

Active Strike-Slip Fault Monitoring Using Marine Geodesy, Offshore Mt Etna, Sicily (Italy)

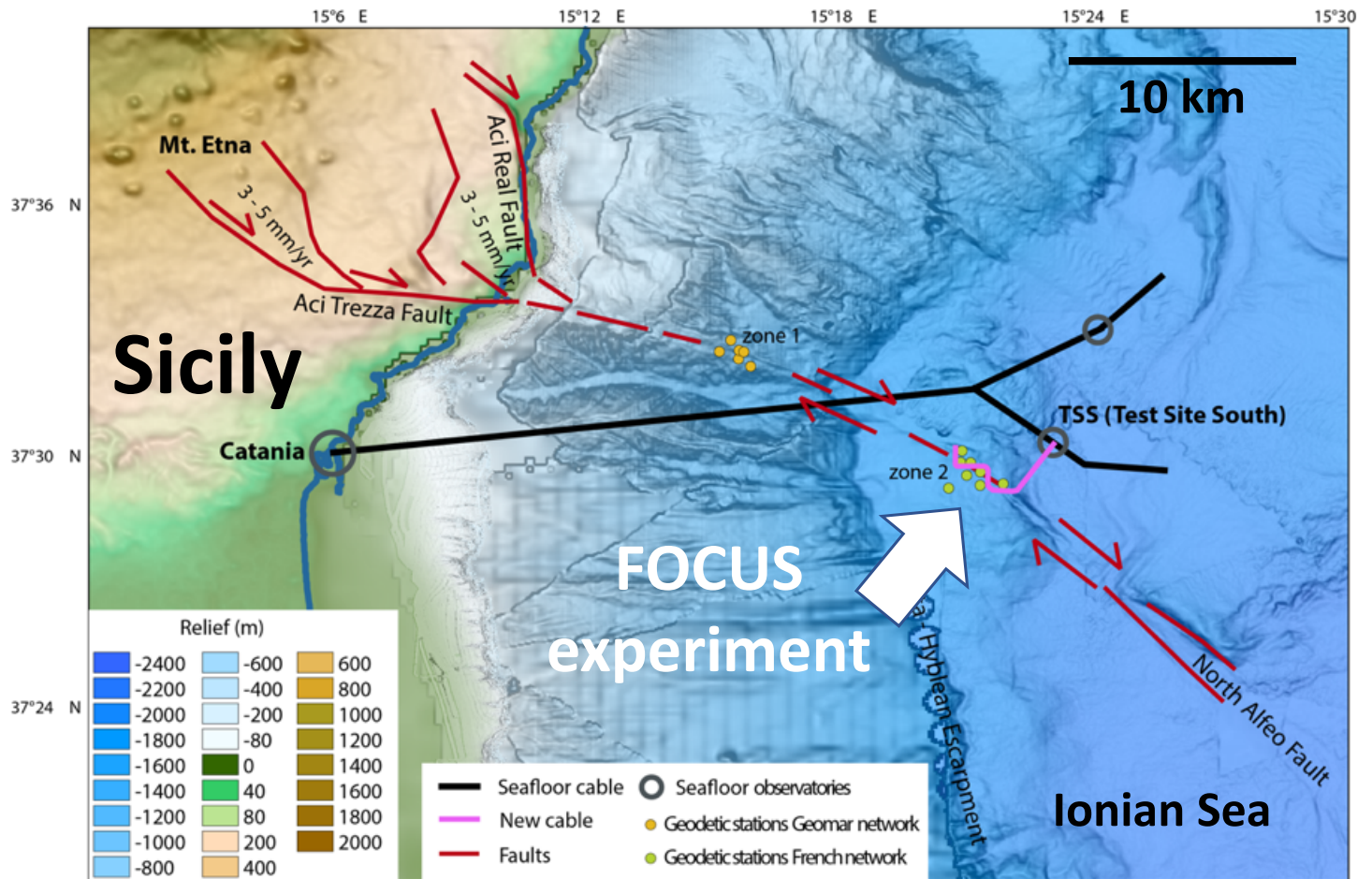
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The North-Alfeo fault off Mt Etna (Sicily)

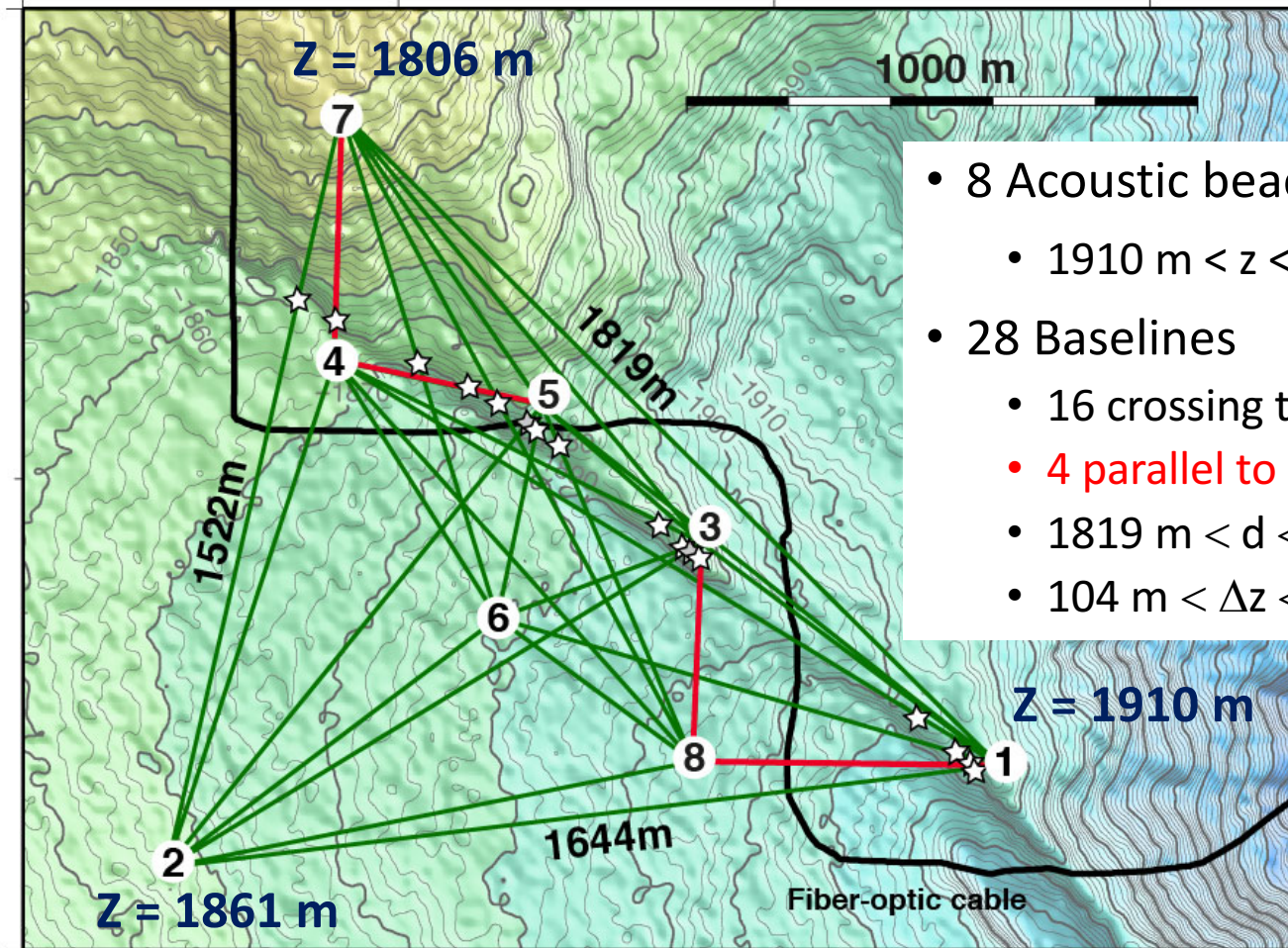


Jointly monitored since October 2020 by **laser reflectometry** and **acoustic ranging** with :

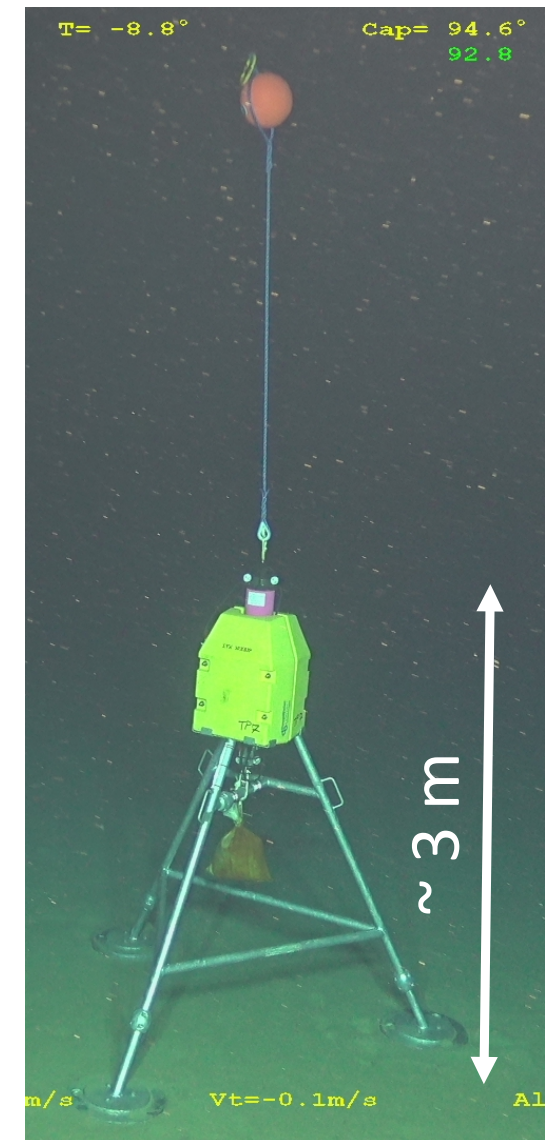
- A 6.2km **optical fiber** crossing 4 times the right-lateral strike-slip fault
- An array of **8 acoustic beacons** set on either side of the fault and cable

2 cm/yr expected

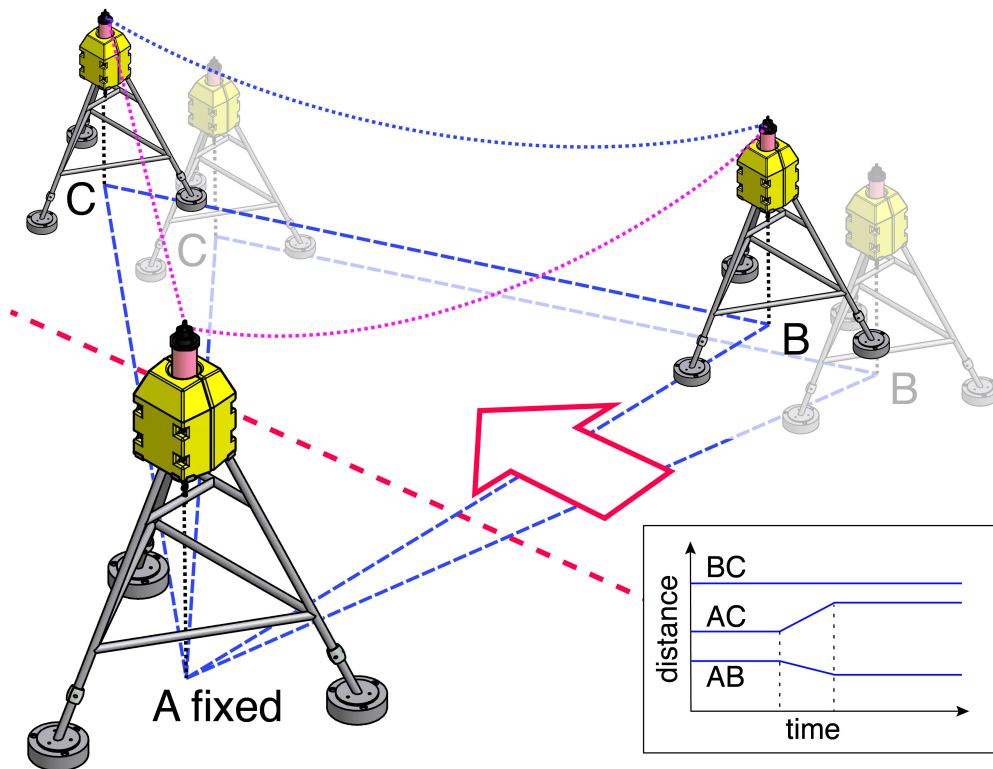
Experimental set-up



- 8 Acoustic beacons
 - $1910 \text{ m} < z < 1806 \text{ m}$
- 28 Baselines
 - 16 crossing the FZ ★
 - 4 parallel to cable
 - $1819 \text{ m} < d < 412 \text{ m}$
 - $104 \text{ m} < \Delta z < 3 \text{ m}$



Experiment principle

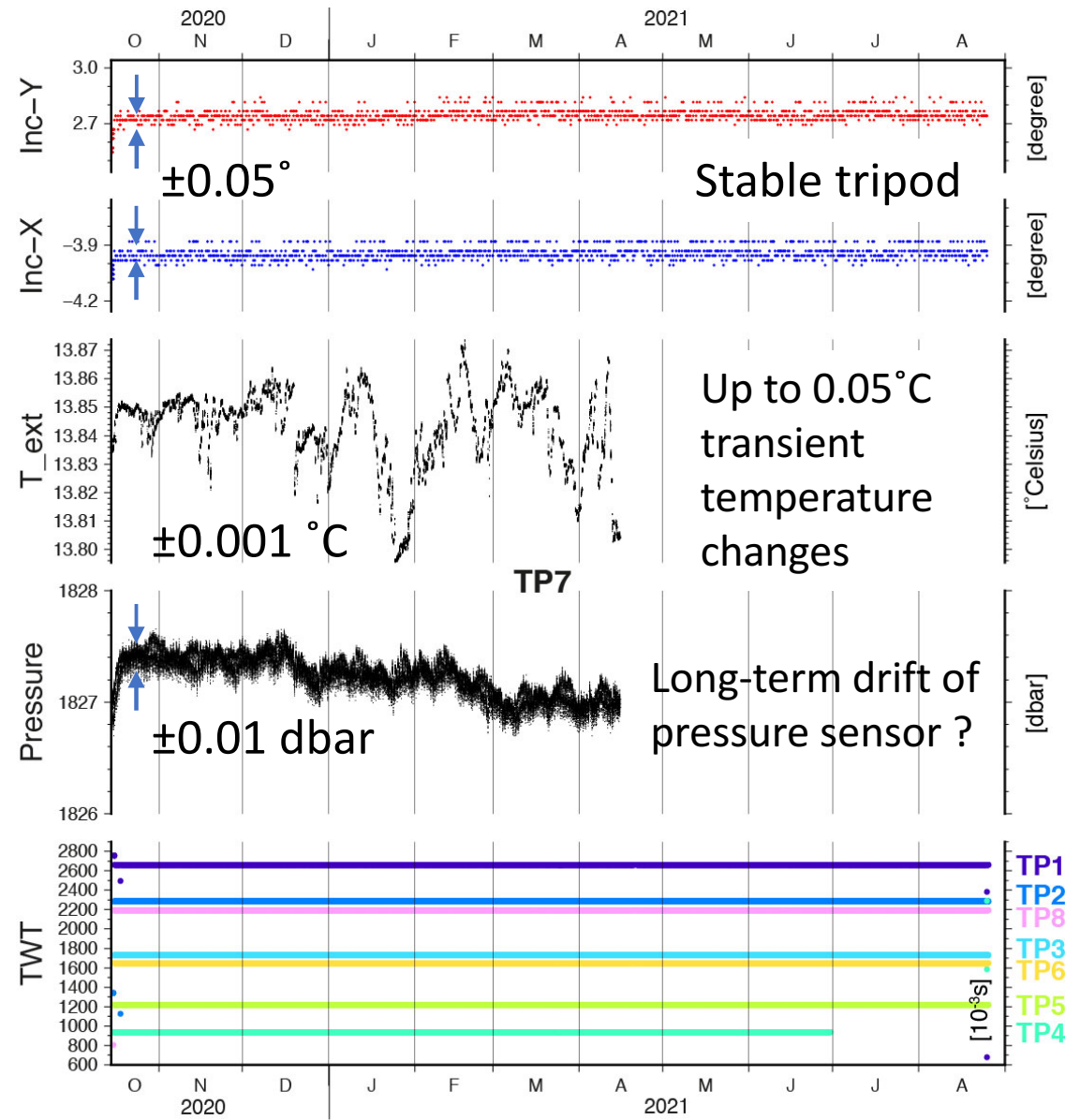
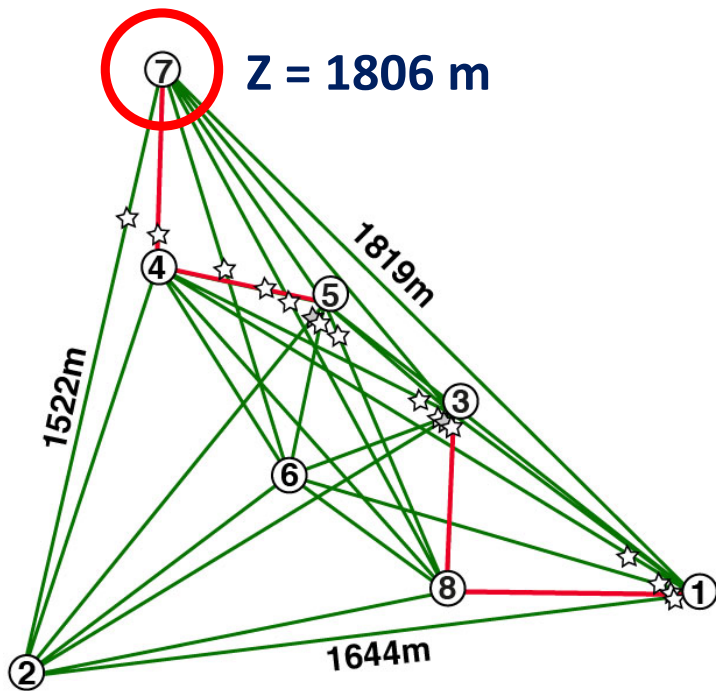


- Baselines are ranged 4 times /day (x 5 pings both ways)
- Joint acquisition of T & P at each beacon, and SSP at 2 stations
- Data can be downloaded from sea-surface with an acoustic modem
- Any displacement of the **fault** will result in changes in the baseline lengths
- To be sorted from
 - a possible tilt of the tripods
 - or changes in the sound-speed

Data example

$\pm 0.05^\circ\text{C} \Leftrightarrow \pm 3\text{ mm displacement}$

- Beacon #7

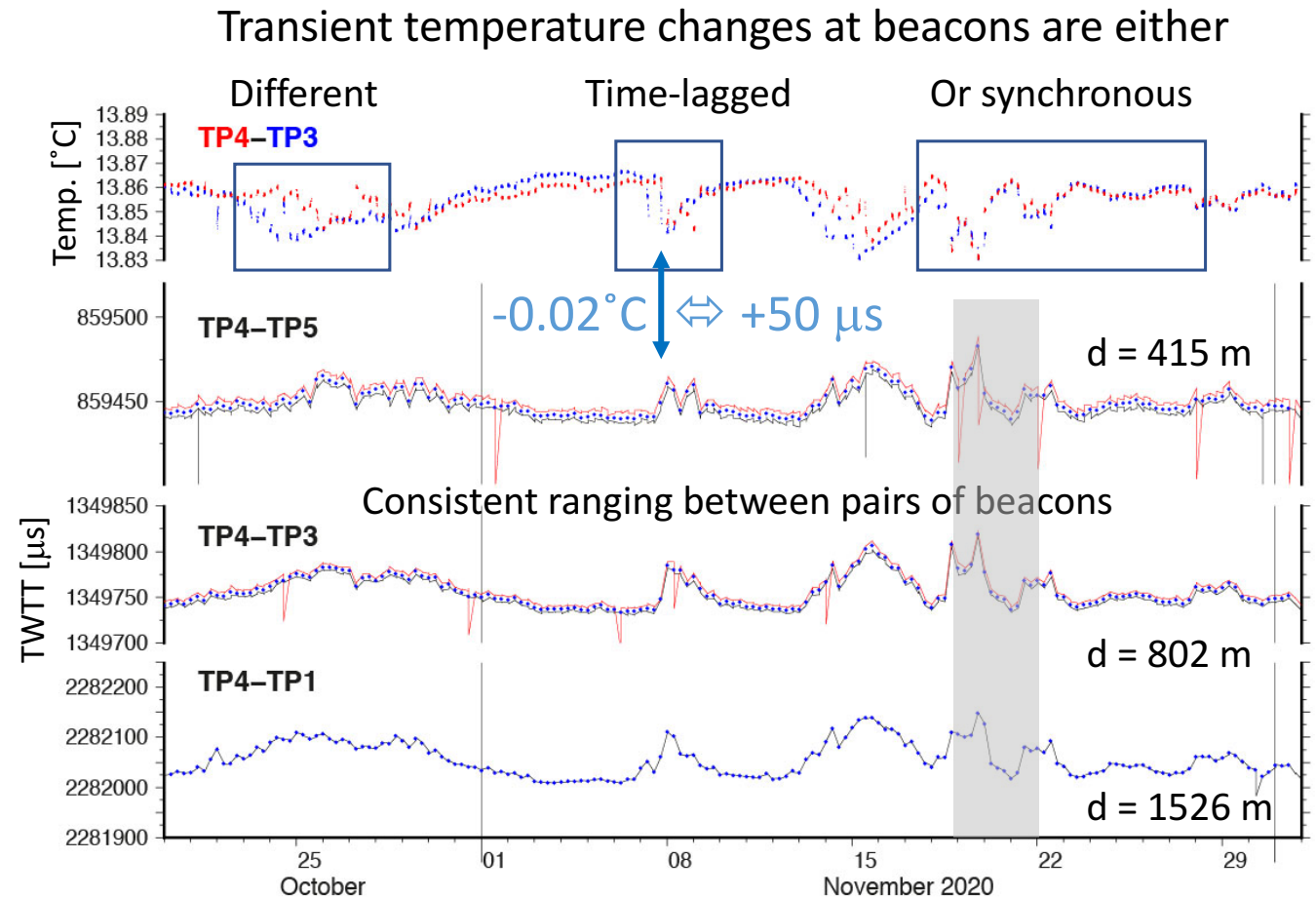
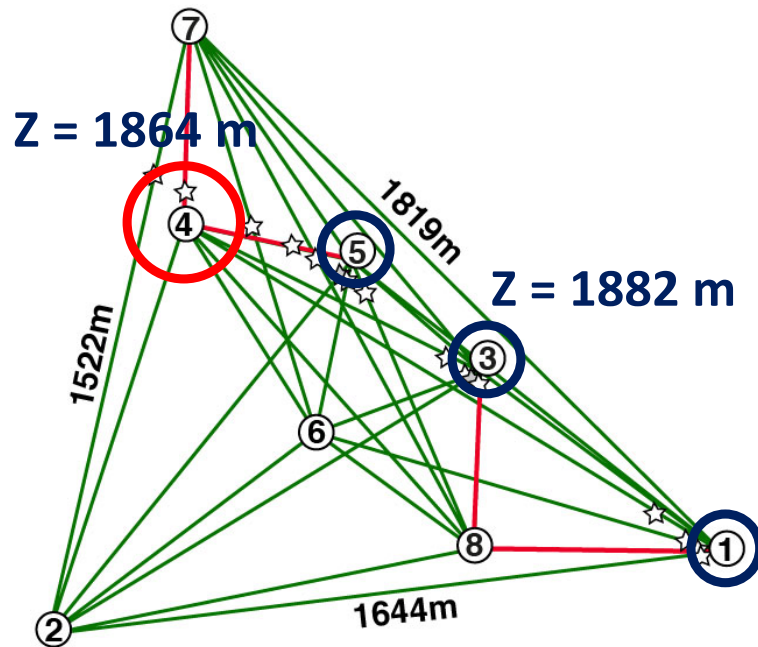


Baseline examples

Differences in baseline behavior reflect inhomogeneous transient environmental changes

$\pm 50 \mu\text{s} \Leftrightarrow \pm 4 \text{ cm}$ at constant SV

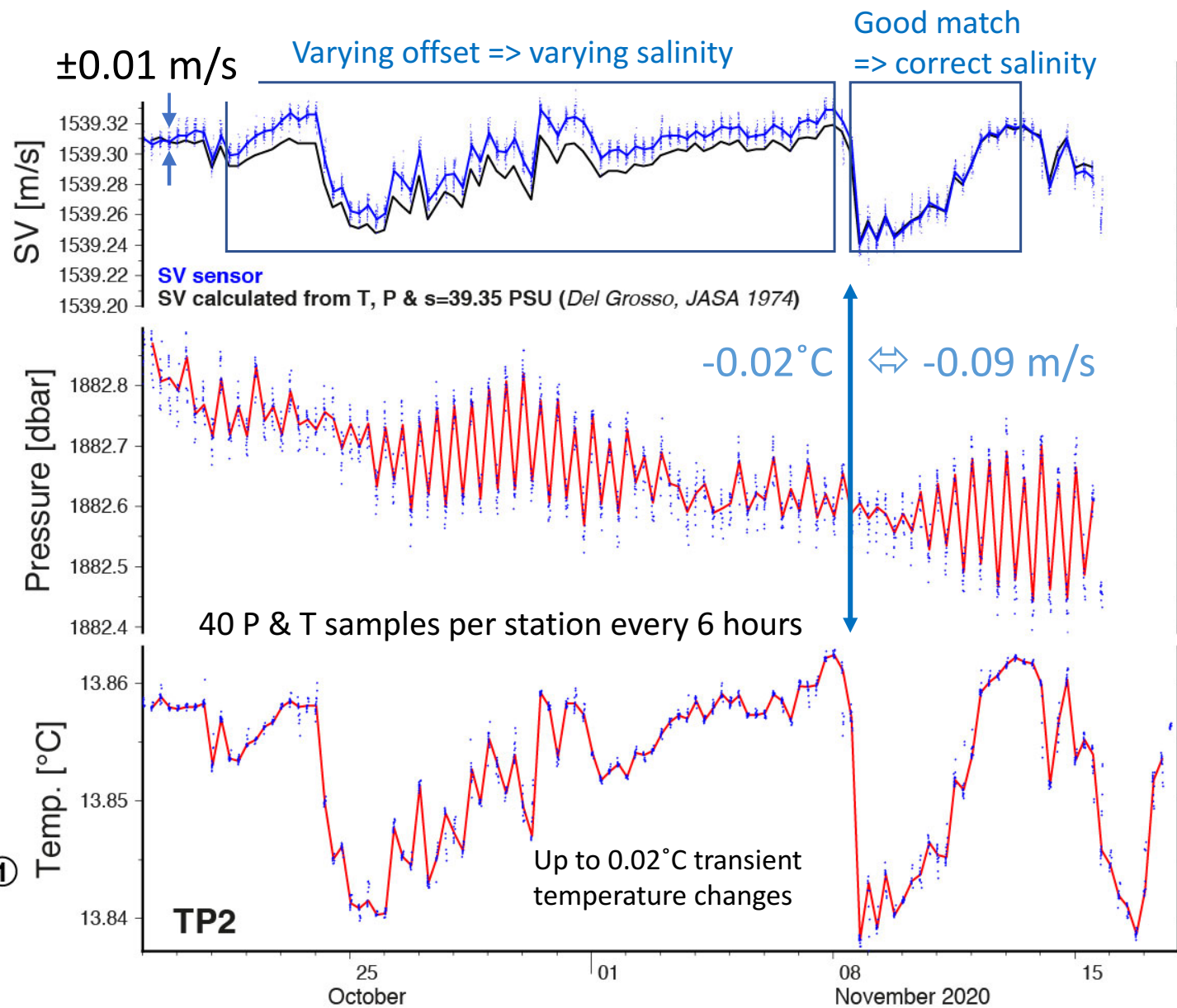
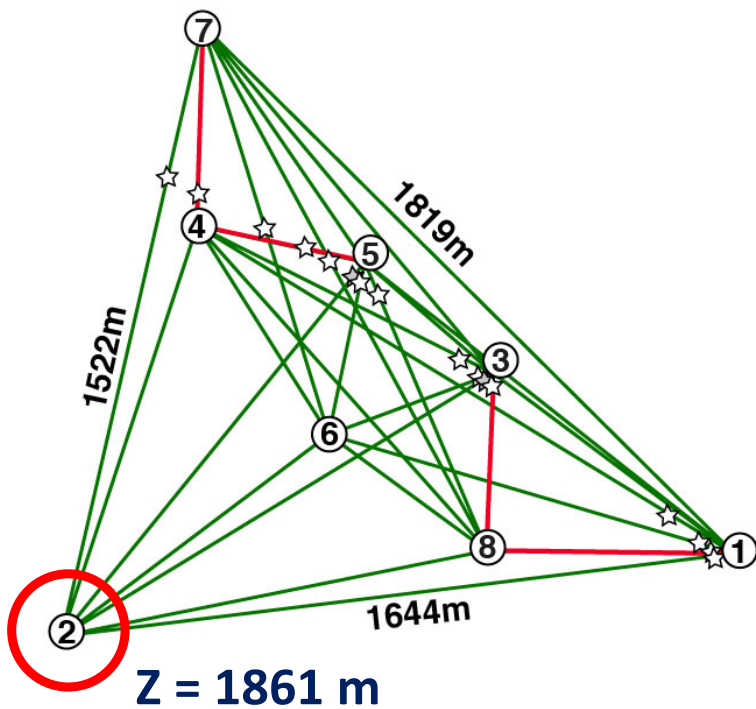
- From beacon #4



Sound velocity

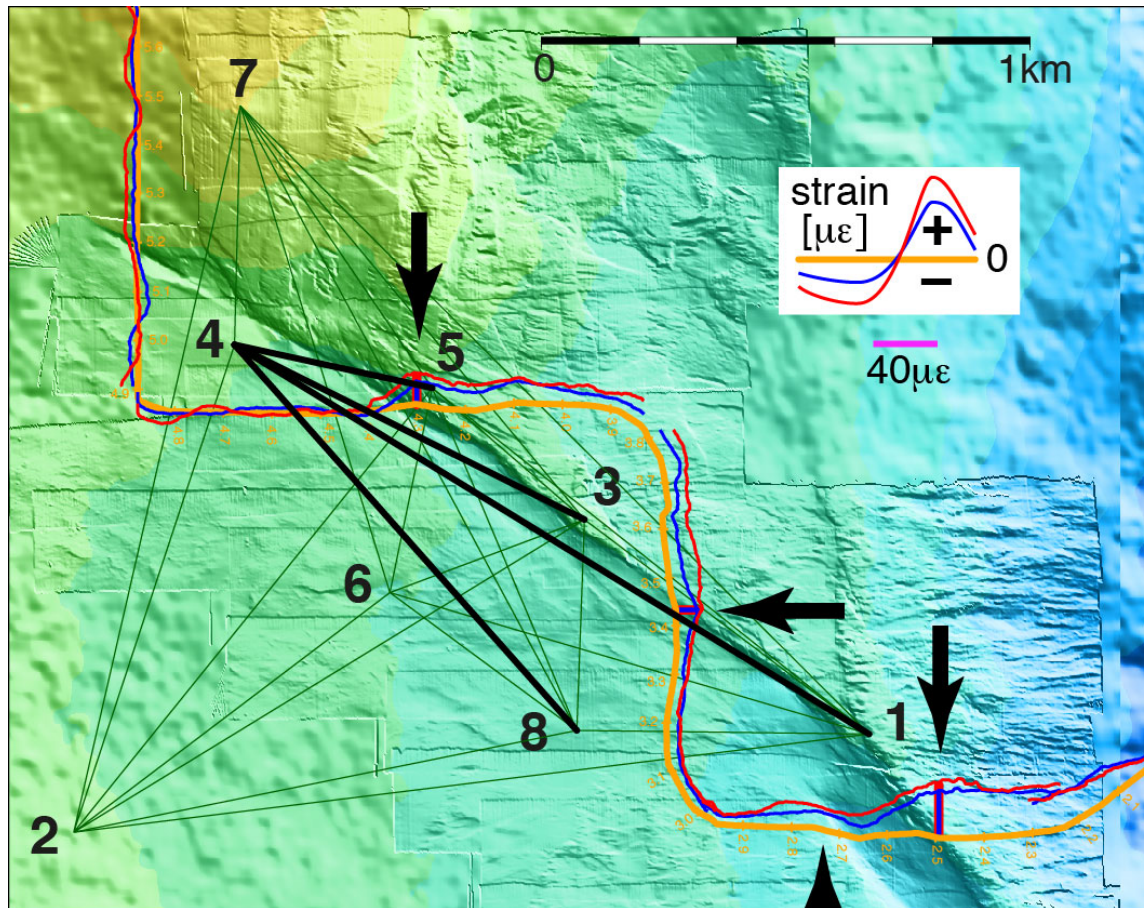
$\pm 0.01 \text{ m/s} \Leftrightarrow \pm 1 \text{ cm}$

- Beacon #2



North Alfeo Fault displacements ?

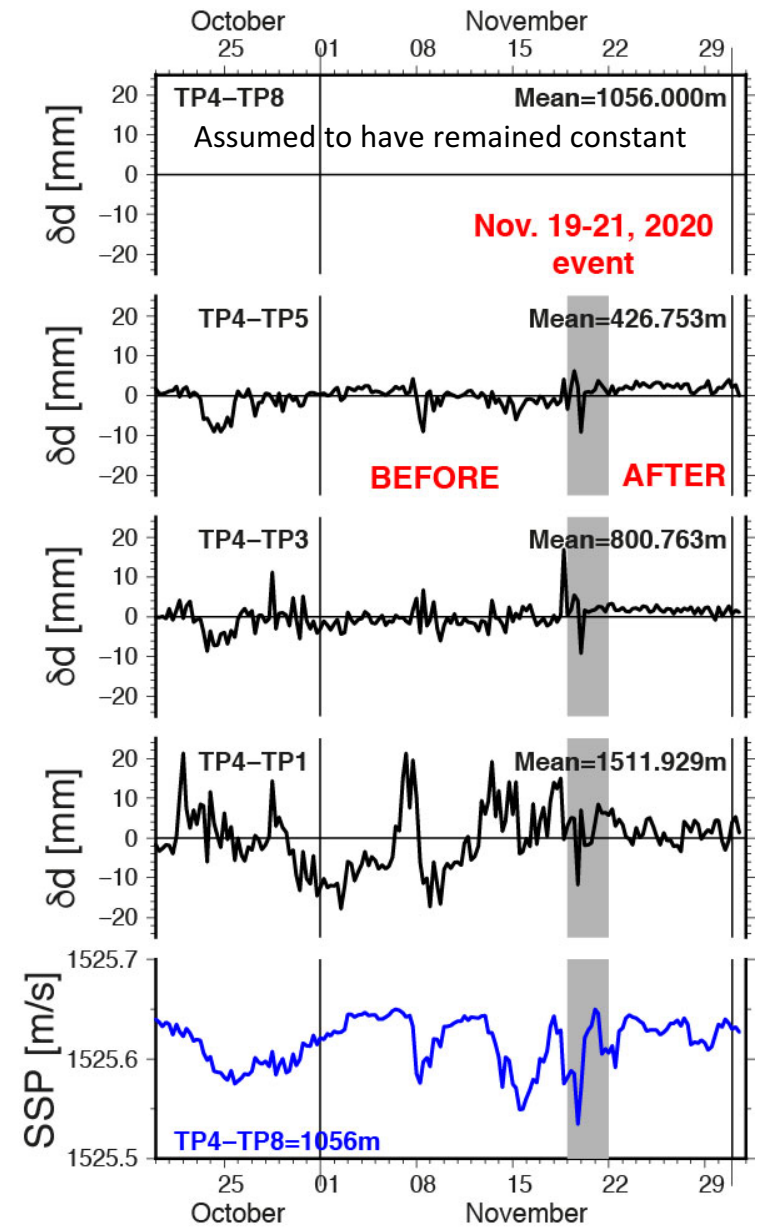
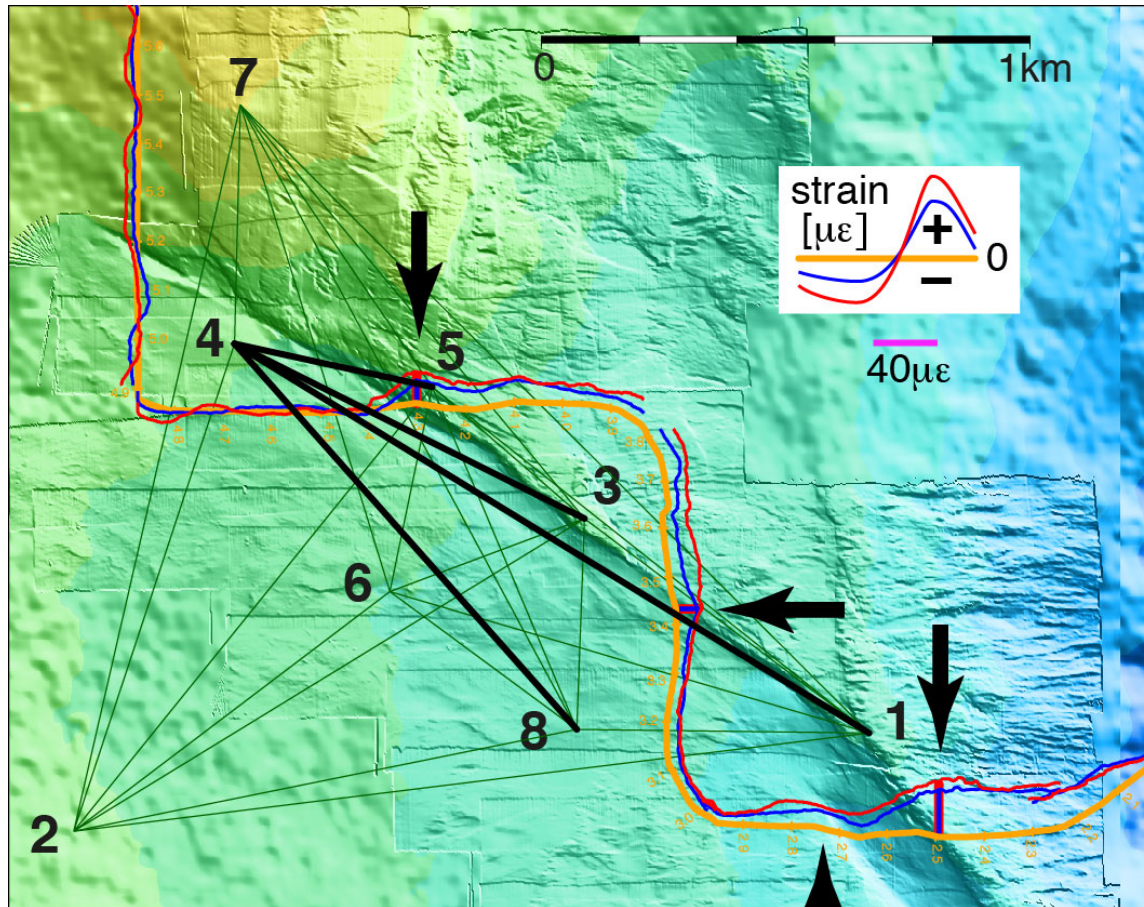
ROV swath-bathymetry survey (2m resolution)



- Optic fiber detected significant elongations of **$\sim 20-40 \mu\epsilon$** at 1, possibly 3 locations, occurring between 19 and 21 Nov. 2020 [[See Gutscher et al. EGU22-7182](#)]
- If due to right-lateral slip of NAF, lengthening should be detected along geodetic baselines crossing the fault :
 - 4 – 5
 - 4 – 3
 - 4 – 1
 - 4 – 8 will be shown as reference

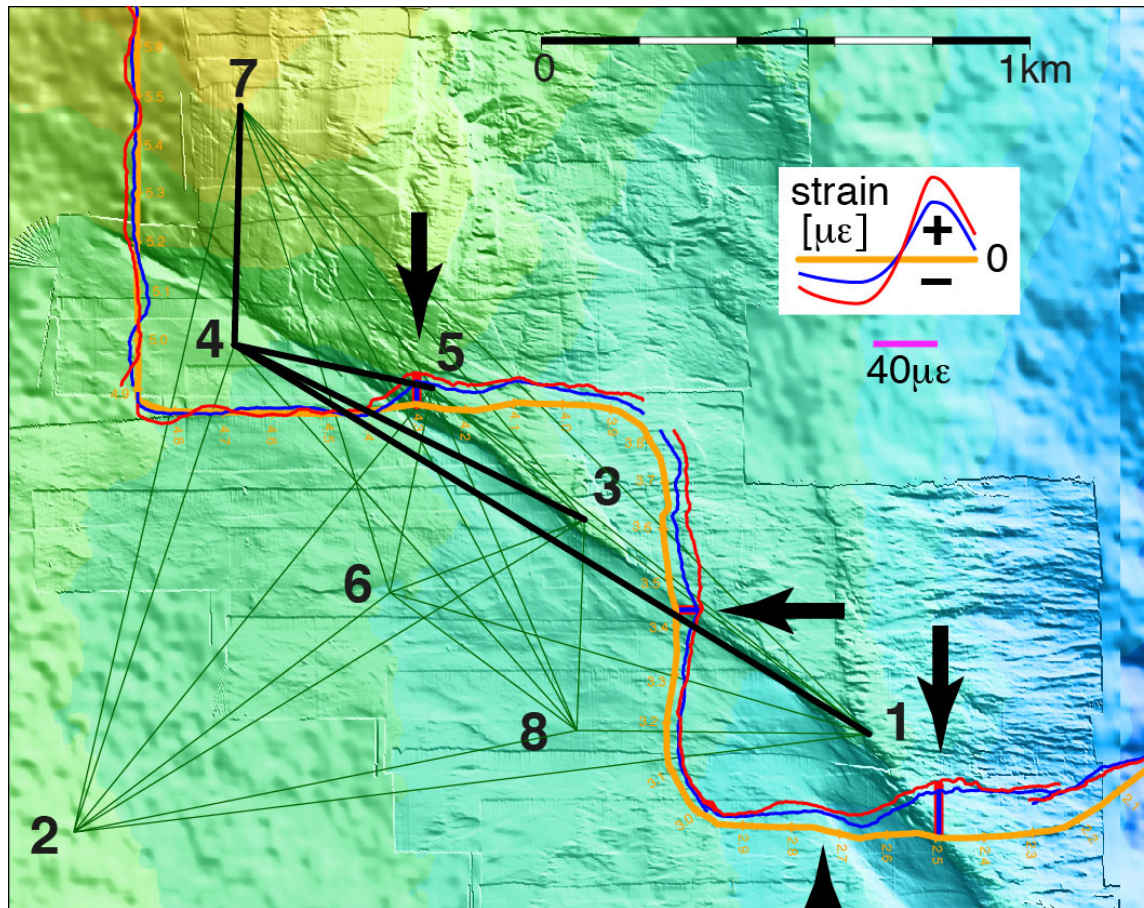
North Alfeo Fault displacements ?

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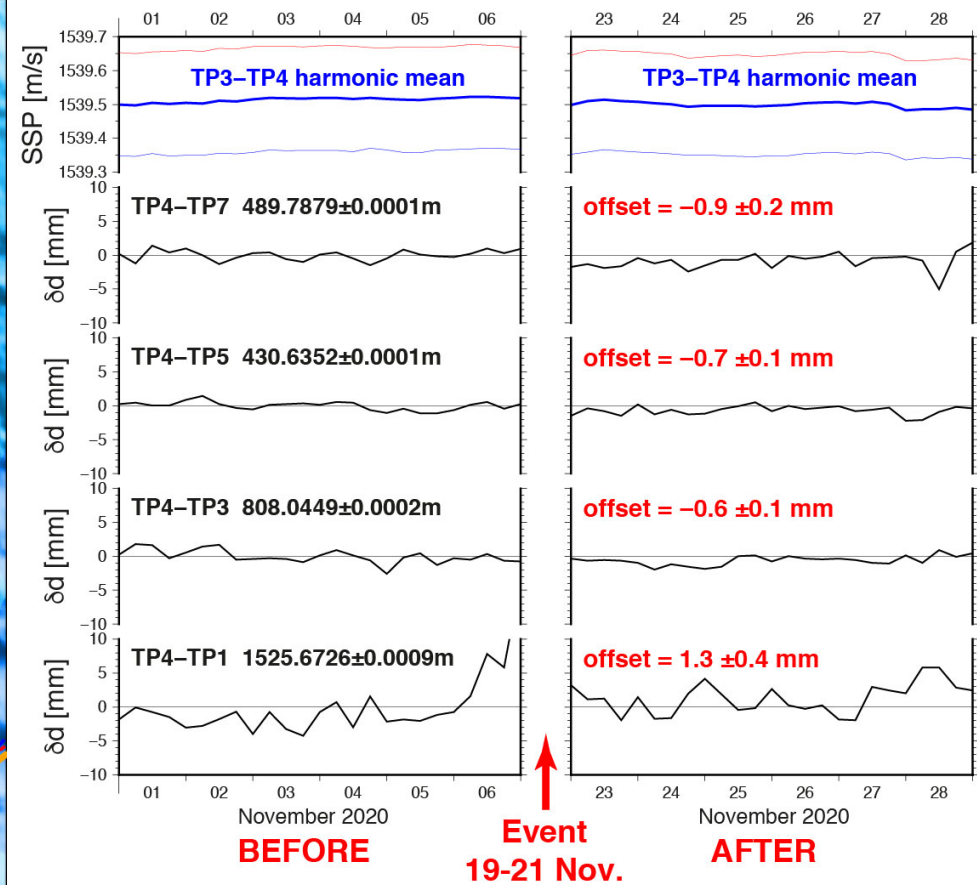


North Alfeo Fault displacements ?

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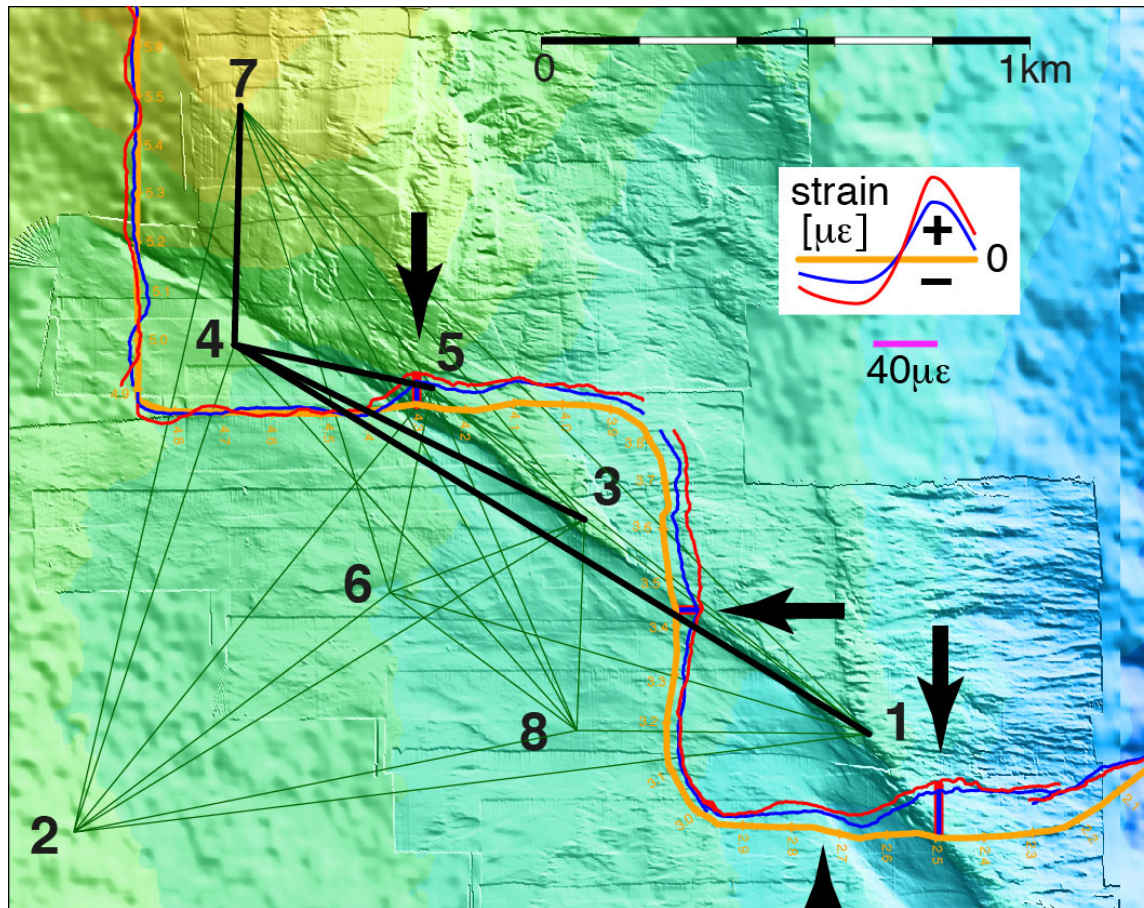


Baseline changes smaller than ranging resolution



North Alfeo Fault displacements ?

ROV swath-bathymetry survey (2m resolution)



- So far, **no significant changes** in geodetic baselines crossing the fault
- Has the cable been strained by :
 - Fault vertical motion (graben collapse) ?
 - Or a deep-water avalanche guided by the fault scarp ?
- **Very inhomogeneous sound speed** in the network and in time
- Not all data have been recovered yet, particularly at #1 (T, P, SSP)
- Seafloor geodesy can be tricky ;-)