Station localization,
Horizontal channel reorientation

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IASPEI Early Career Scientists School
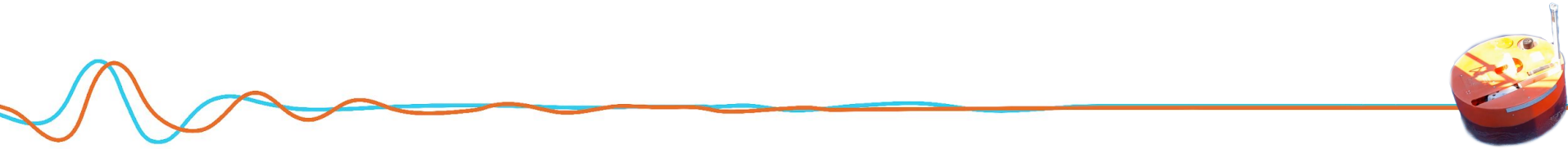August 25 – 30 2025 | Lisbon, Portugal

OBS deployments

OBSs are usual deployed in free-fall from the sea surface, or on the end of a cable with a short-baseline transponder (for easier localization).
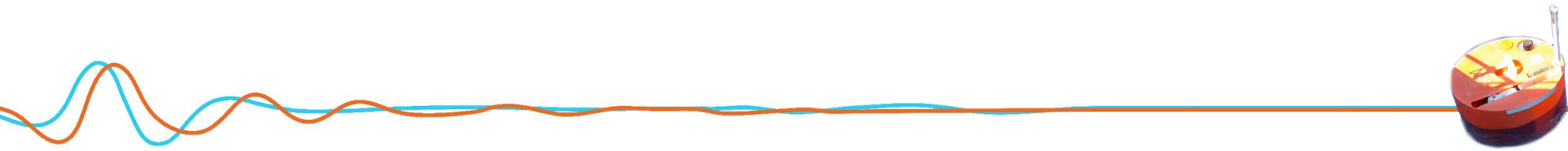
Compasses integrated into OBSs give false north because of the metal and electronics

Horizontal channels are rarely aligned with geographic N and E, and we do not know the misalignment on recovery

When deployed from the sea surface, the instruments can drift by several hundred meters
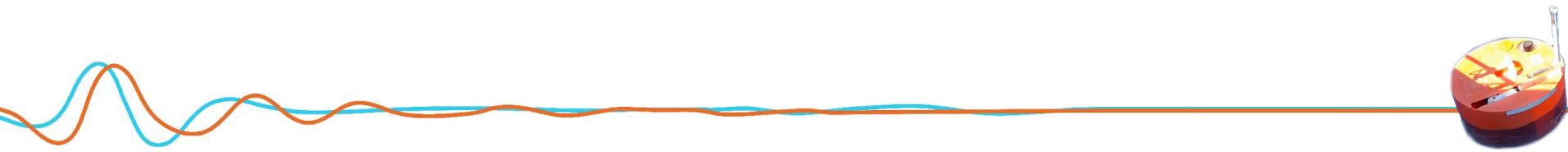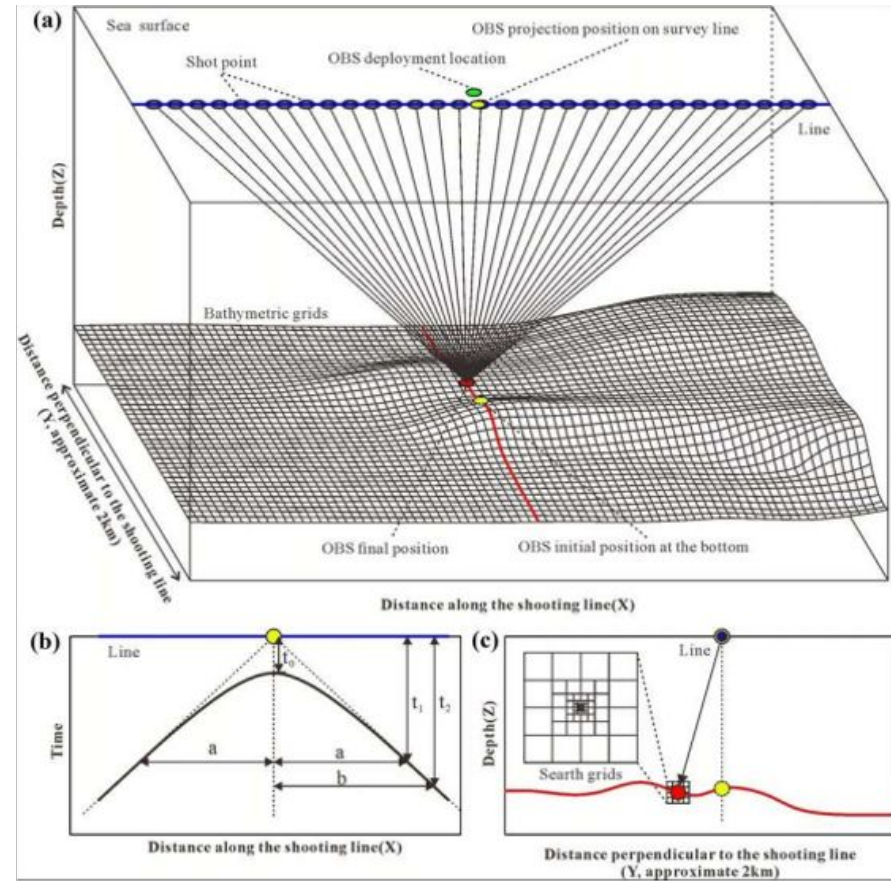
Relocating OBSs

Relocalization methods

Airgun shots

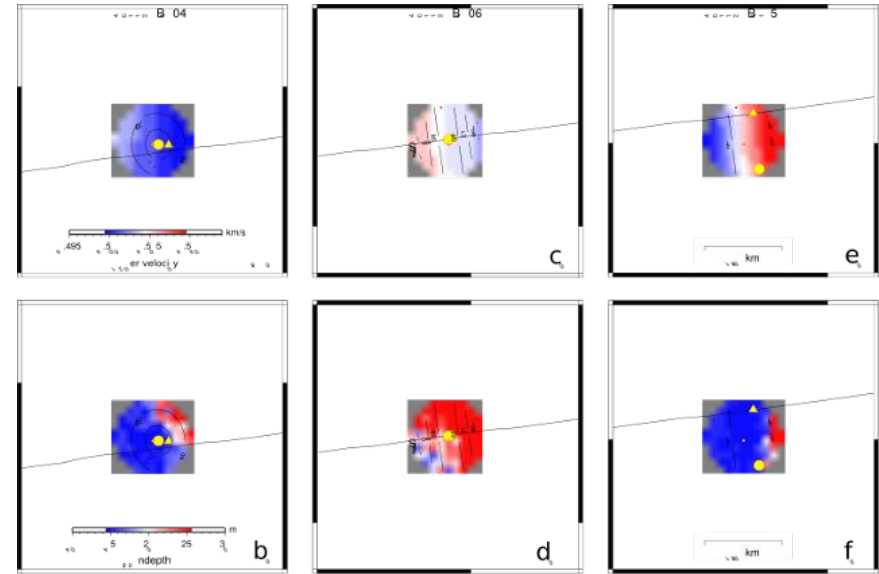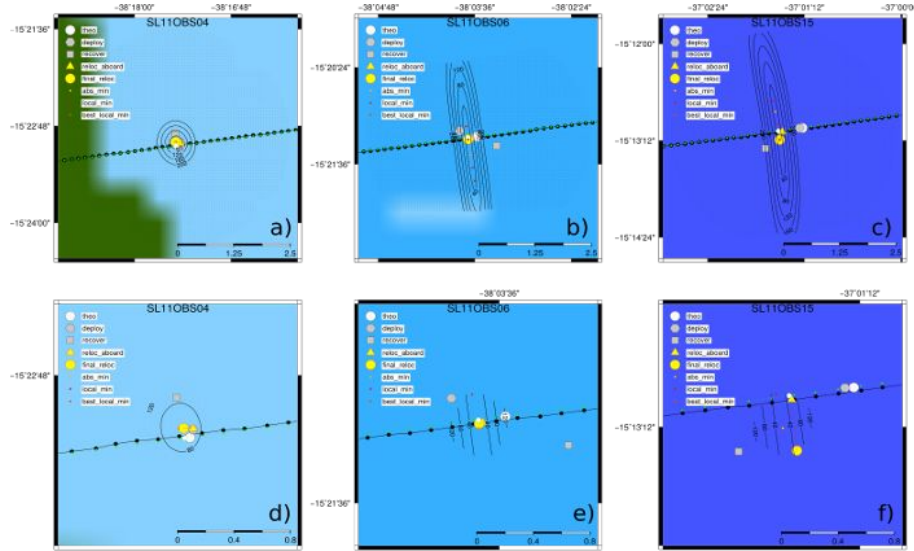Acoustic surveys [Russell et al, 2019]

Airgun shots for relocalization

Using the known location of the airgun shots and our best bathymetric grids, we can do a least squares inversion for the position of the OBS, based on the propagation times of the direct waves
Further refinements come from testing varying airgun depths and sound velocity parameters along the path

Airgun shots for relocalization

Varying water propagation velocities and airgun depth

Coarse and bathymetric grids
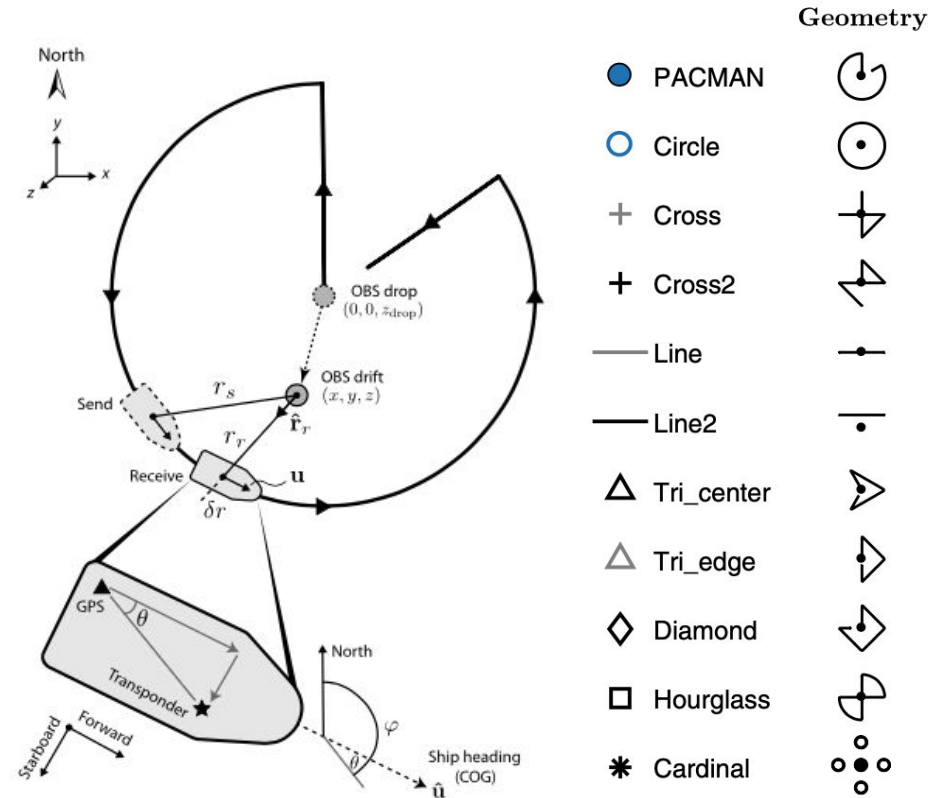
Acoustic relocation

Need

- At least 3 "distant" points, equally spread on a circle of radius ~½ the water depth
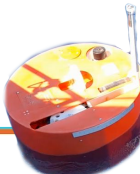- 1 point over the OBS

OBSrange

- Does the triangulation (can use variable water wave speed)
- Can include the water wave speed in the inversion
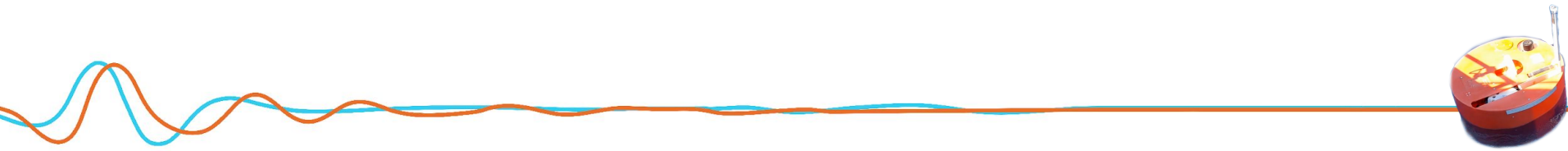- Can take into account the ship's shift between transmission and reception

  Install and test before you go to sea!

Russell et al, 2019

Geometry

- PACMAN
- Circle
- Cross
- Cross2
- Line
- Line2
- Tri_center
- Tri_edge
- Diamond
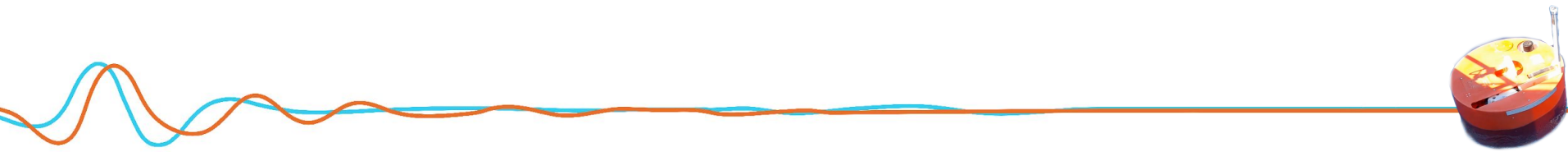- Hourglass
- Cardinal

Determining horizontal channel orientation

Methods

Airgun shots

Whale and boat tracking [Trabattoni et al., 2020]

Earthquake back-azimuths [Scholz et al., 2017; Doran & Laske, 2017; orientPy]

Ambient noise orientation [Ensing & van Wijk, 2019]
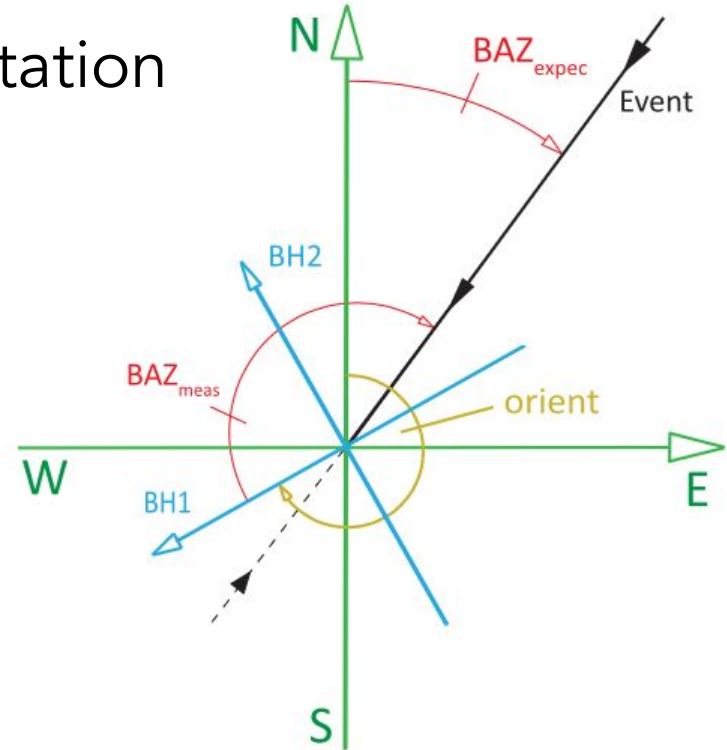
Earthquake back-azimuths for orientation

Compare the back-azimuths

- BAZ_{expec} from the position of the OBS and the earthquake
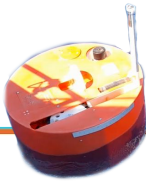- BAZ_{meas} from the measured particle motions assuming the "1" channel is North

The orientation of "1" is $BAZ_{expec} - BAZ_{meas}$

Repeat many times to reduce uncertainty
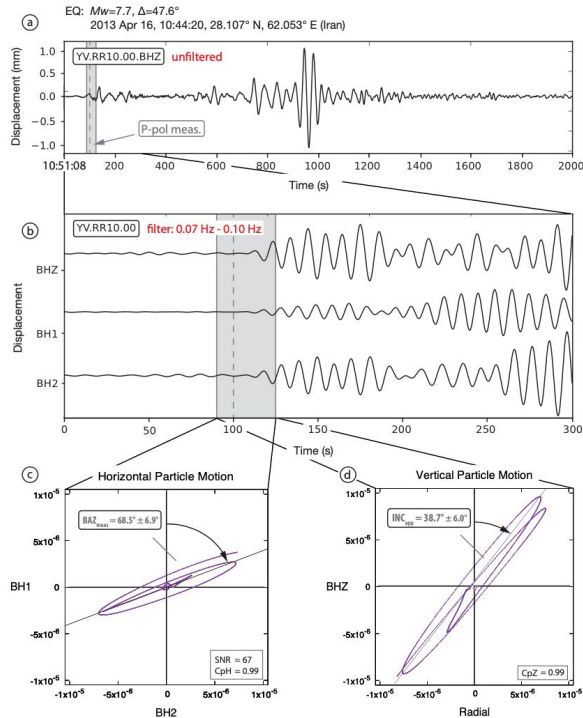
Should have a good spread of BAZ_{expec}

Scholz et al., 2017

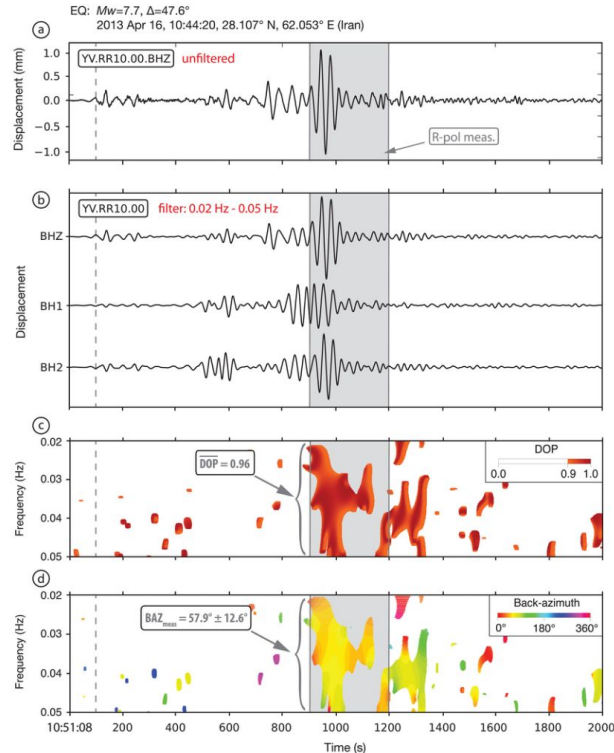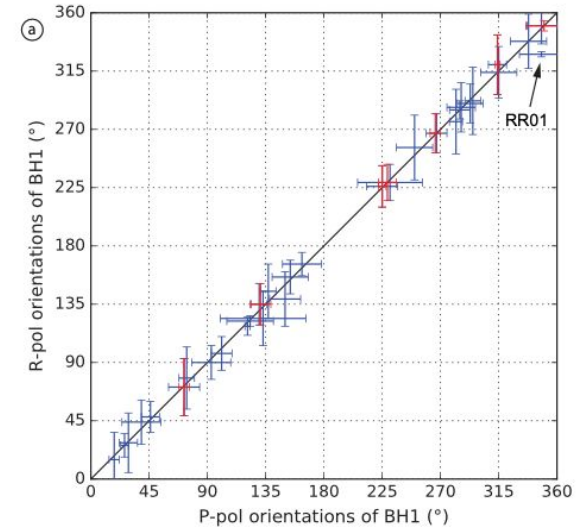# Earthquake back-azimuths for orientation

P-pol example
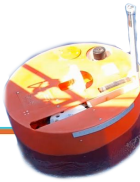
R-pol example
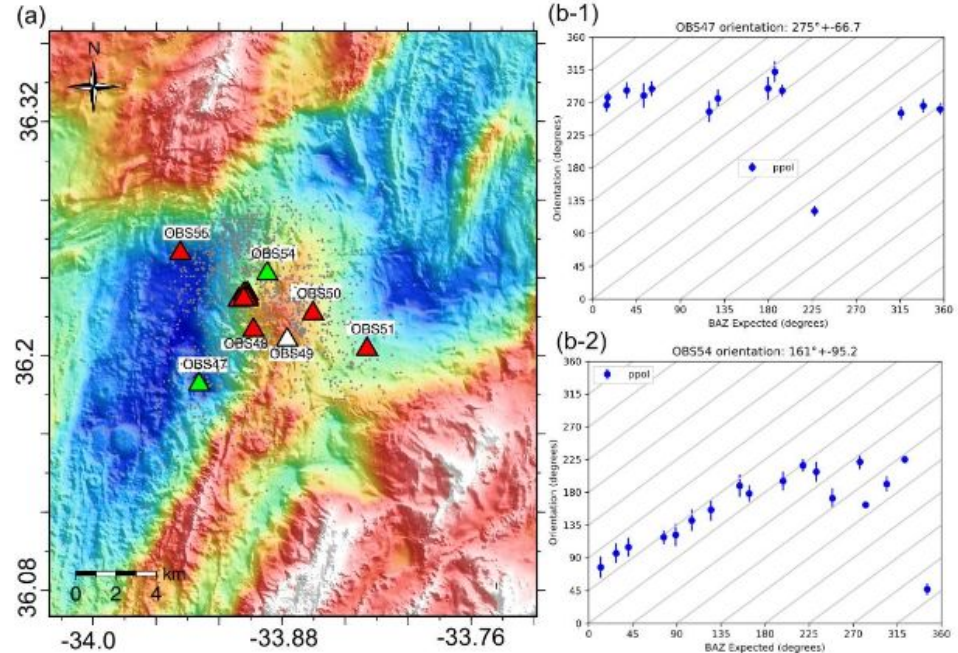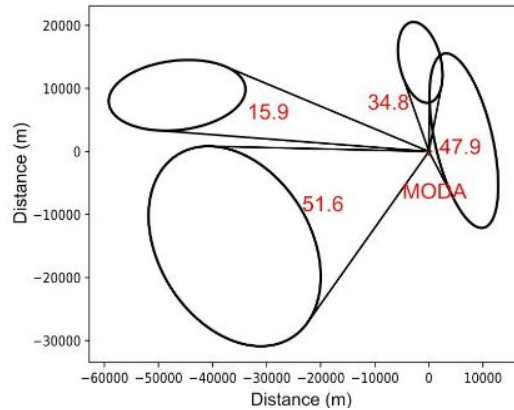
Comparison of results

Scholz et al., 2017

There is a problem for short-period seismometers

Need to use local earthquakes
- Should include position uncertainty

Results are not yet robust

Bohidar, 2023 (PhD thesis)