Observing the Earth and Ocean with SMART Subsea Cables

Mitigating Environmental Hazards
The Mediterranean

***S**cience **M**onitoring **A**nd **R**eliable **T**elecommunications*

Bruce M. Howe, *Chair, JTF SMART Cables*
Ceci Rodriguez Cruz, *Director SMART IPO*
University of Hawai'i at Mānoa
And many others!

ITU WMO UNESCO IOC

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

DEEP OCEAN OBSERVING STRATEGY

pogo Partnership for Observation of the Global Ocean

GORDON AND BETTY MOORE FOUNDATION

First Data Buoy Cooperation Panel Mediterranean Training Workshop on Ocean Observations and Data Applications (DBCP-Medi-1)-Part 2
2-4 May 2023, Tunis, Tunisia

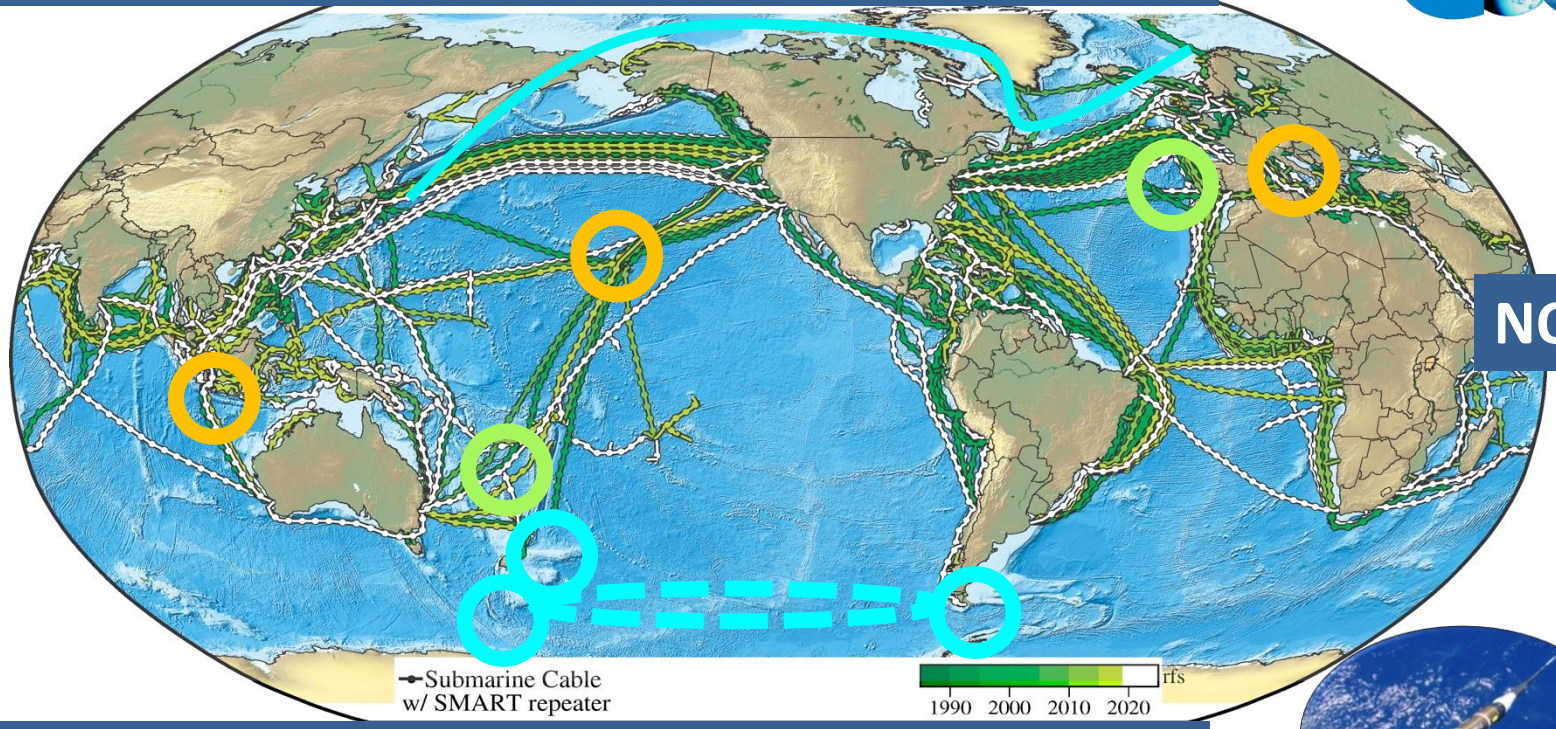
SCHMIDT MARINE TECHNOLOGY PARTNERS

SMART Subsea Cables

Global Array: Climate, Oceans, Sea Level, Earthquakes, Tsunamis

Create a Planetary sensor, power, Internet network

1st order addition to Ocean-Earth observing system



Share submarine cable infrastructure

Telecom + science

↓€$

NO Interference

1.2+ GM

~20,000 repeaters

20 year refresh

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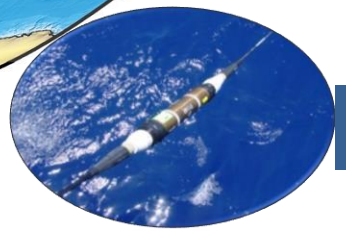
Know the environment – protect the network

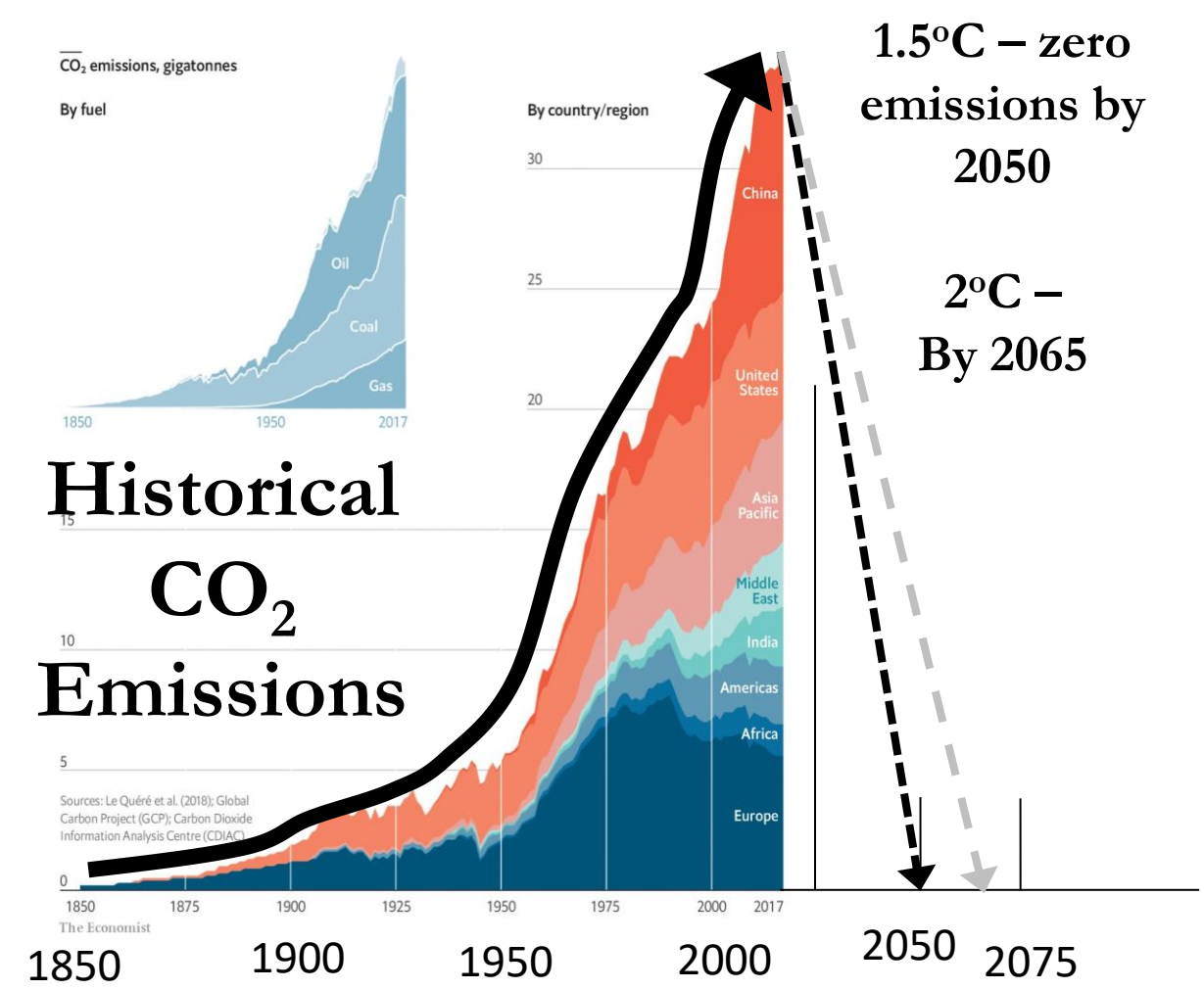


repeaters ~70 km

SMART CAM: 3700 km, install 2025, Gov't €154M
Continent/Portugal-Azores-Madeira ring

Bottom temperature, pressure, seismic acceleration

Global Warming



Historical CO_2 Emissions

1.5°C – zero emissions by 2050

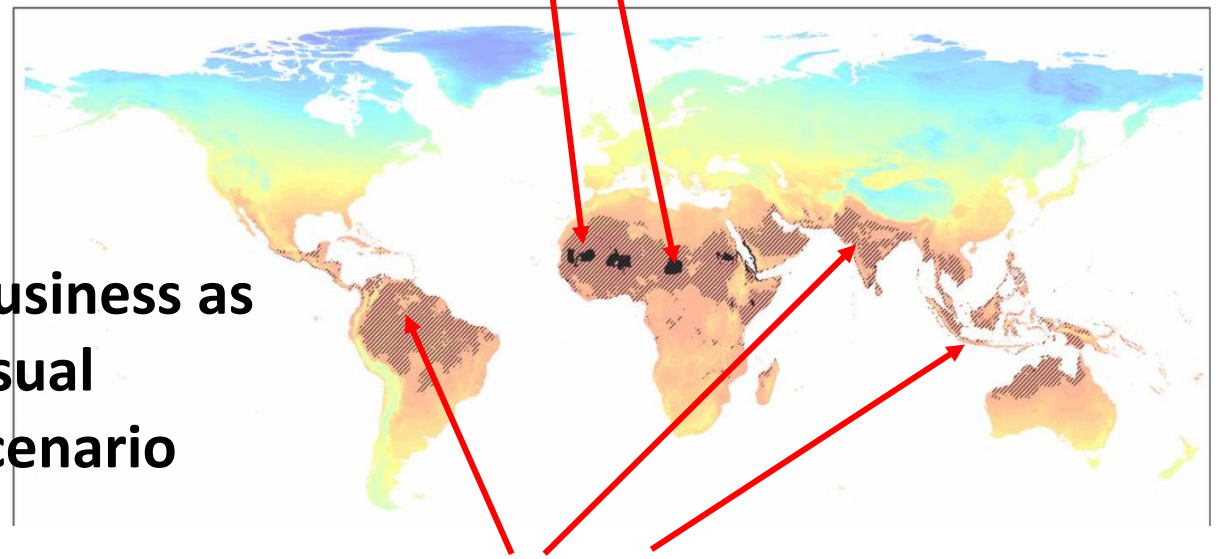
2°C – By 2065

We must remove CO_2 from the air for the rest of the century.

Courtesy C. Fletcher

Why SMART? Ocean = Flywheel of Climate: Stores 90% Heat, CO2, Determines future Temperature

TODAY – 0.8% of land surface, too hot for human existence



Business as usual scenario

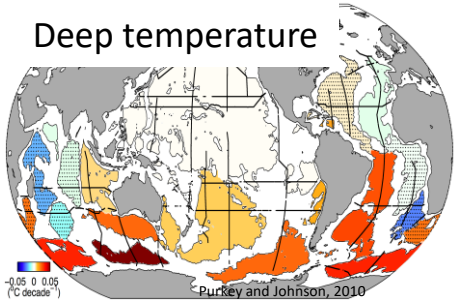
2070 - 19% of land surface, too hot for human existence

Mean Annual Temperature > 29 ℃

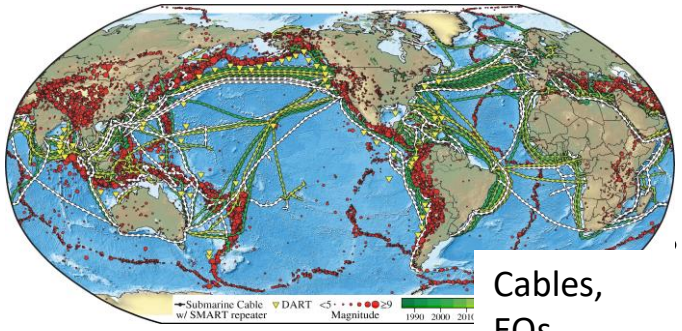
Science and Early Warning - Observables

Climate and Oceans

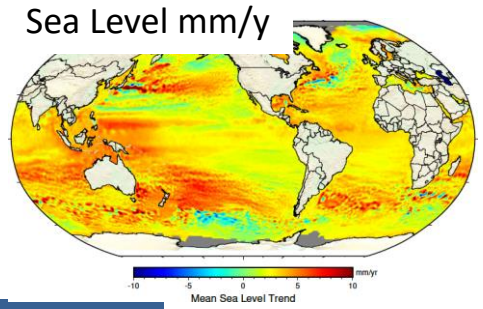
Temperature



- SMART ➜ **Subsurface temperature, EOV**
- Deep ocean warming ➜ sea level rise.
- Δ **deep ocean temperature** ➜ Δ circulation, Δ climate.

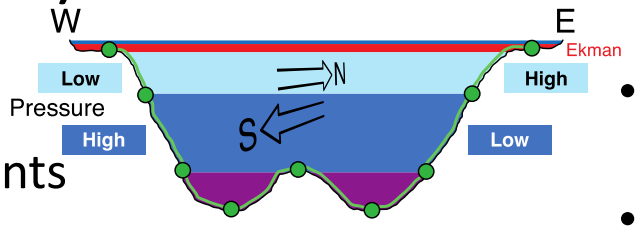


Cables, EQs, DARTs



Circulation, sea level rise, mass distribution

- **SMART Ocean bottom pressure (OBP, eEOV)** ➜ expansion, melting ice ➜ sea level change (x,t).
- Δ_x between OBP ➜ depth-averaged currents and ocean circulation.



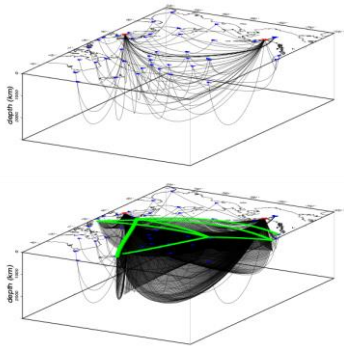
Hazards

Tsunami, Earthquake Warning

- SMART cables - vastly increase existing ocean **pressure/seismic sensors**
- Improve tsunami warning precision, Reduce unnecessary warnings/evacuations.

Seismology

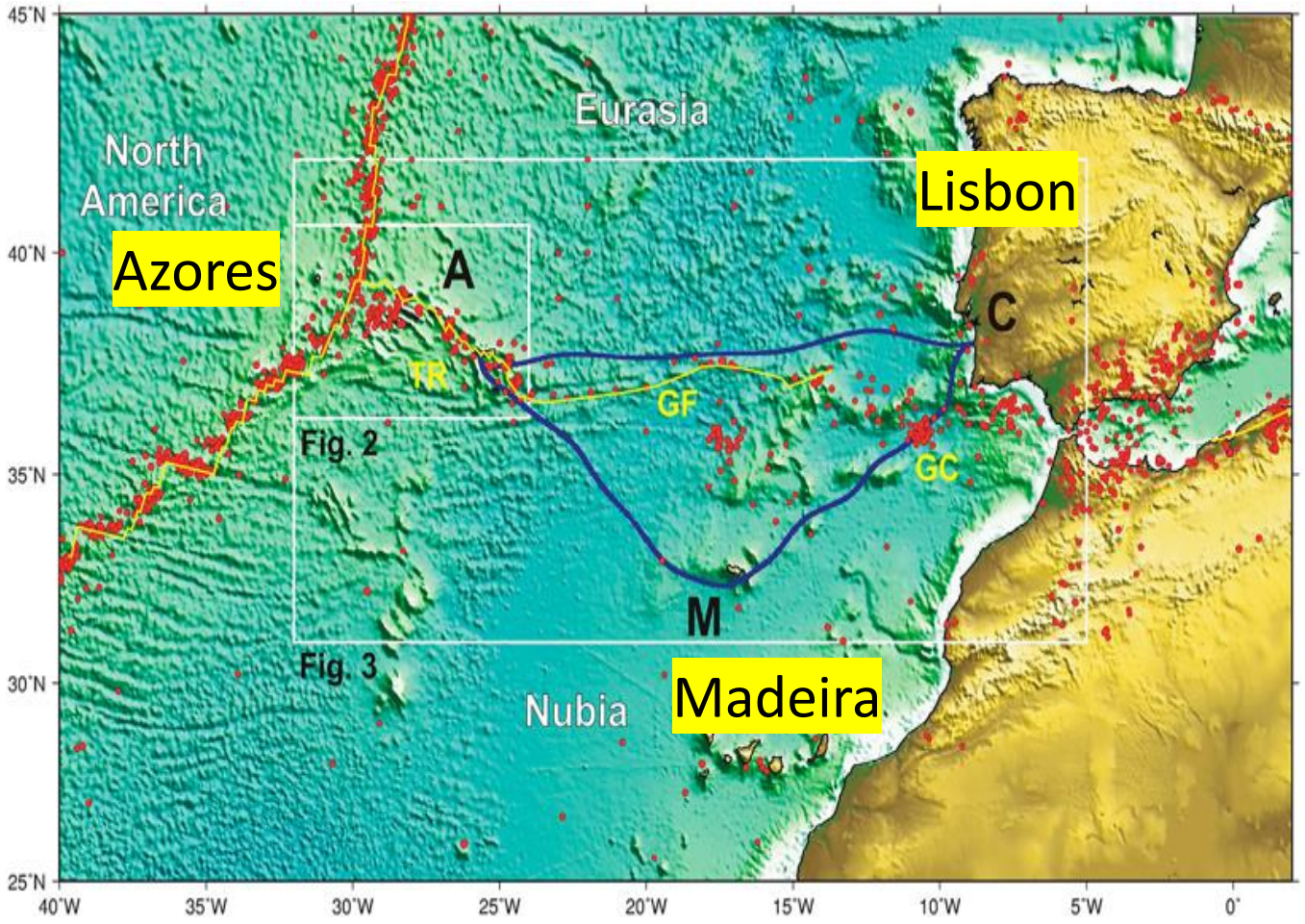
- SMART **Seismic accelerometers** ➜ advance seismology:
- Detect, locate small quakes below ocean floor
- Rupture type and dynamics larger offshore earthquakes
- Image Earth's interior



sampling w/o, w SMART

SMART Atlantic CAM Cable System

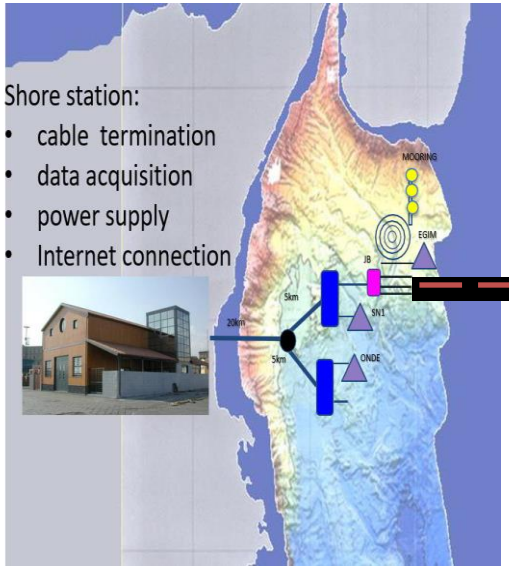
Approved – underway!

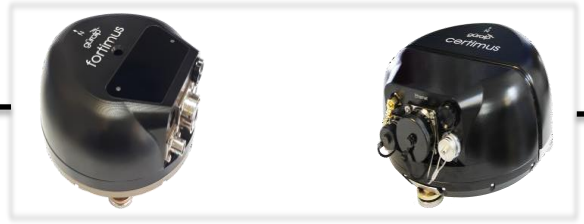


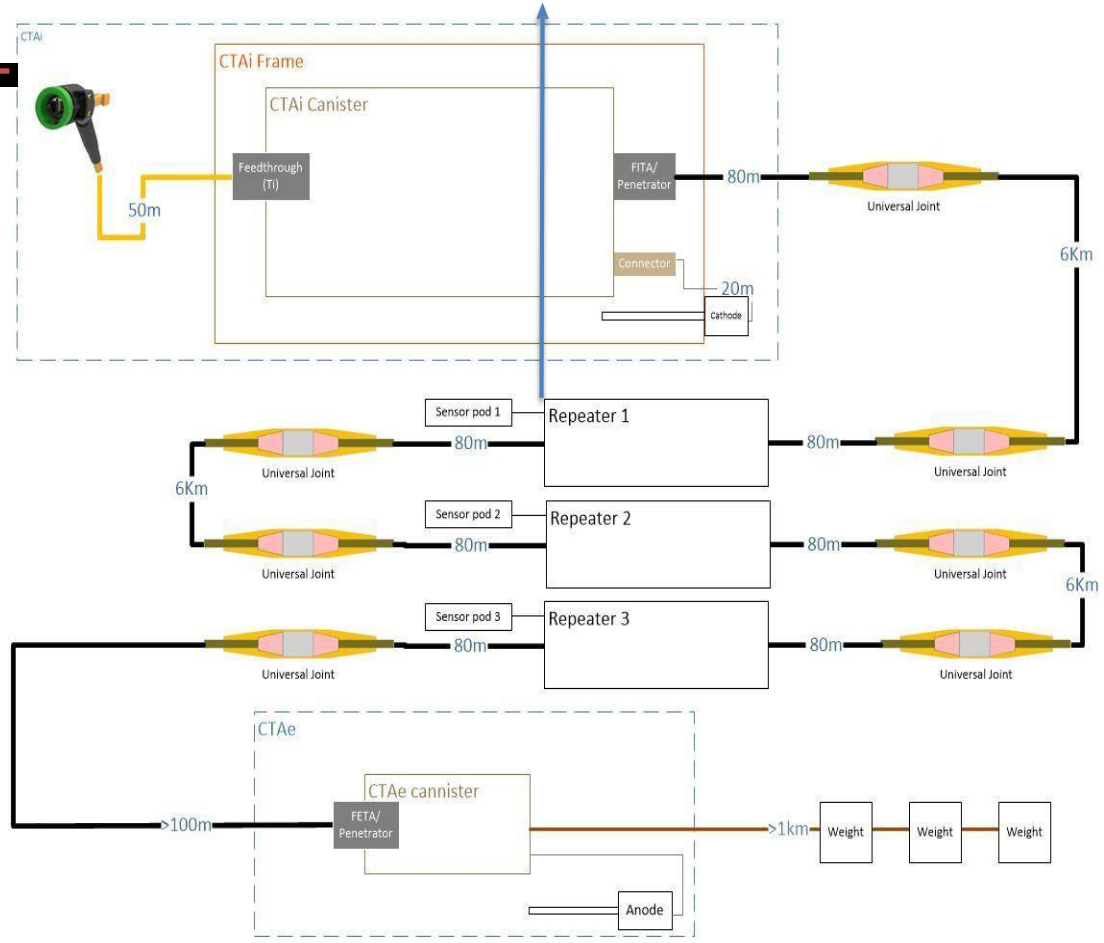
- Domestic, international connections, Digital hub
- 1755 earthquake tsunami
- Seismic, tsunami, ocean, environment
- 3700 km, 50 SMART repeaters, €154M approved
- RFP 2023Q1, Ready For Service 2025
- ANACOM connection to telecom

- Risk analysis (V. Silva, pers. comm.)
- Improved EEW (~10 s) with less loss of life will more than pay for the system
- Next: include infrastructure and tsunami inundation

InSea SMART Wet Demo Project - Western Ionian Sea

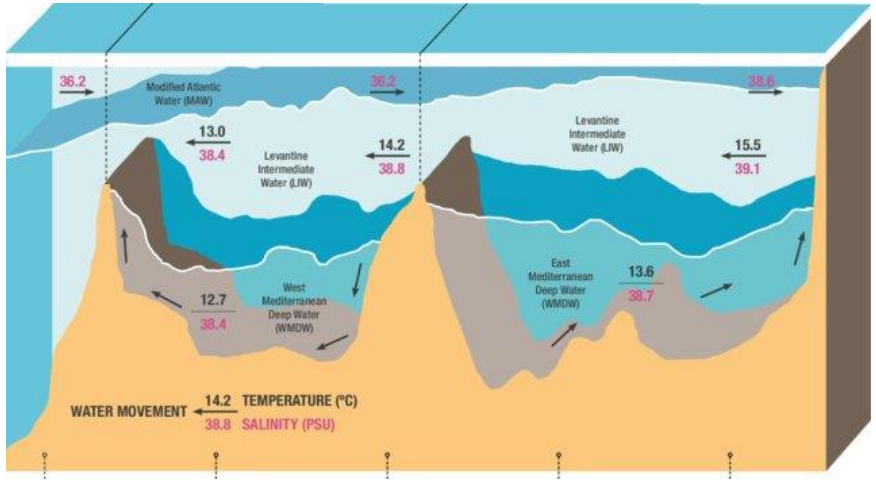


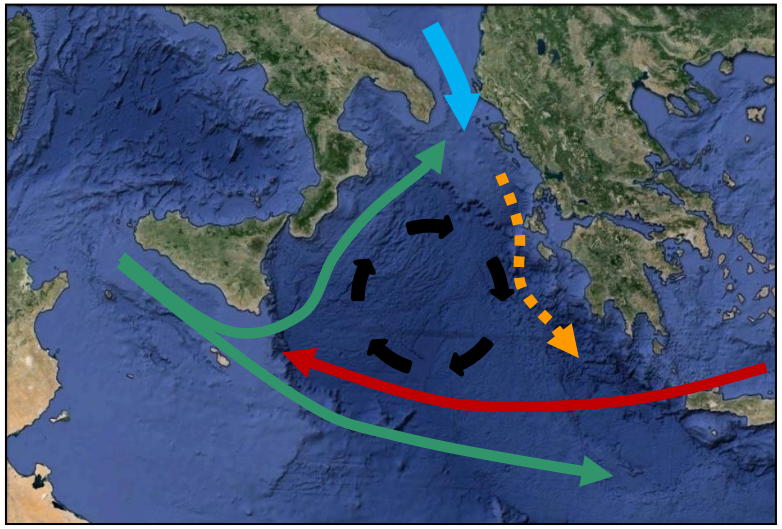


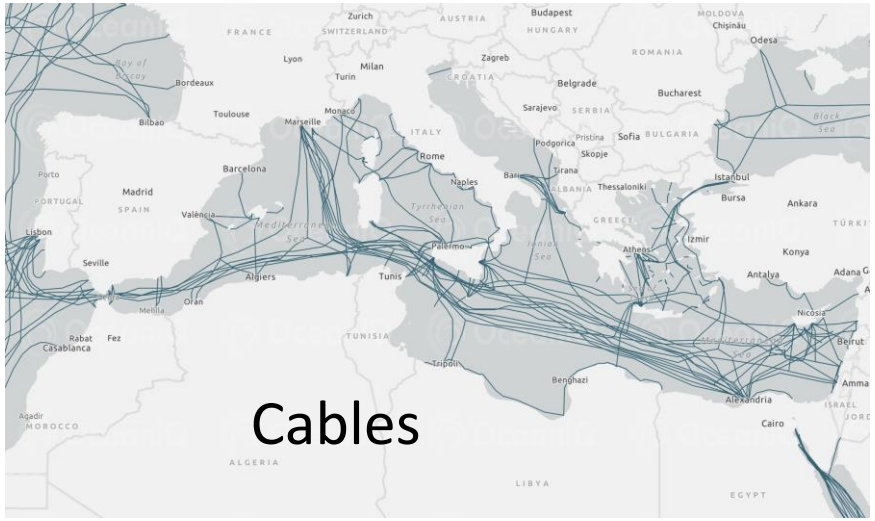


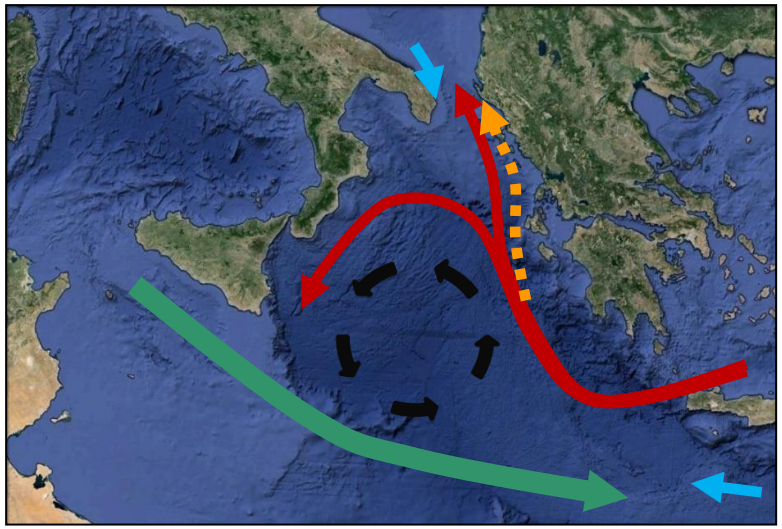
- Incremental advances
- Contract June 2020, Installation summer 2023
- Force-balance seismometer and accelerometer
- Temperature and Pressure sensor
- Objectives
  - Demonstrate installation technique
  - Assess usefulness of seismic data
  - Encourage system suppliers

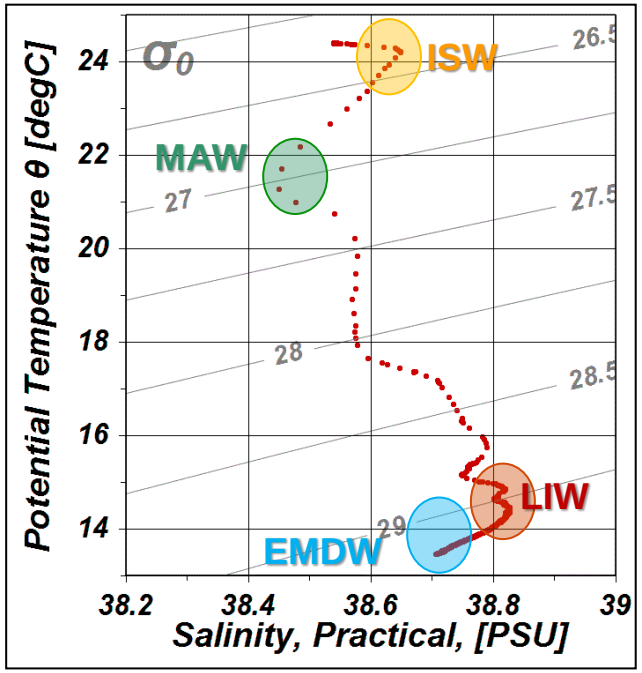
Ocean circulation in the Central Mediterranean











Modified Atlantic Water (MAW)

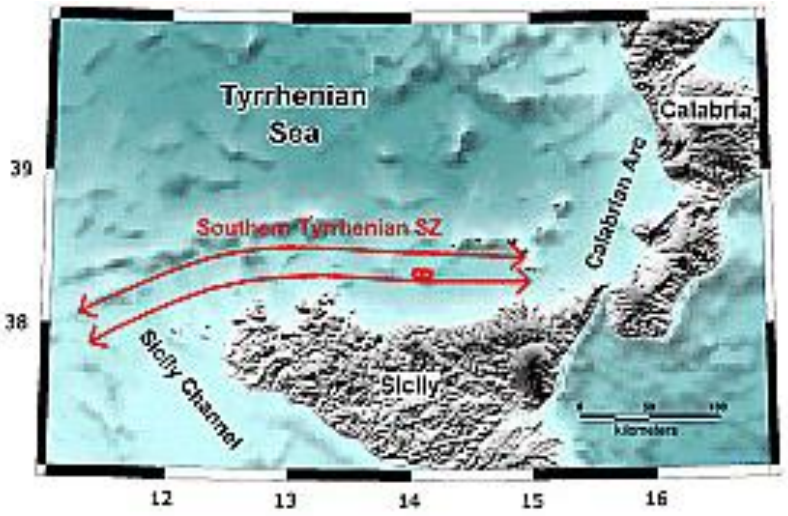
Levantine Intermediate Water (LIW)

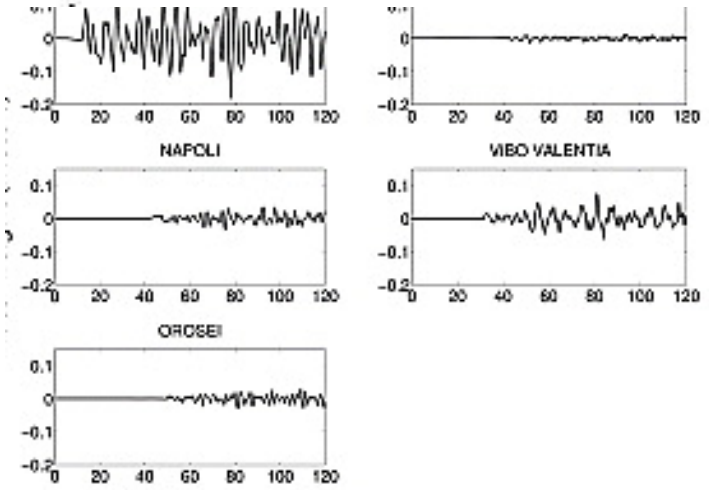
Eastern Mediterranean Deep Water (EMDW)

Ionian Surface Water (ISW)

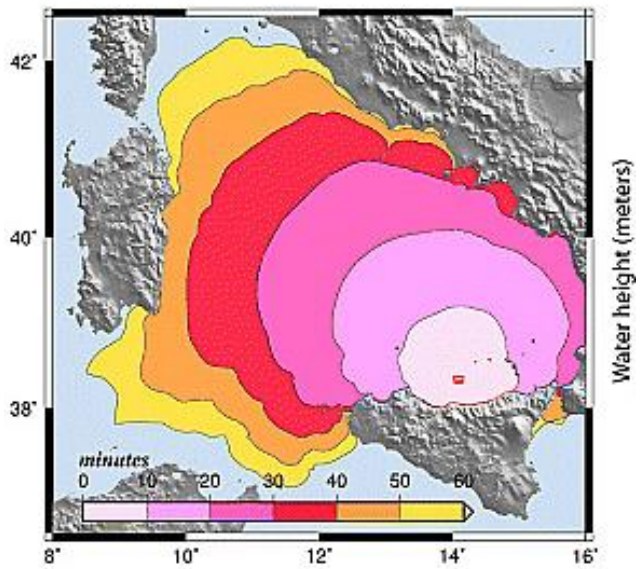
Bios decadal inversion

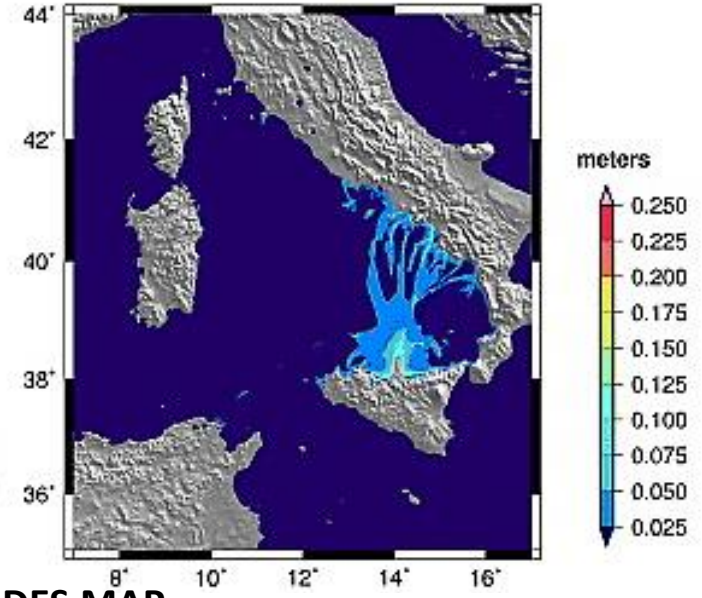
Tsunamis in the Mediterranean: Potential threats to Southern Italy



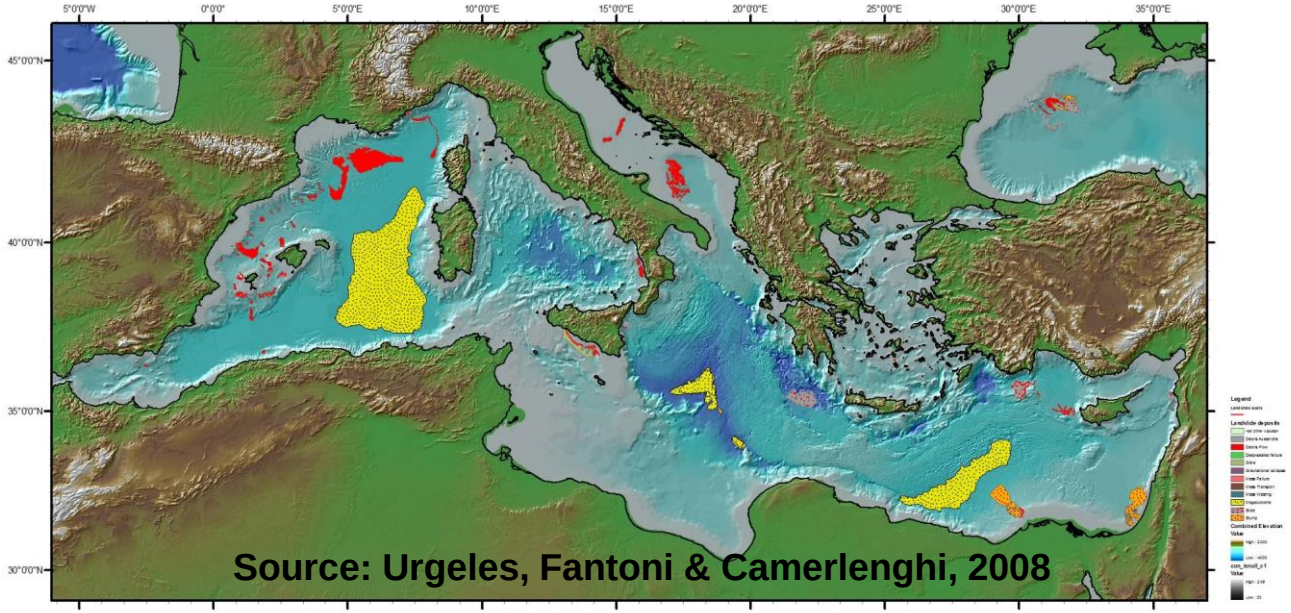


Lorita et al, 2008

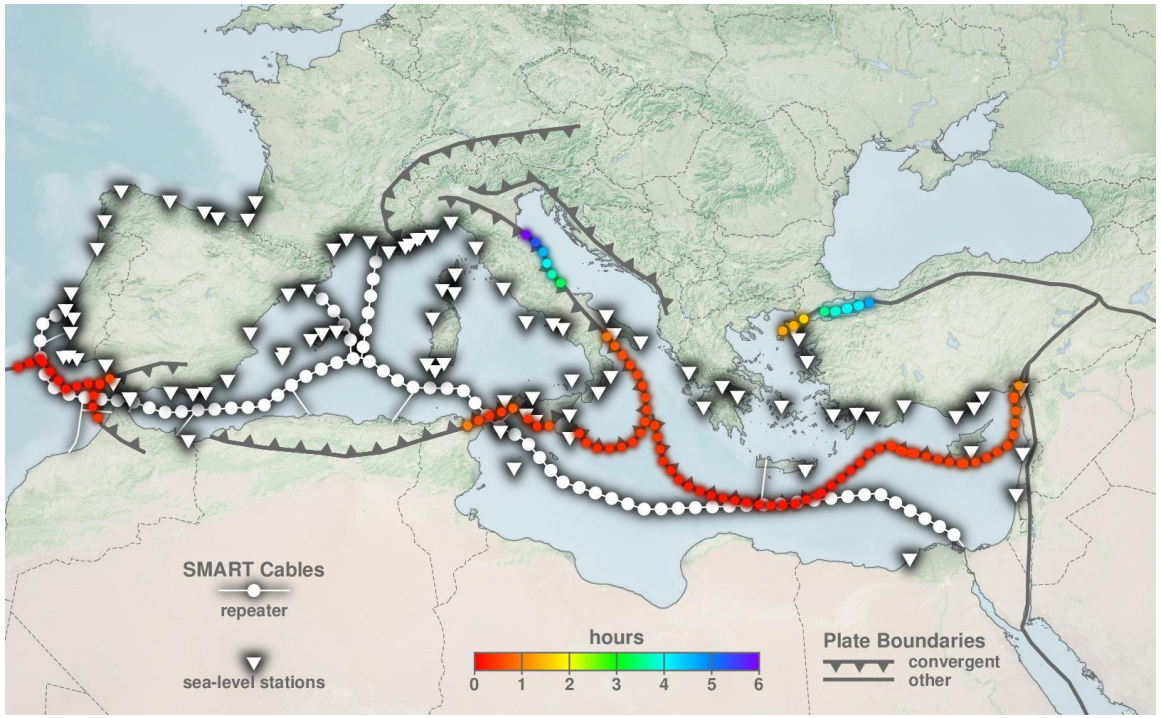




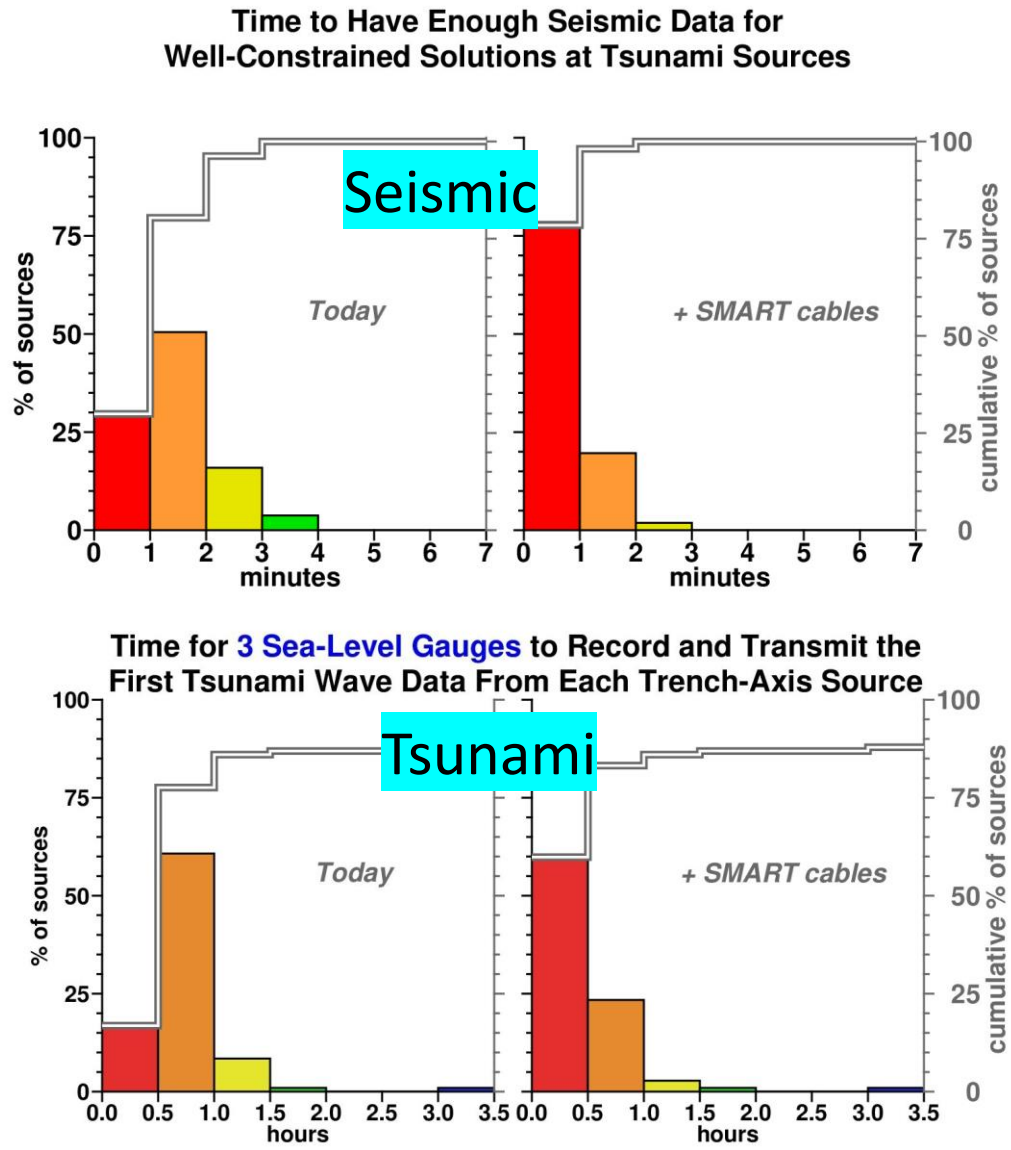
SUBMARINE LANDSLIDES MAP



MEDUSA SMART Cable System



- Install 2024/25
- Possibly up to ~60 SMART repeaters on main cables
- Improve coverage for large regional area
- Raising funds for SMART capability now

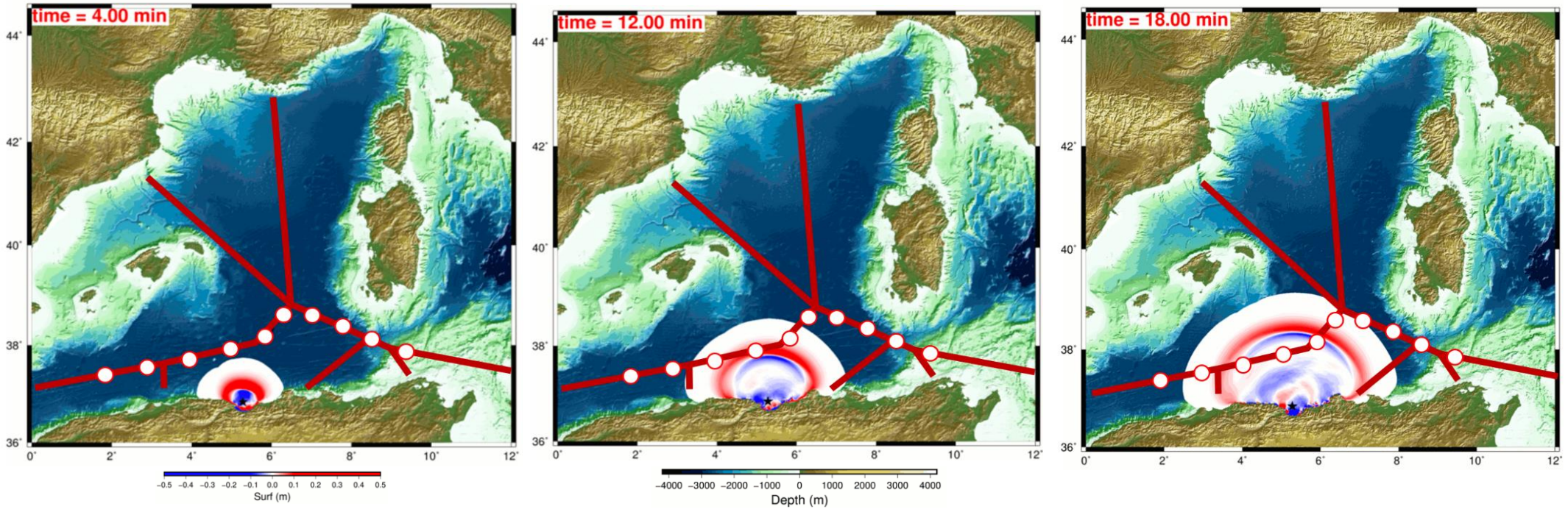


Nate Becker, Stu Weinstein, NOAA PTWC

MEDUSA SMART Cable System

Depending on spatial discretization of receivers

- First tsunami motion available within 5 min
- First sea level full wave within 15-20 min (full = space/time, Nyquist sample)
  - Allows update before arrival in France, Algeria (partly), Tunisia, Morocco, Spain, Italy



WTAD 2021 scenario for French exercises (Gailler, Cenalt, 2021)
M ~ 7, North Algeria

Helene Hebert, CENALT

Concluding Remarks

CLIMATE, OCEAN SEA LEVEL, EARTHQUAKE, VOLCANO, TSUNAMI

- SMART – essential ocean variables and disaster risk reduction, SDGs
- Global scale, seafloor power+internet, sustained, realtime, 25+ year life, highly reliable, 170 y experience, leverage $5B/y industry, low lifetime cost
- EU Connectivity Funding: Cables, w/ SMART, outlying territories, €100M
- SMART systems: CAM, MEDUSA, V-NC, Antarctica, … improve knowledge of climate change, ocean circulation, and early warning for earthquakes and tsunamis; as well as setting valuable precedents
- **In Med – Need! – Climate+DRR+Connectivity – opportunities**
- **SMART – fruitful marriage with telecom – three for the price of one – saves resources on all fronts**

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Thank you!

Questions?

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