the Messina Strait on May 31st - June 1st 2022, the third one in the Ionian Sea from February 6th to April 27th 2022: the seismic sequence was recorded from February 20th to March 1st, while the 4.2 event of April was quite isolated in time and space.

We applied a **template matching technique** to discover events not detected by the seismic surveillance.

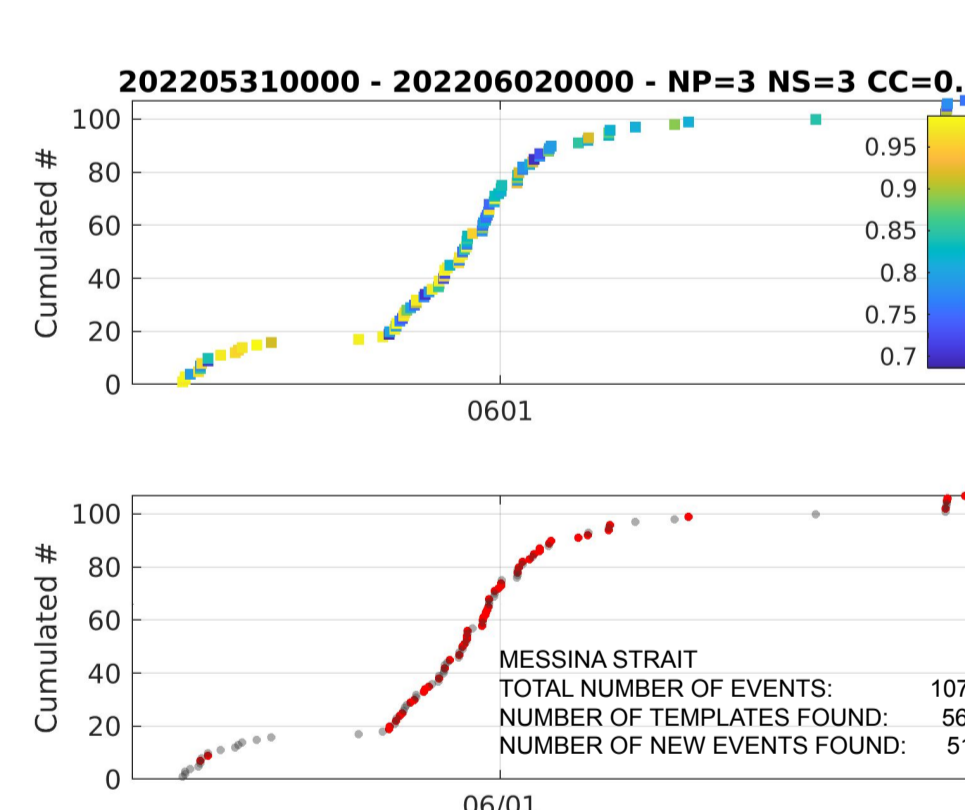
We include events showing cross correlation coefficients down to 0.60. All the discovered events have magnitude lower than 2.0



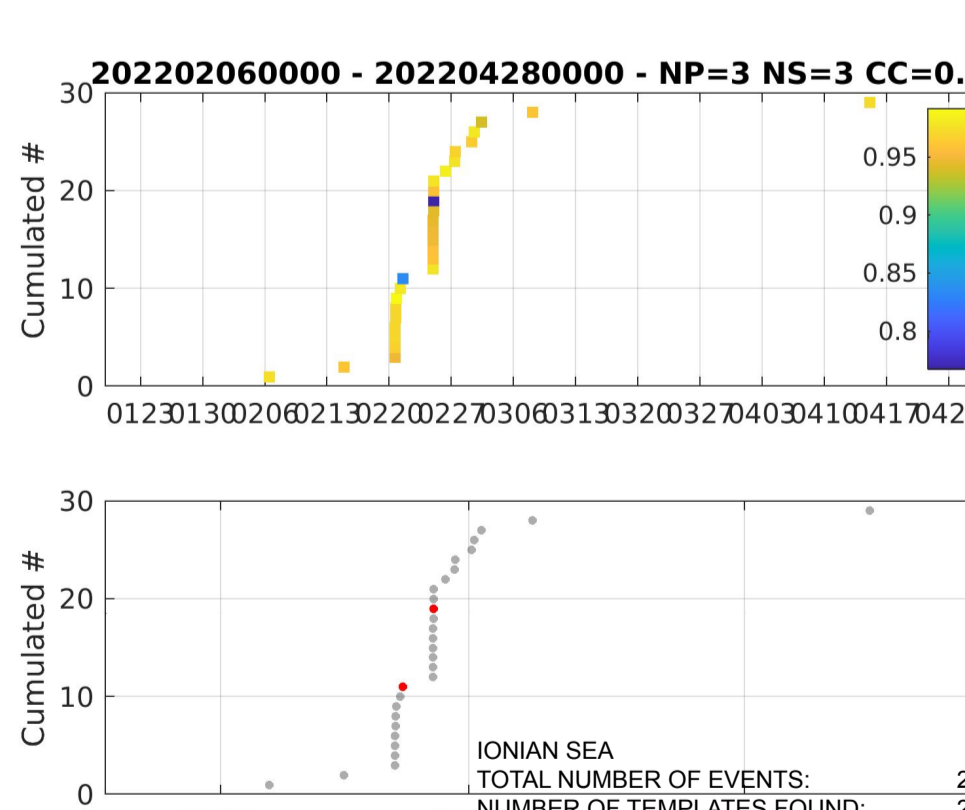
MOTTA - CATANIA



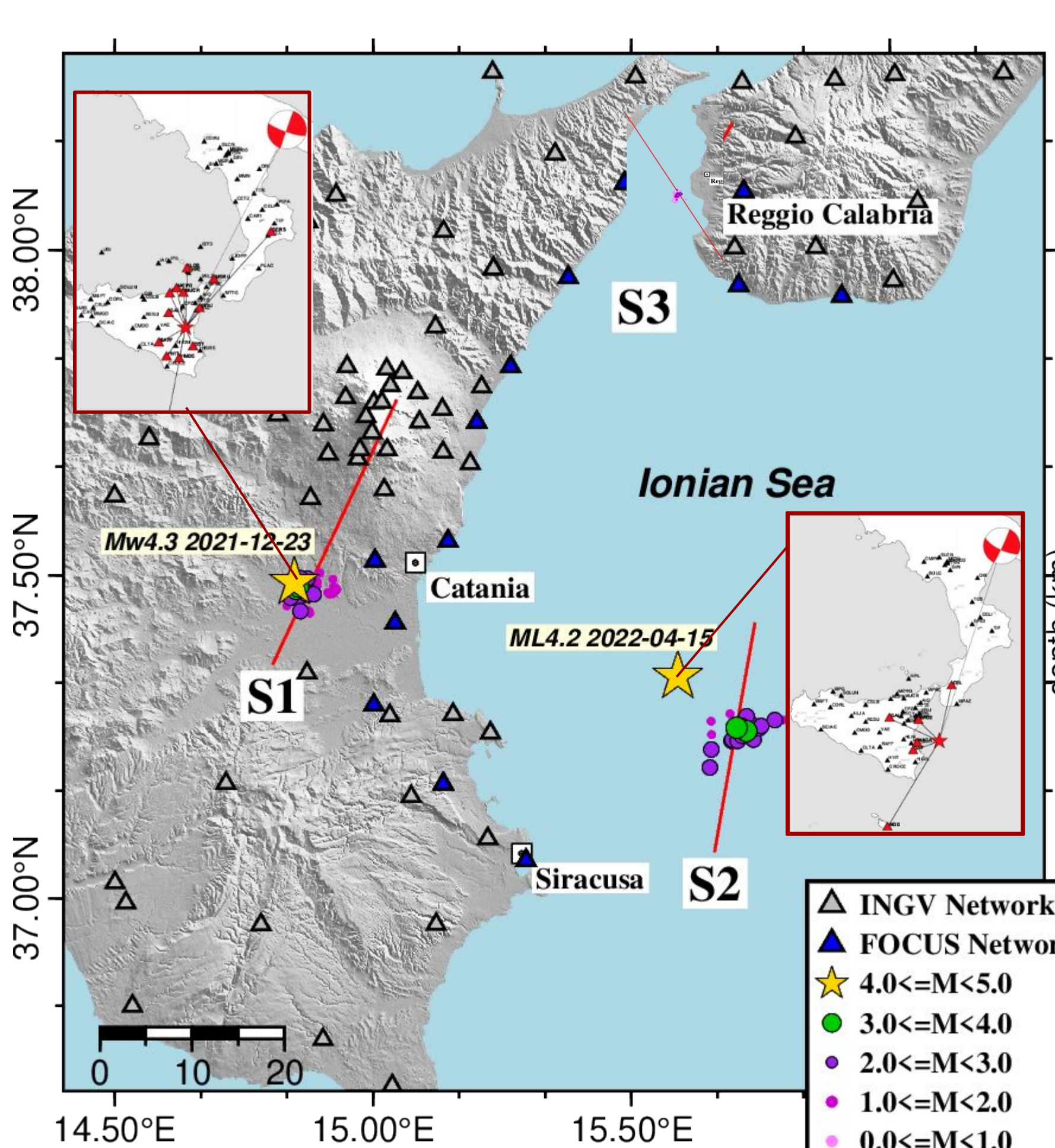
MESSINA STRAIT



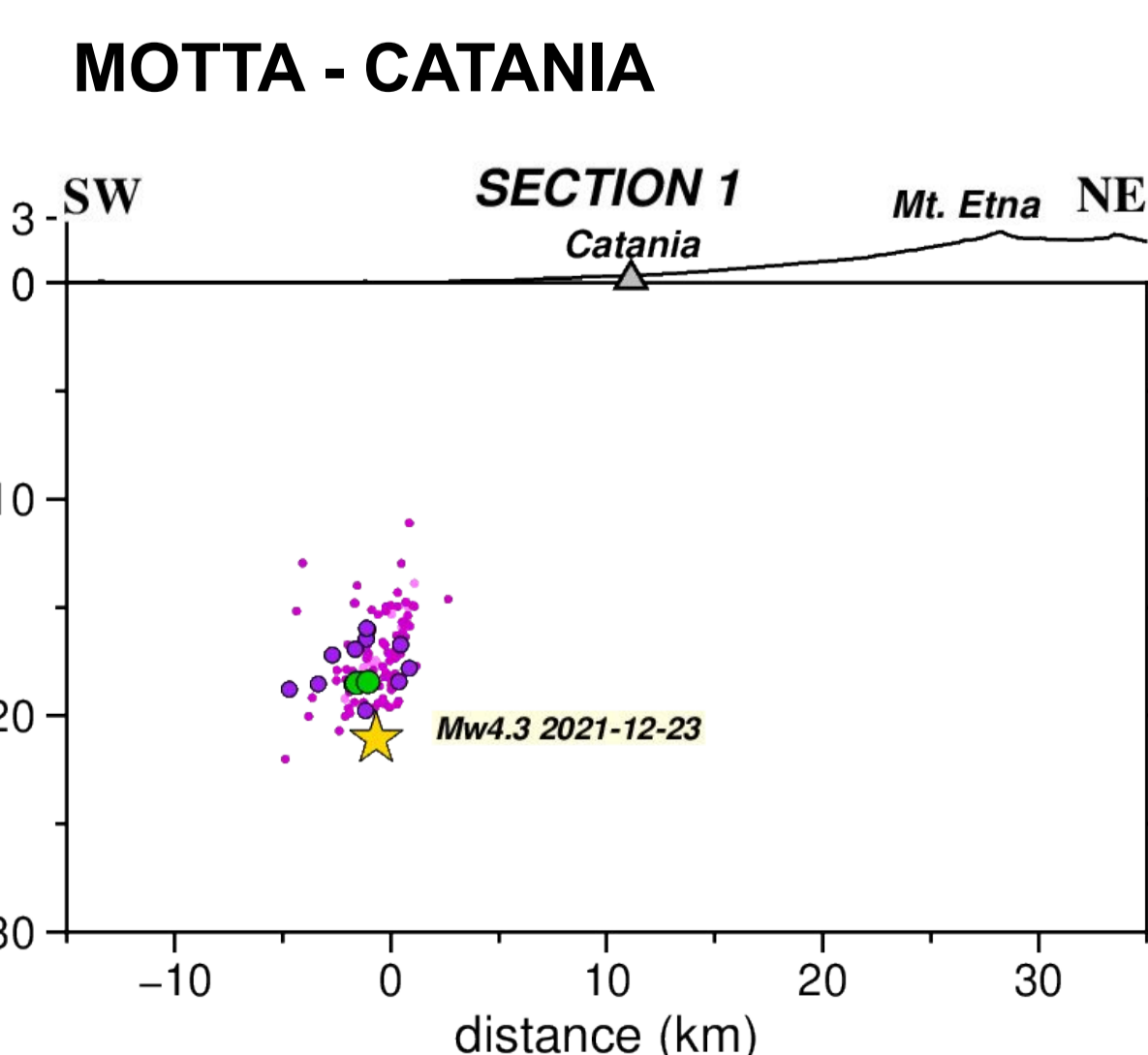
IONIAN SEA



The template matching technique almost doubled the number of detected events: in the Motta - CT seismic sequence the number of events increased of 42% and in the Messina Strait of 48%; this did not happen for the seismicity in the Ionian Sea where only 2 events; about 7% of the seismicity were found. The distance of the closest station goes from 14 km in Motta - CT, to about 10 km in the Messina Strait, to about 45 km for the Ionian Sea.

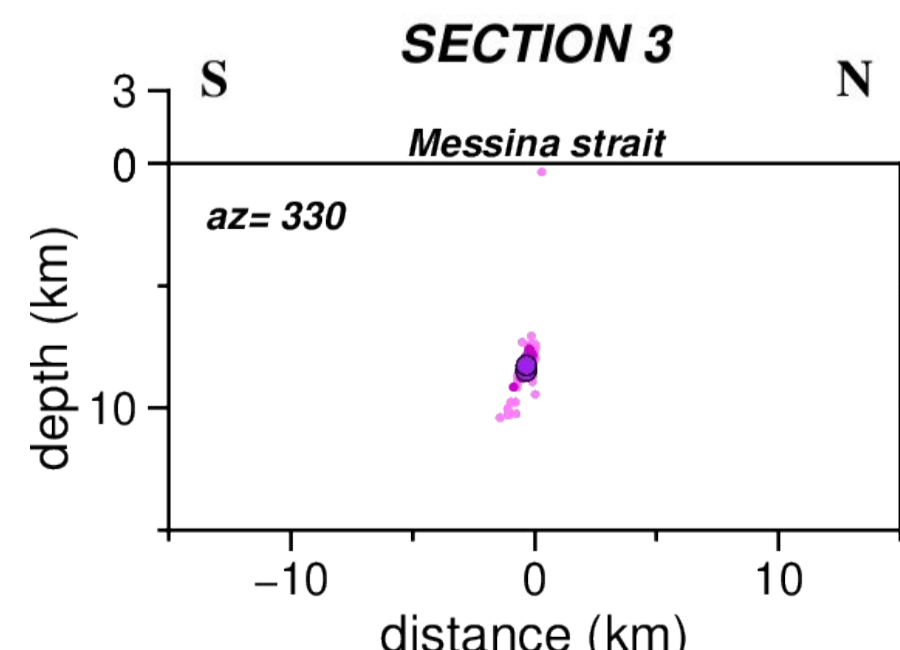


We located the earthquakes using **NonLinLoc** software. The the location errors are quite large for the events in the Ionian sea

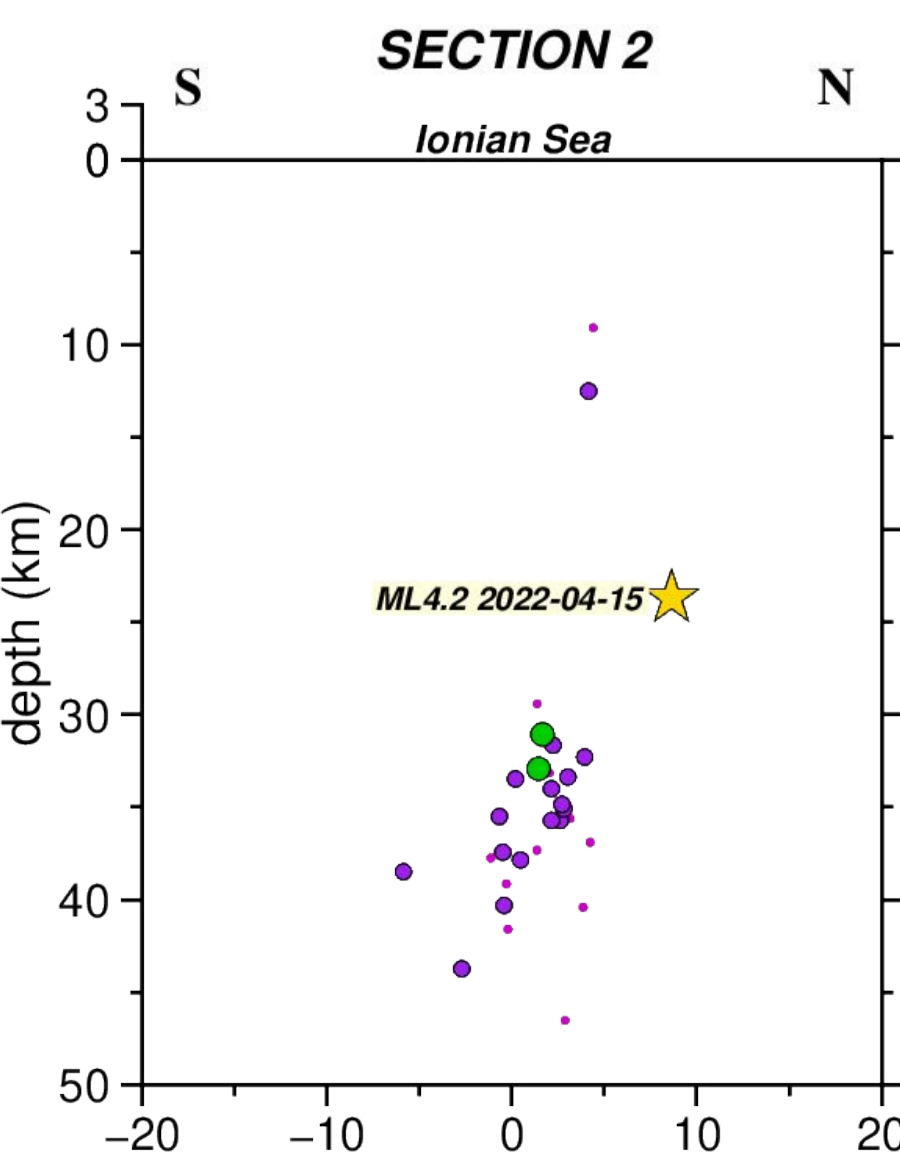


The Time domain moment tensors of the two events $M < 4.0$ show an almost pure strike slip movement

MESSINA STRAIT SECTION 3



IONIAN SEA SECTION 2



To improve detection and locations we are awaiting the data from the FXOBS (XH), a network of broadband and short period OBSs deployed in the Ionian Sea. The data were recovered in March 2023 and below you can see a sample.

OBS Deployment Network SH FocusX3 cruise

