Effects of cable geometry and specific noise sources on DAS monitoring potential

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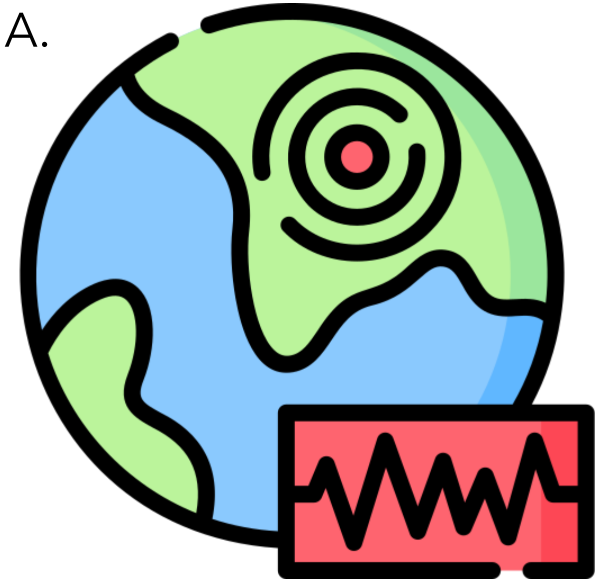

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Outline

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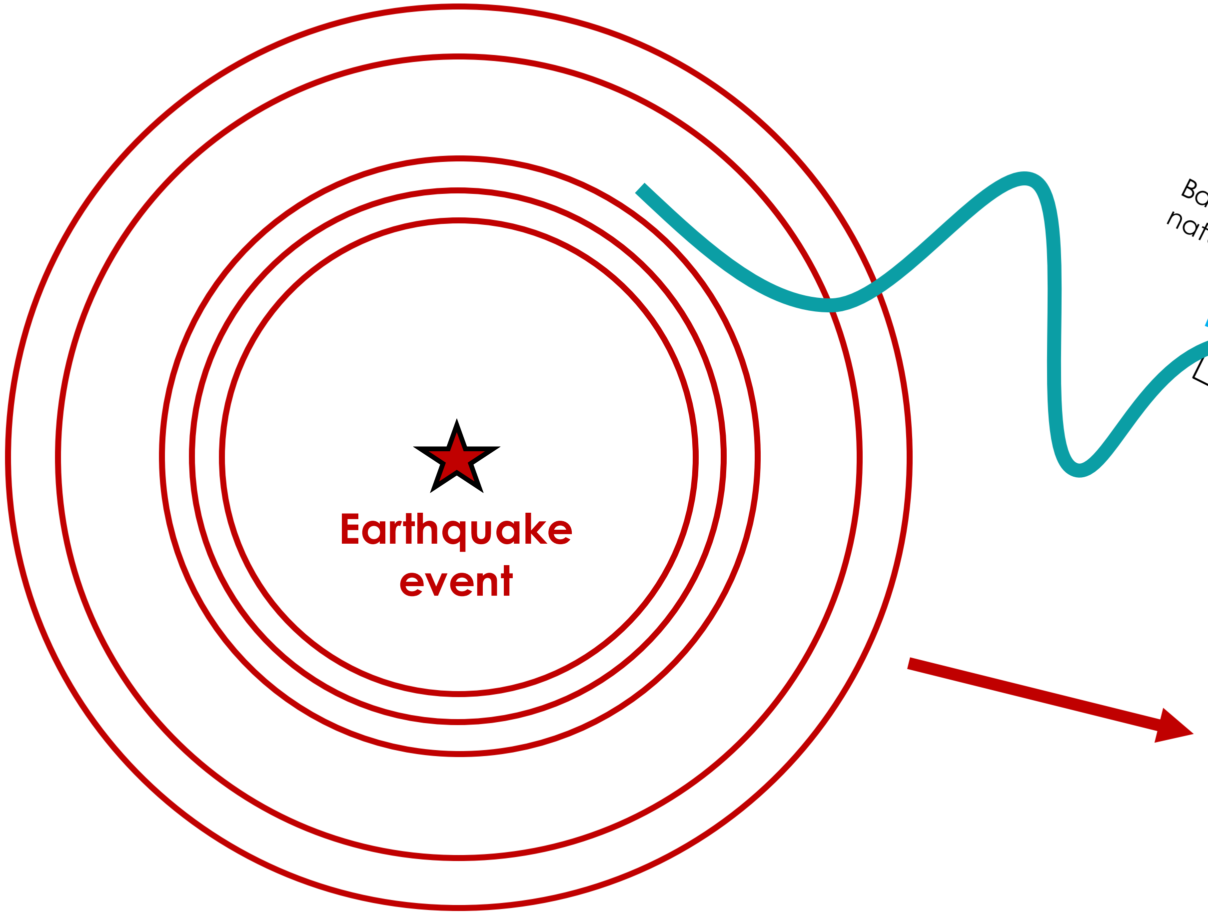
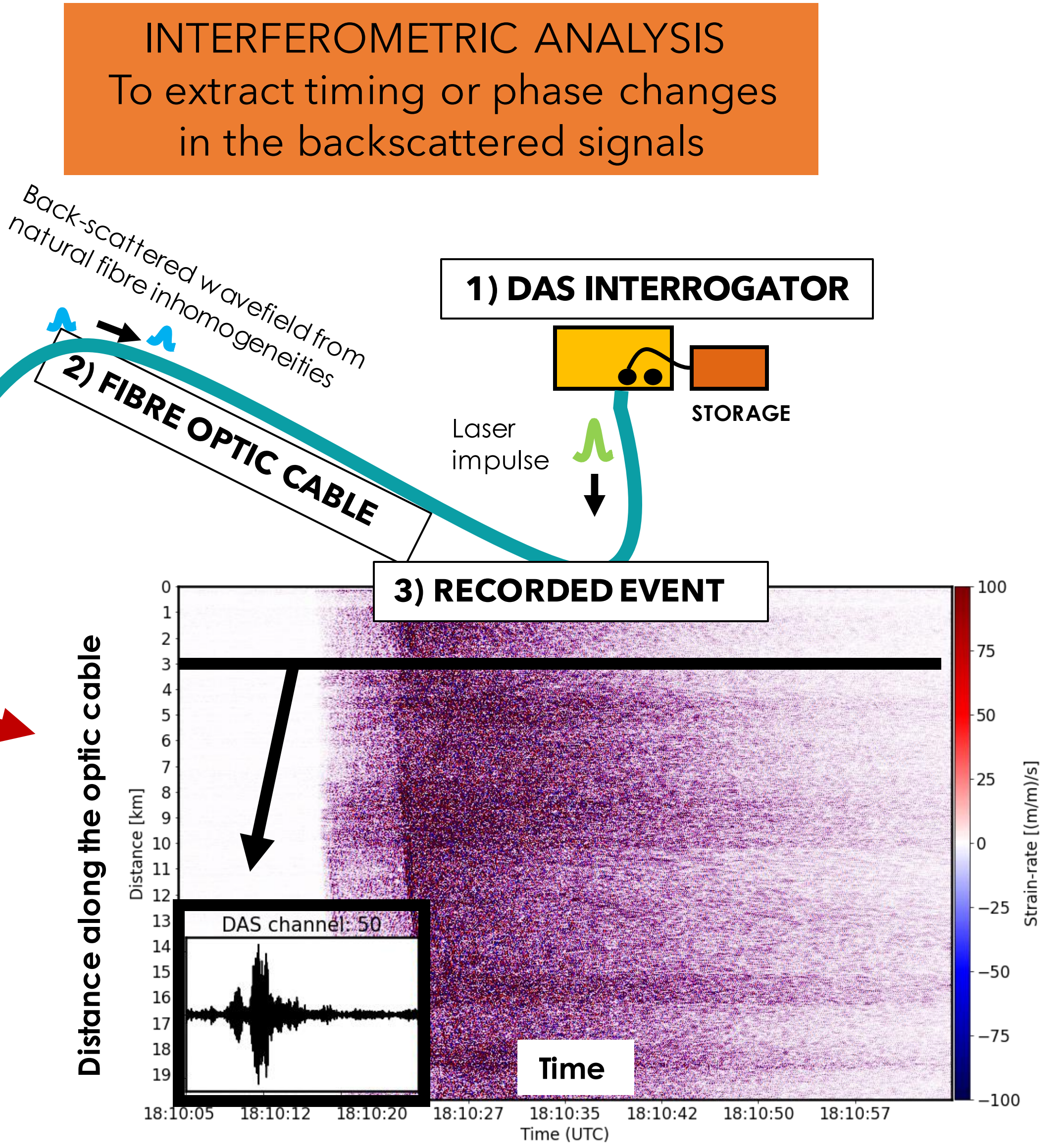
EGU General Assembly #EGU23 23 - 28 April 2023

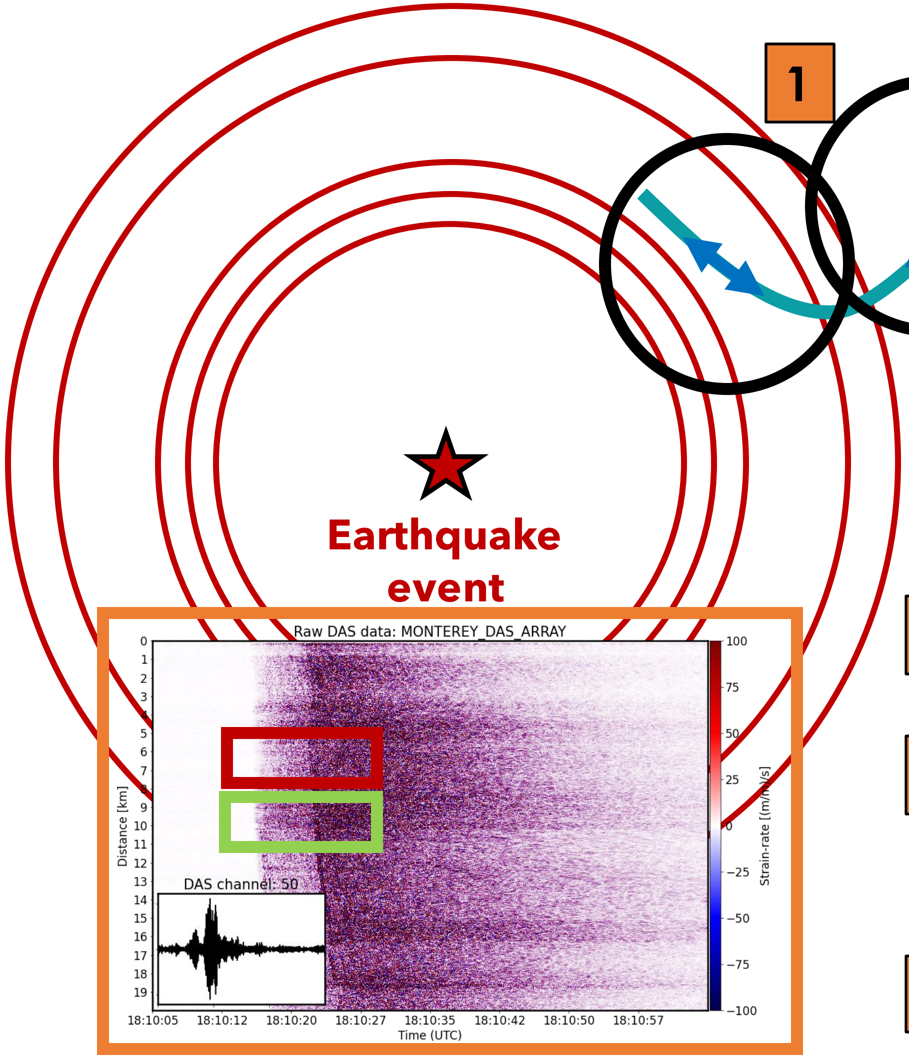
DAS and seismology

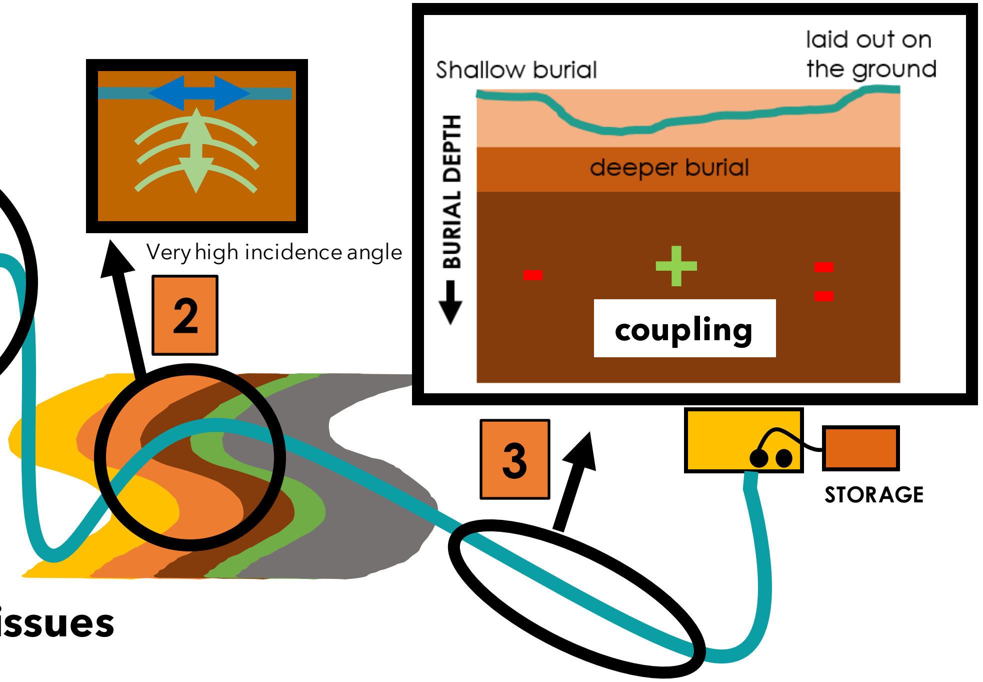




The transit of seismic waves locally modifies the shape of fibre optic cable, provoking a phase change of the back-scattered light pulses. These optic phase changes allow very dense (up to < 1 m) measurements of the fibre strain/strain rate (**DAS method**).

Motivations





DAS issues

1. **Signal directivity** (DAS system)
2. **High sensitivity to small-scale elastic properties variations and phases with low incidence angles** (Strain/strain rate physical properties)
3. **Cable coupling inhomogeneities** (Installation context)

+ a variety of local noise sources (e.g., cars, pedestrians)

Geometry and site-effects affect SNRs and signal coherency along the cable

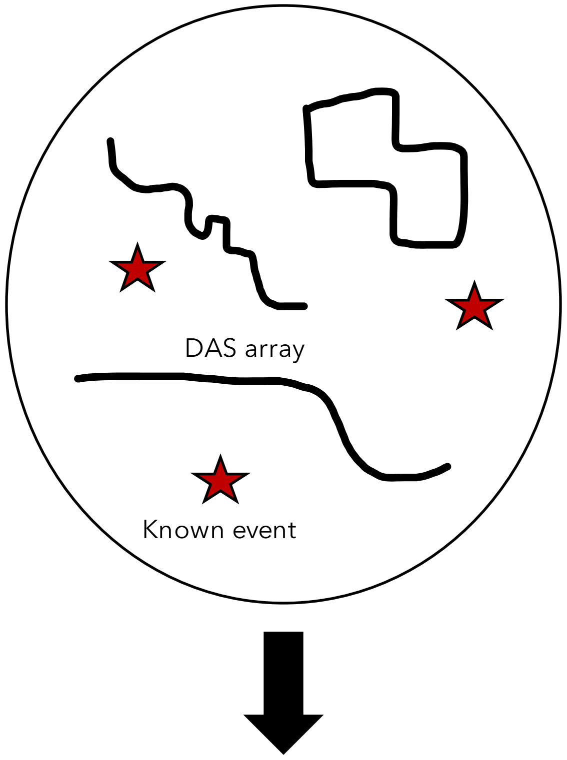
Noise sources are difficult to model, especially for superficial arrays (complicated propagation pattern)

Arrival time estimations are affected >> consequences on event location uncertainties

The workflow

1.DATA GATHERING

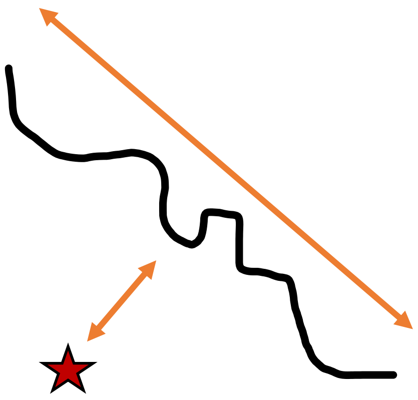
(event + a variety of DAS geometries)

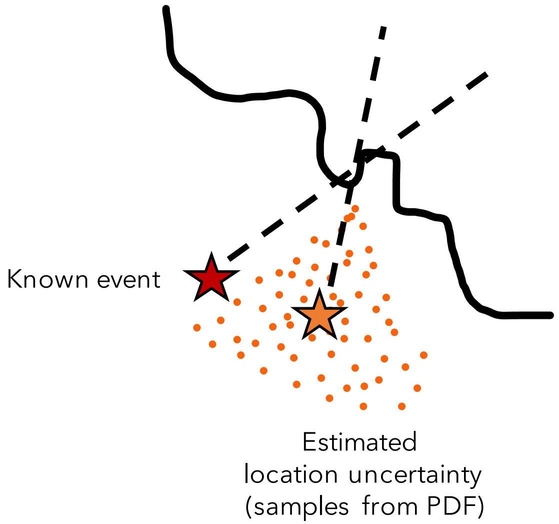


Database

2. DEFINITION OF THE GEOMETRICAL PARAMETERS

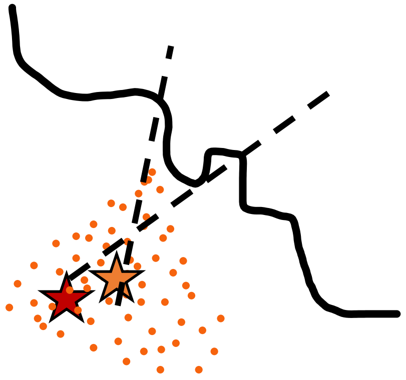
(Geometry of the problem, event + DAS array)





3. OBSERVED LOCATION UNCERTAINTIES

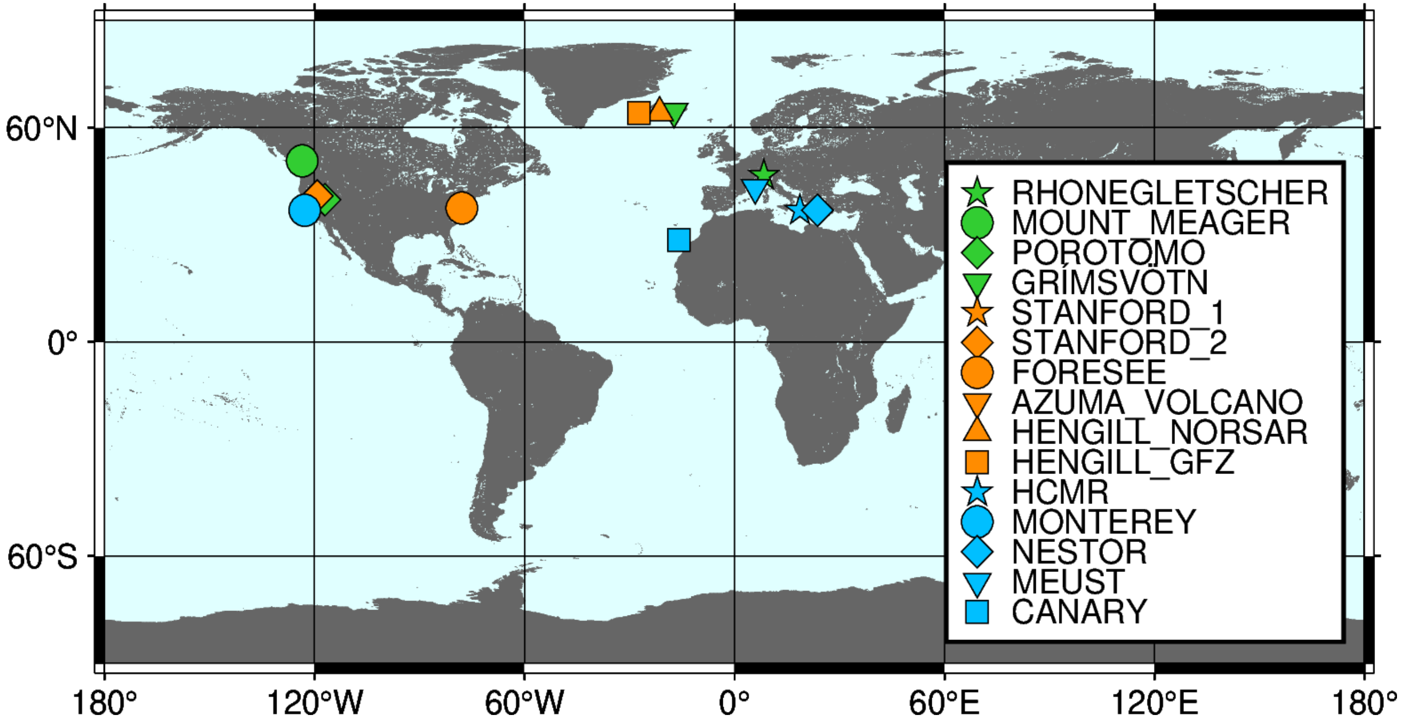
(Inversion of observed arrival times)



4. TEST DIFFERENT NOISE STATISTICS ASSUMPTIONS TO REPRODUCE THE OBSERVED LOCATION UNCERTAINTIES

(Synthetic traveltimes from known event location and tests on noise statistics assumptions >> event location estimation)

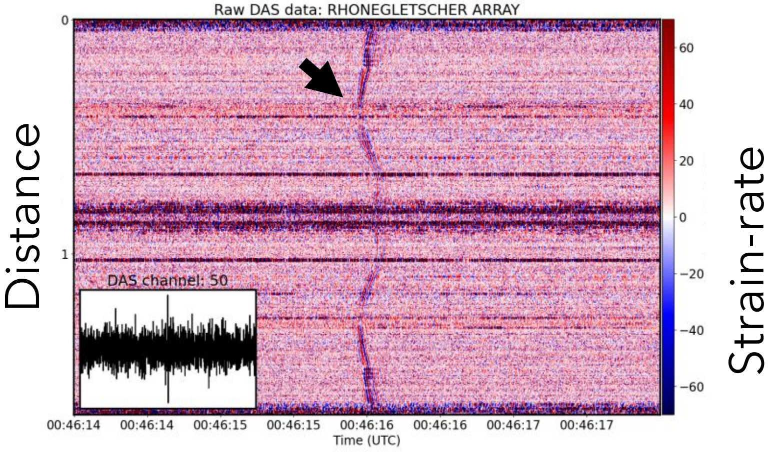
Data

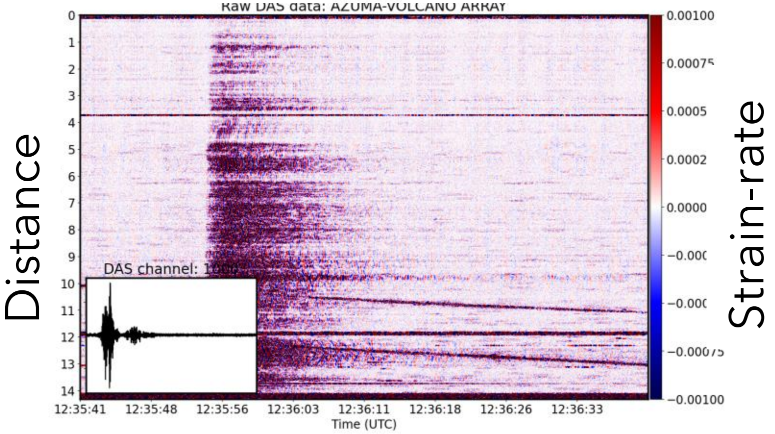


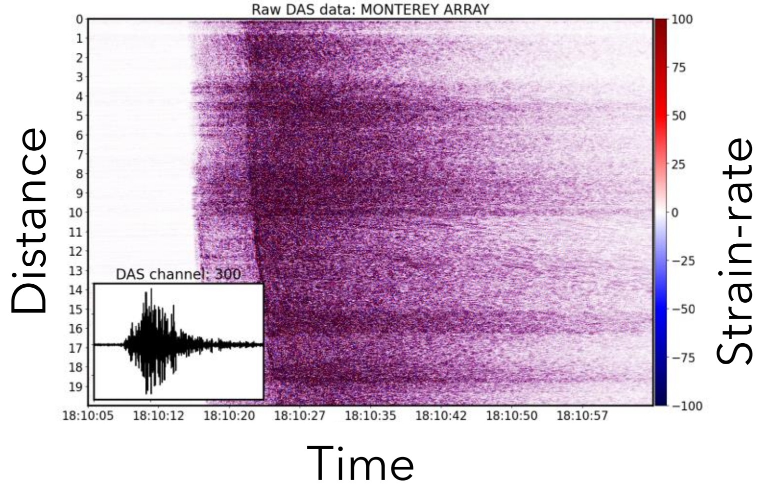
(Bozzi et al., in prep.)

A diversified dataset.
15 DAS datasets and selected events with known location

- **"fit-for-purpose" installations**
- **Sub-aerial telecom installations**
- **Submarine telecom installations**



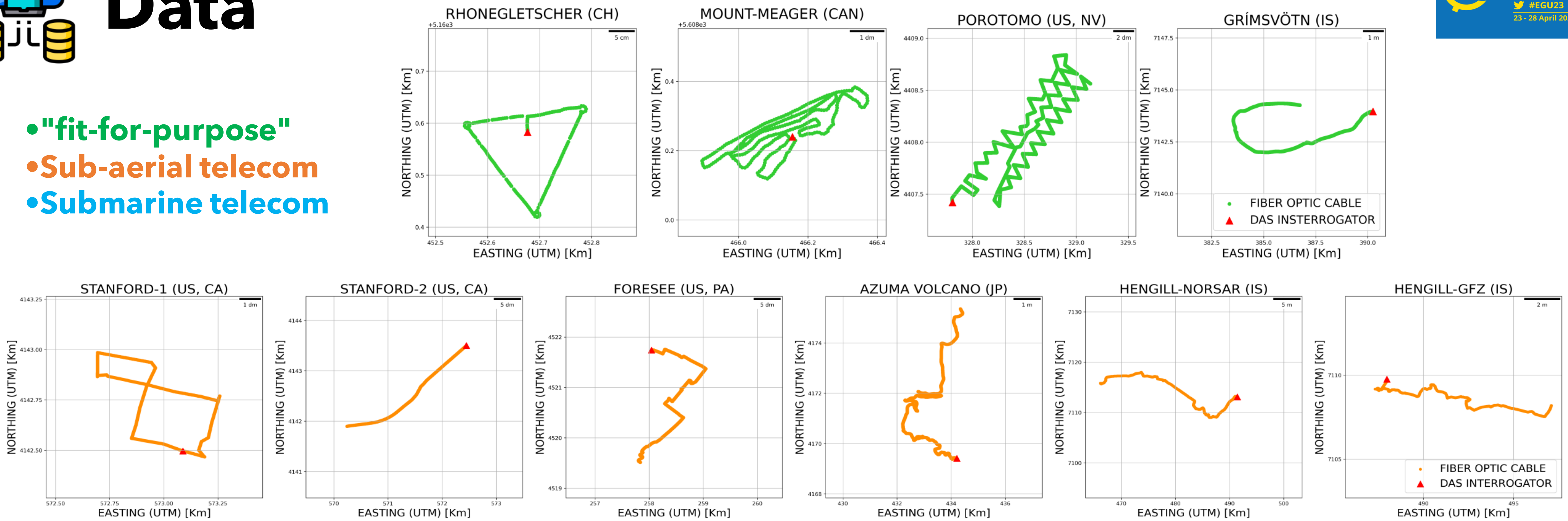


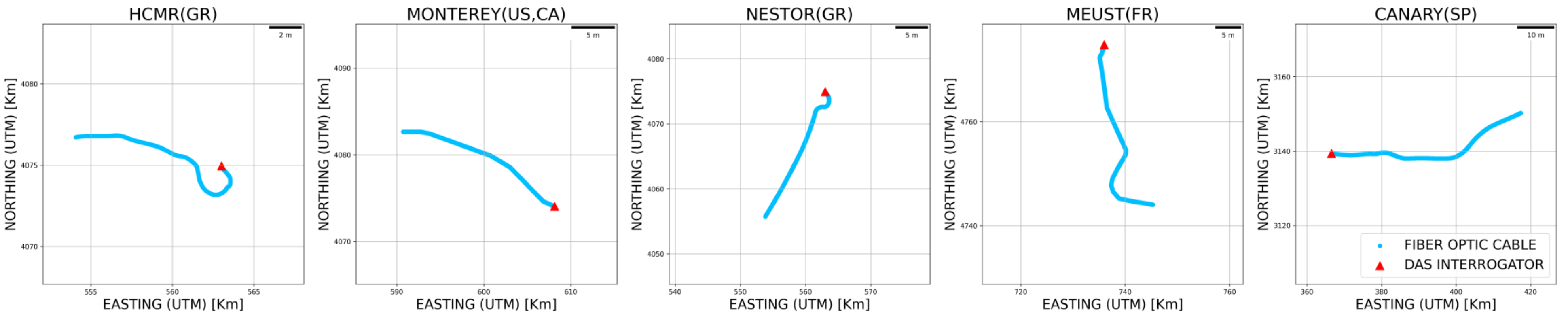


Events

Data

- "fit-for-purpose"
- Sub-aerial telecom
- Submarine telecom





The **DAS array geometries** show varying shapes and covered azimuthal directions

(Bozzi et al., in prep.)

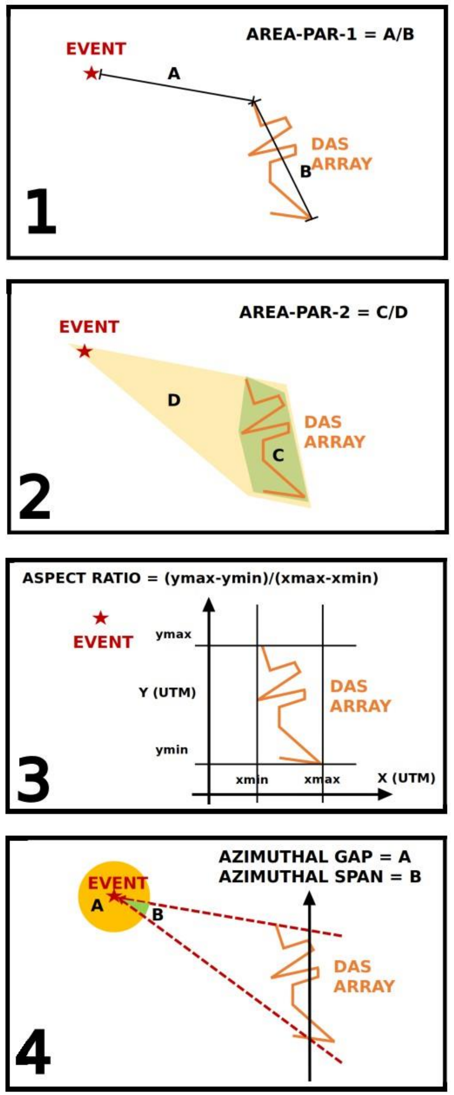
Methods

1. Definition of **four geometrical parameters**

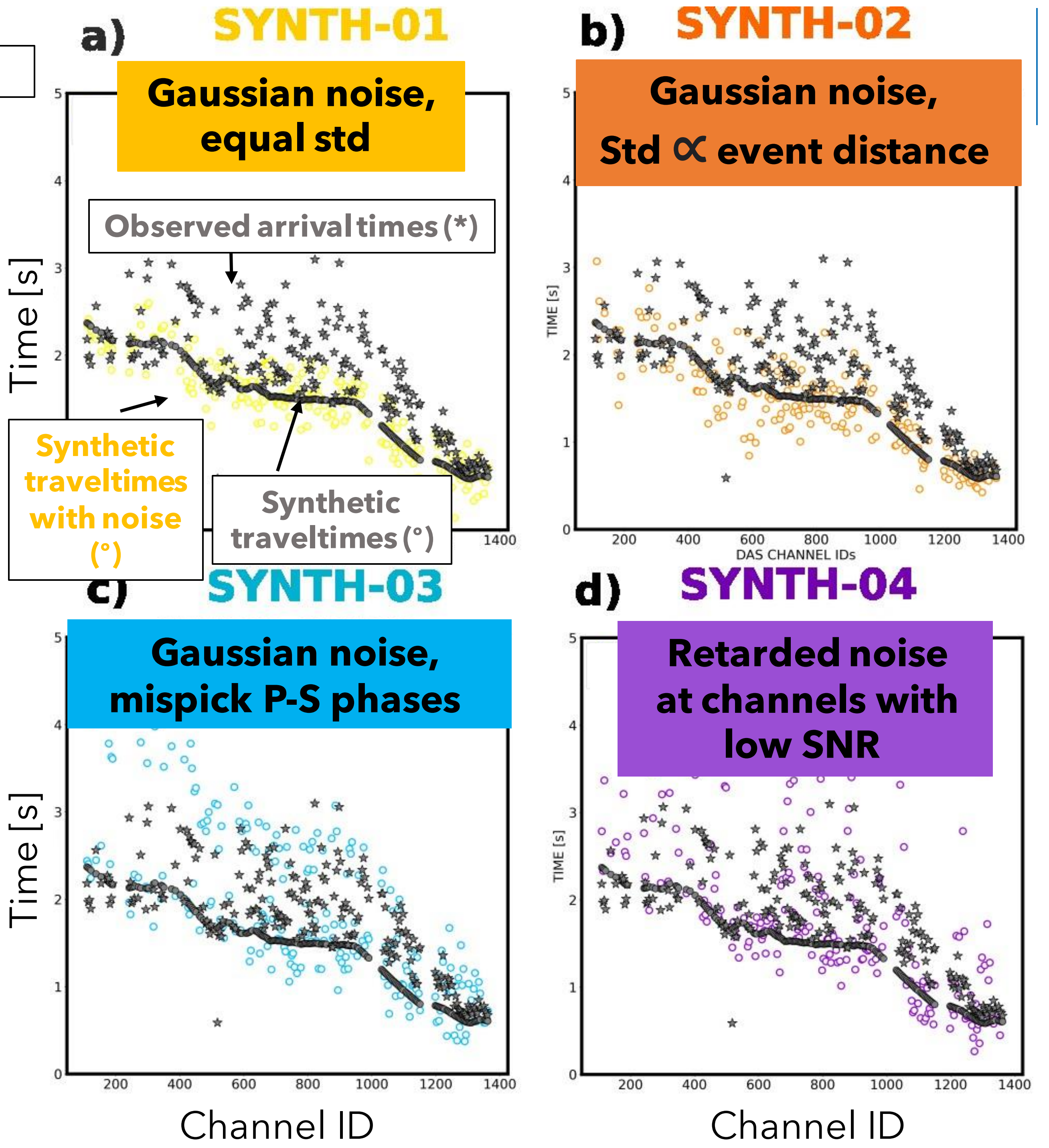
2. **Automatic onset arrival time picking** and **event location estimation** (McMC method)

3. **Synthetic tests** to explore the reproducibility of the observed location uncertainties with simple **noise statistic assumptions** (inspired by common noise patterns)

Geometrical parameters

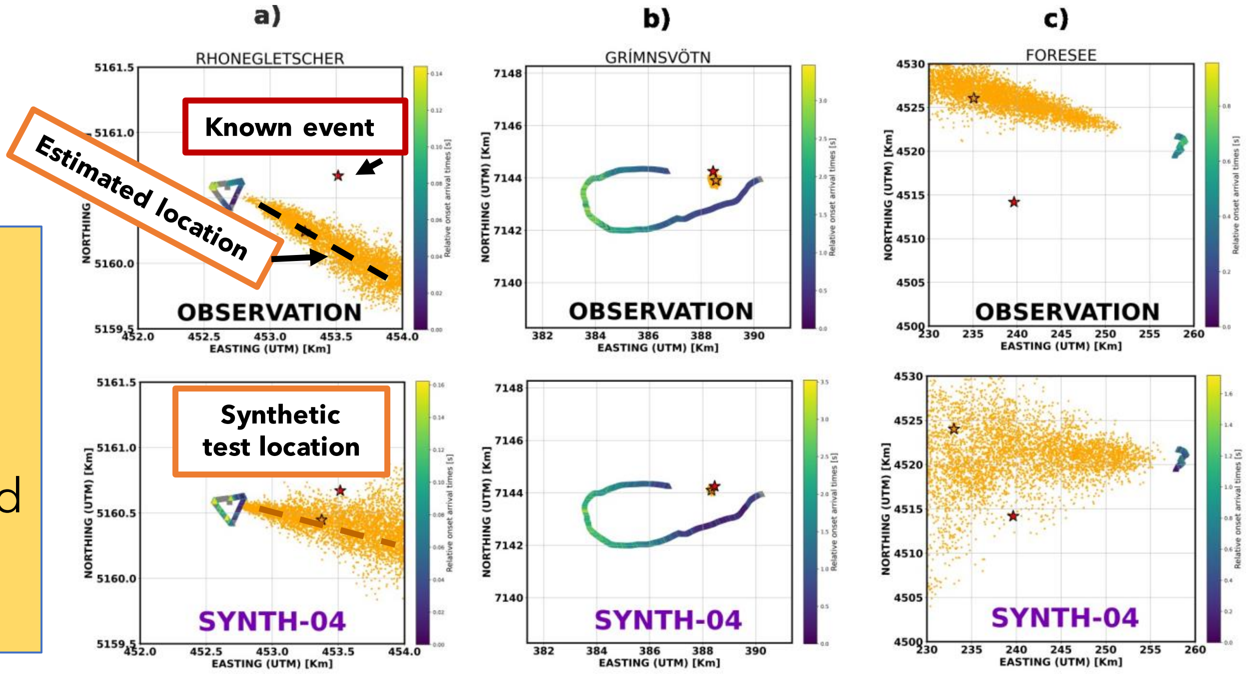


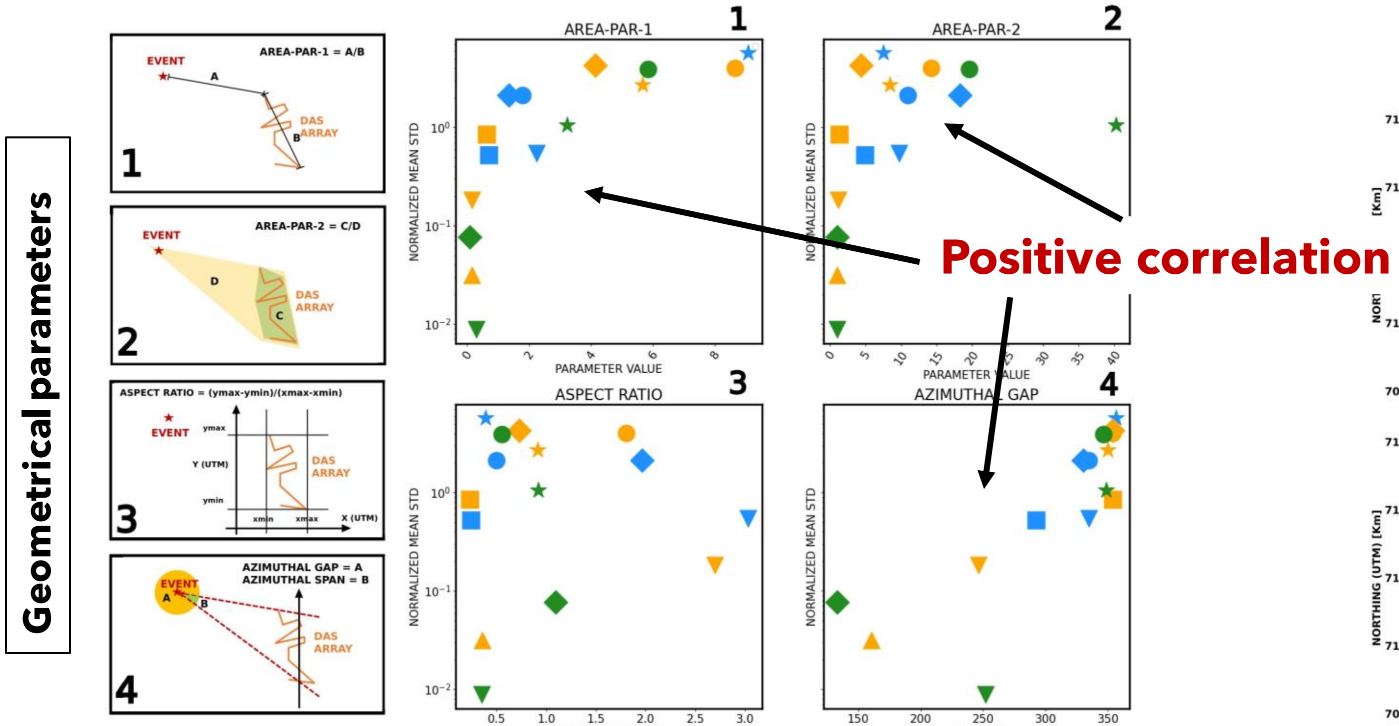
(Bozzi et al., in prep.)

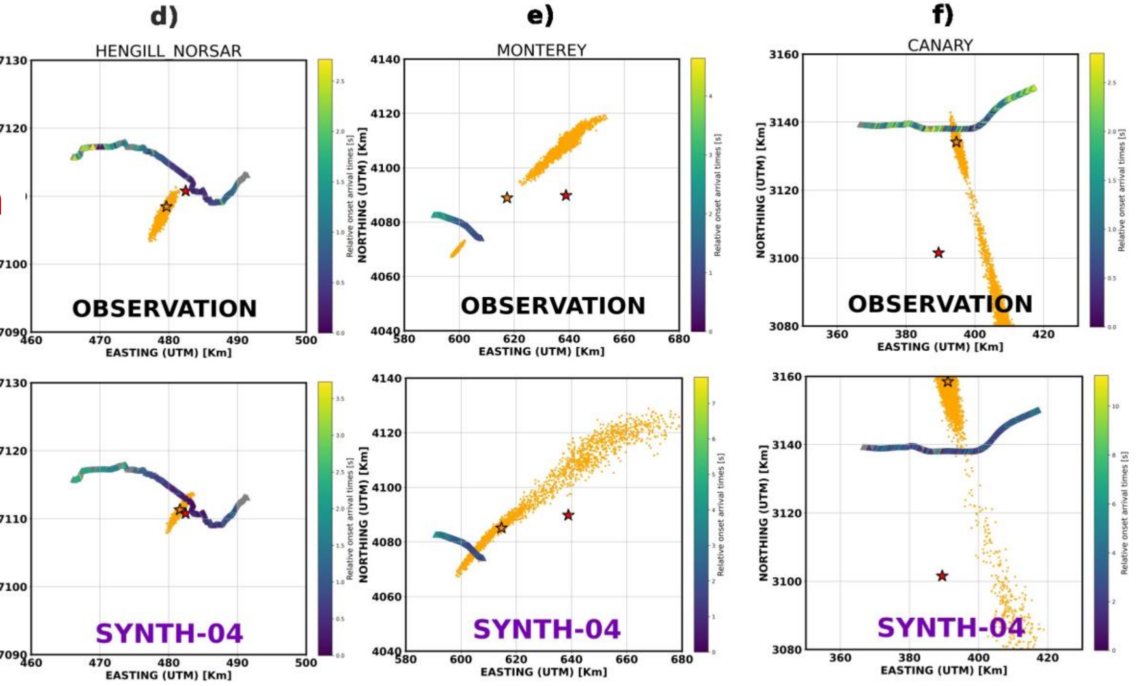


Results

- **Correlation between three geometrical parameters and location uncertainties** (Area-par-1, Area-par-2, azimuthal gap)
- **SYNTH-04** test **reproduces** the azimuth of the observed uncertainties (directionality of the "uncertainty cone") in **around 40 % of the case studies**







(Bozzi et al., in prep.)

Conclusions

- **Geometry of the DAS problem.** As in the case of traditional seismometry, the geometry of the DAS sensors and their position with respect to the source zones assume great importance in determining the location accuracy .

- **SYNTH-04 test**. A mixed noise statistics, where a portion of DAS channels are contaminated by gaussian noise, while other by only-retarded noise, provide a better explanation of the observed location uncertainties.

- **Opportunities :**

1) Understand the origin of SYNTH-04-like sources and better modeling procedures,
2) Study mitigation strategies in common seismic monitoring procedures,
3) Further studies can benefit from this work to explore noise parameters and/or outliers' thresholds via Monte Carlo sampling.

Thank you for listening! Questions?

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