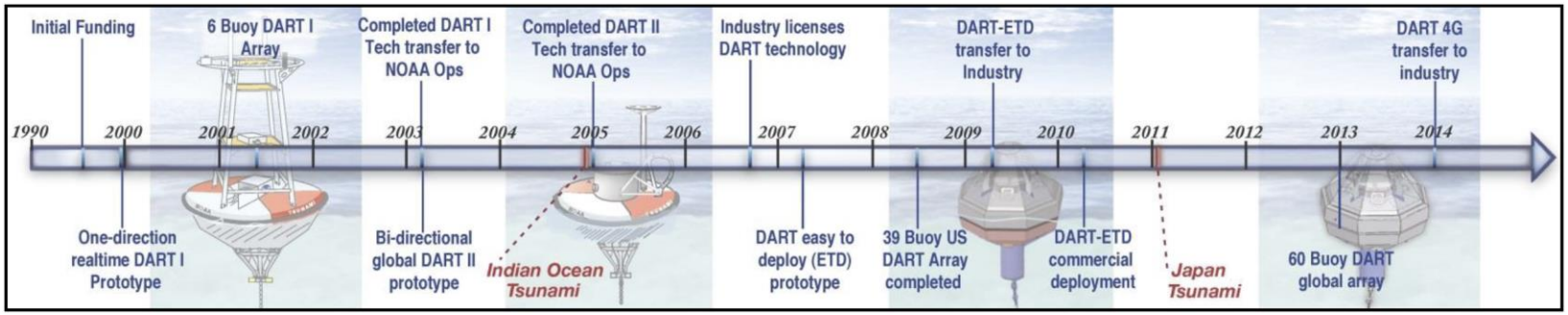
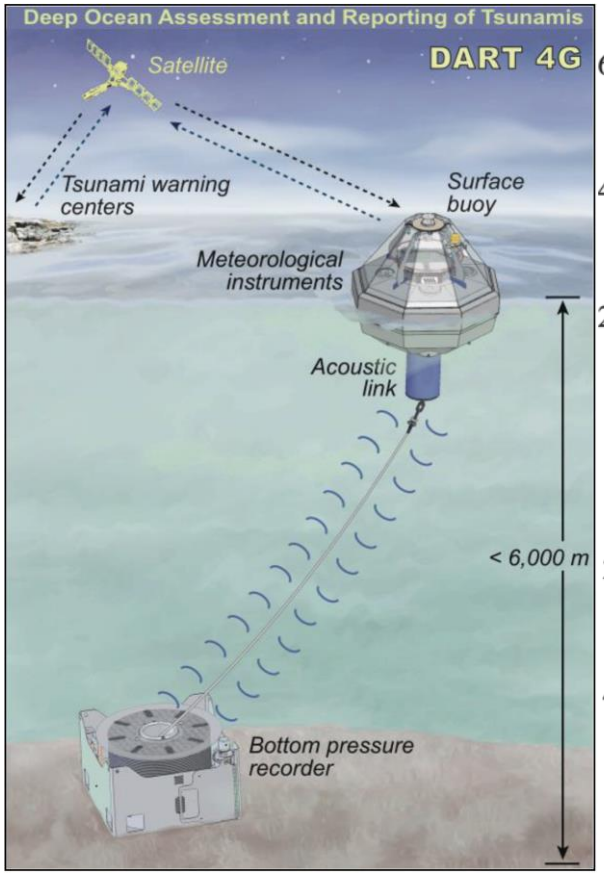
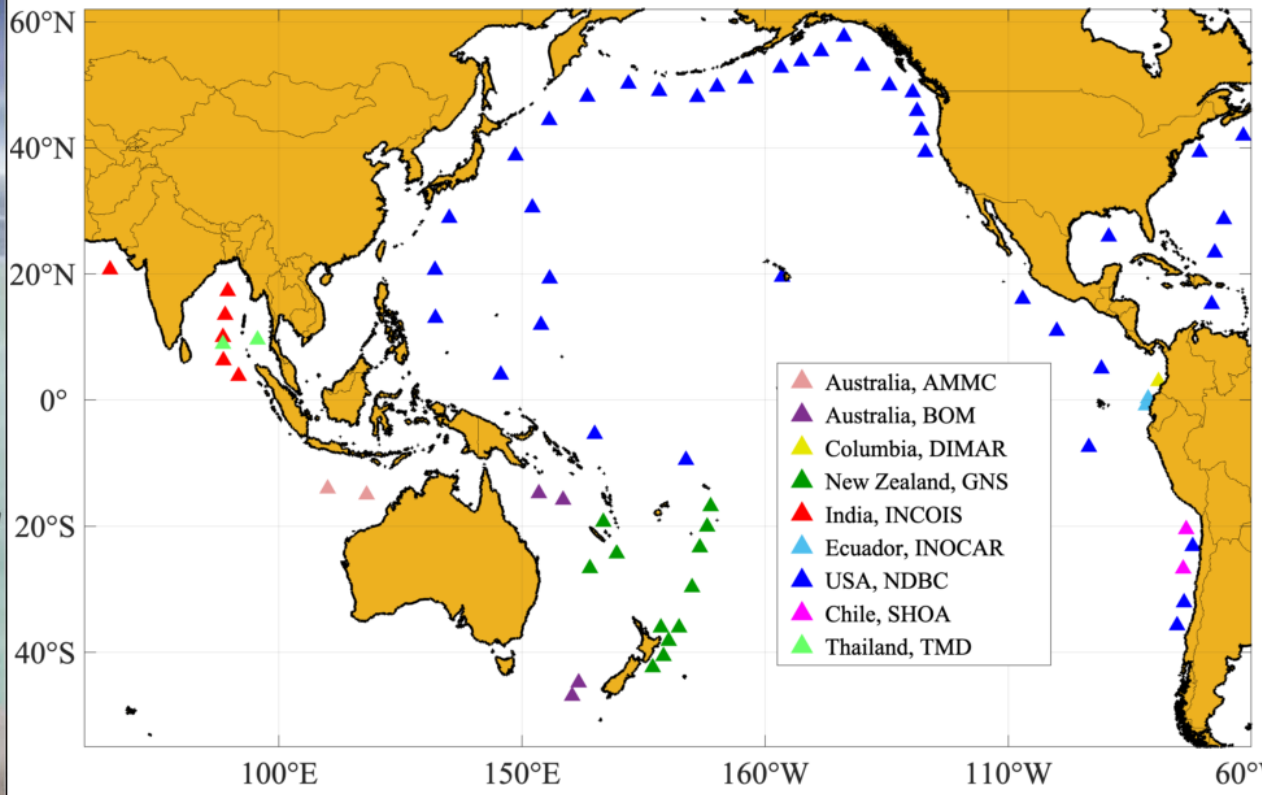
Tsunami buoy sensor design and use in forecasting

- Christopher Moore
Director, NOAA Center for Tsunami Research
Pacific Marine Environmental Lab (PMEL)

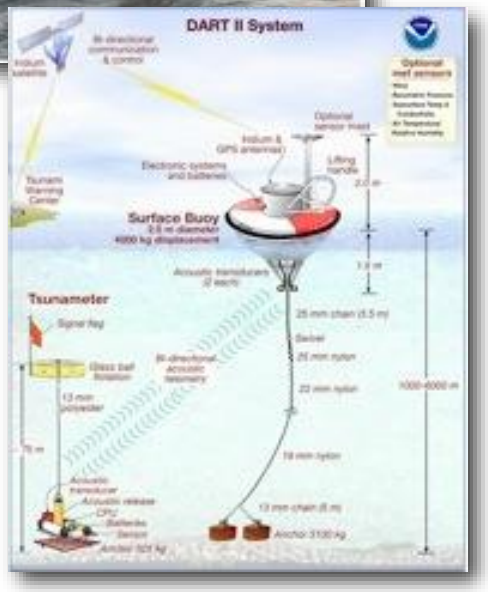
DART development and current array configuration



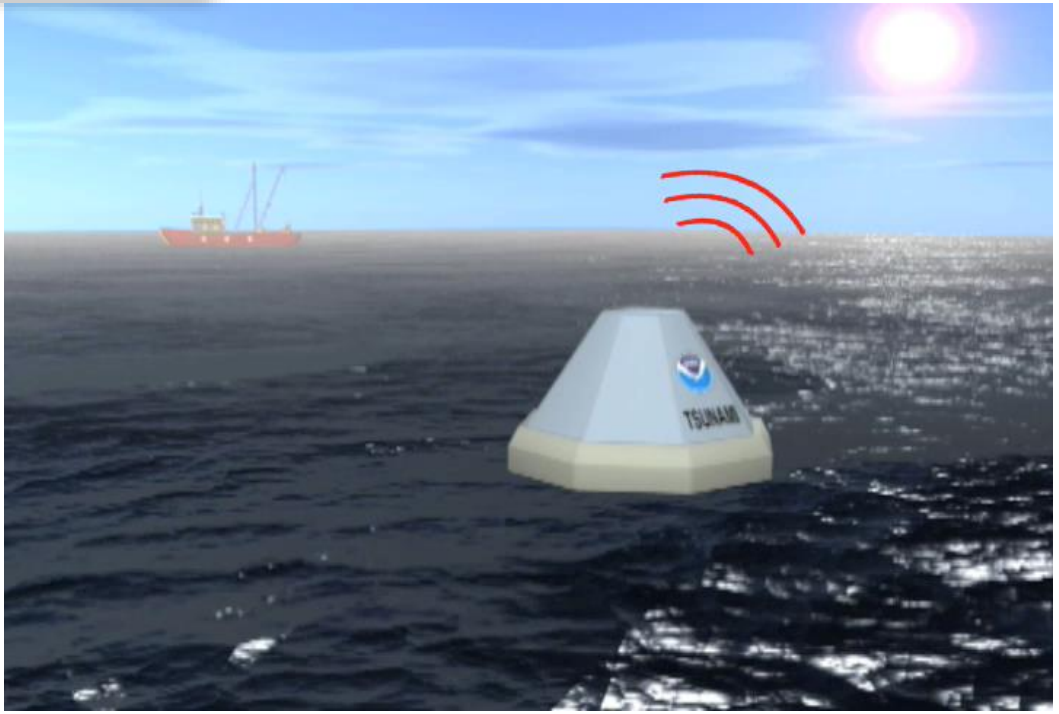




Tsunami Real-time Detection

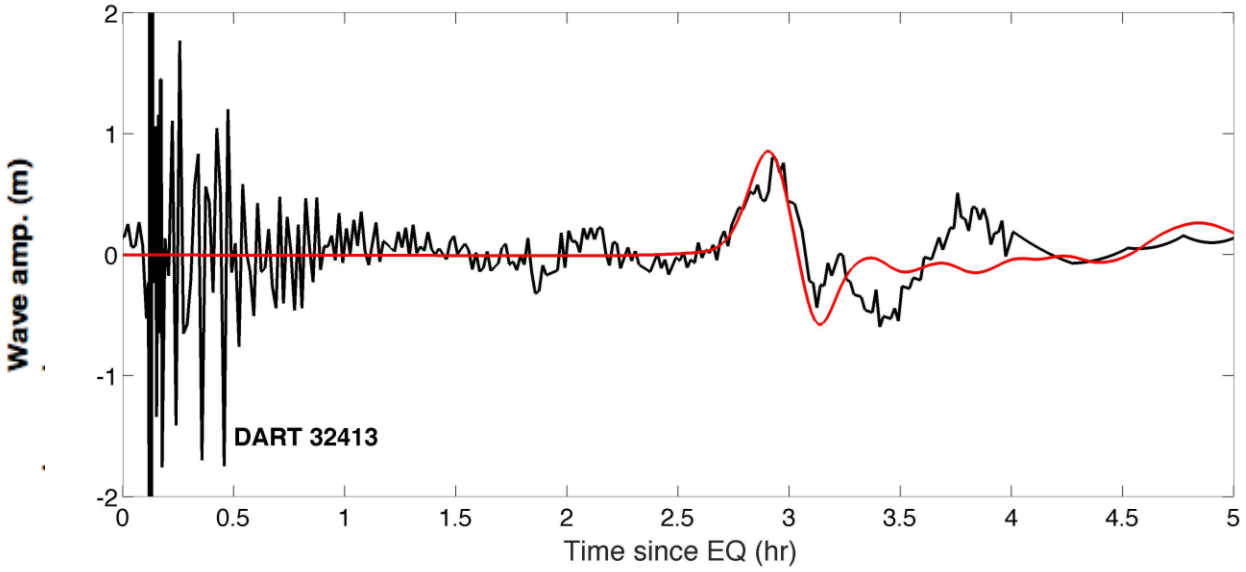


Deep-ocean Assessment and Reporting for Tsunamis (DART)



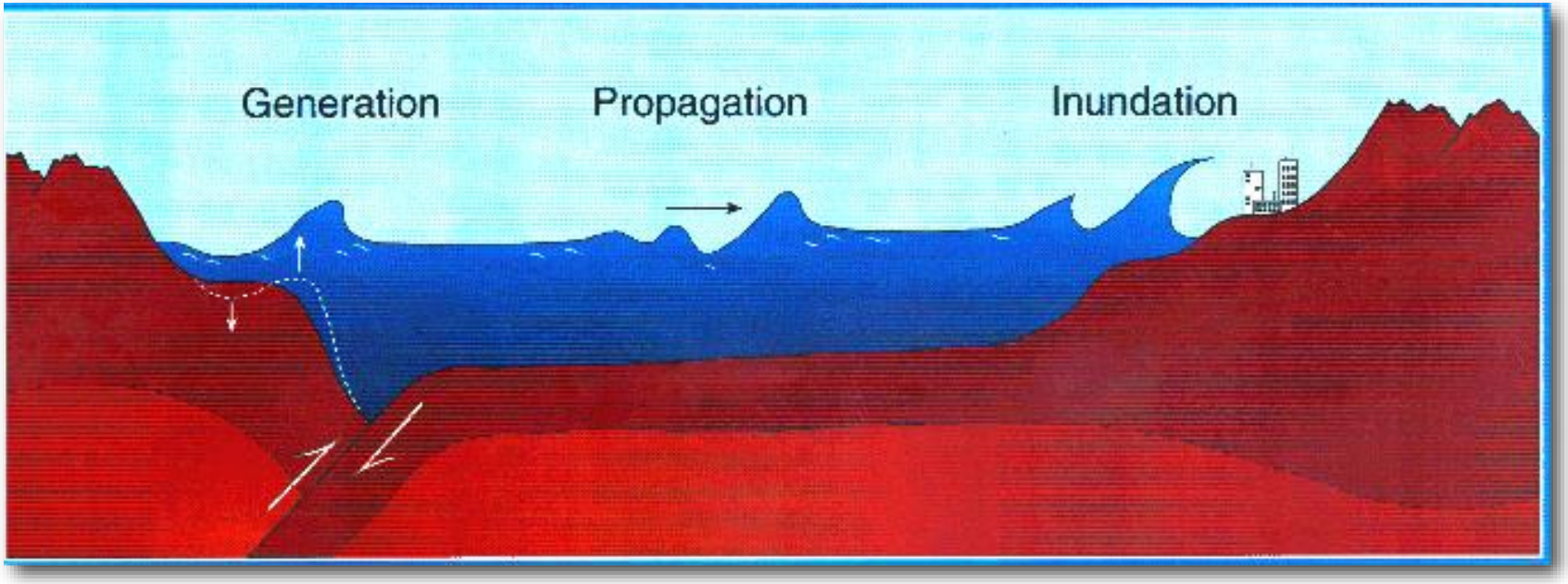
How do we use buoy sensors in the tsunami forecast?

- Deploy Detection Hardware.
- Develop algorithms to interpret in-coming data.
- Develop numerical models to forecast/assess tsunami impact on the coast.

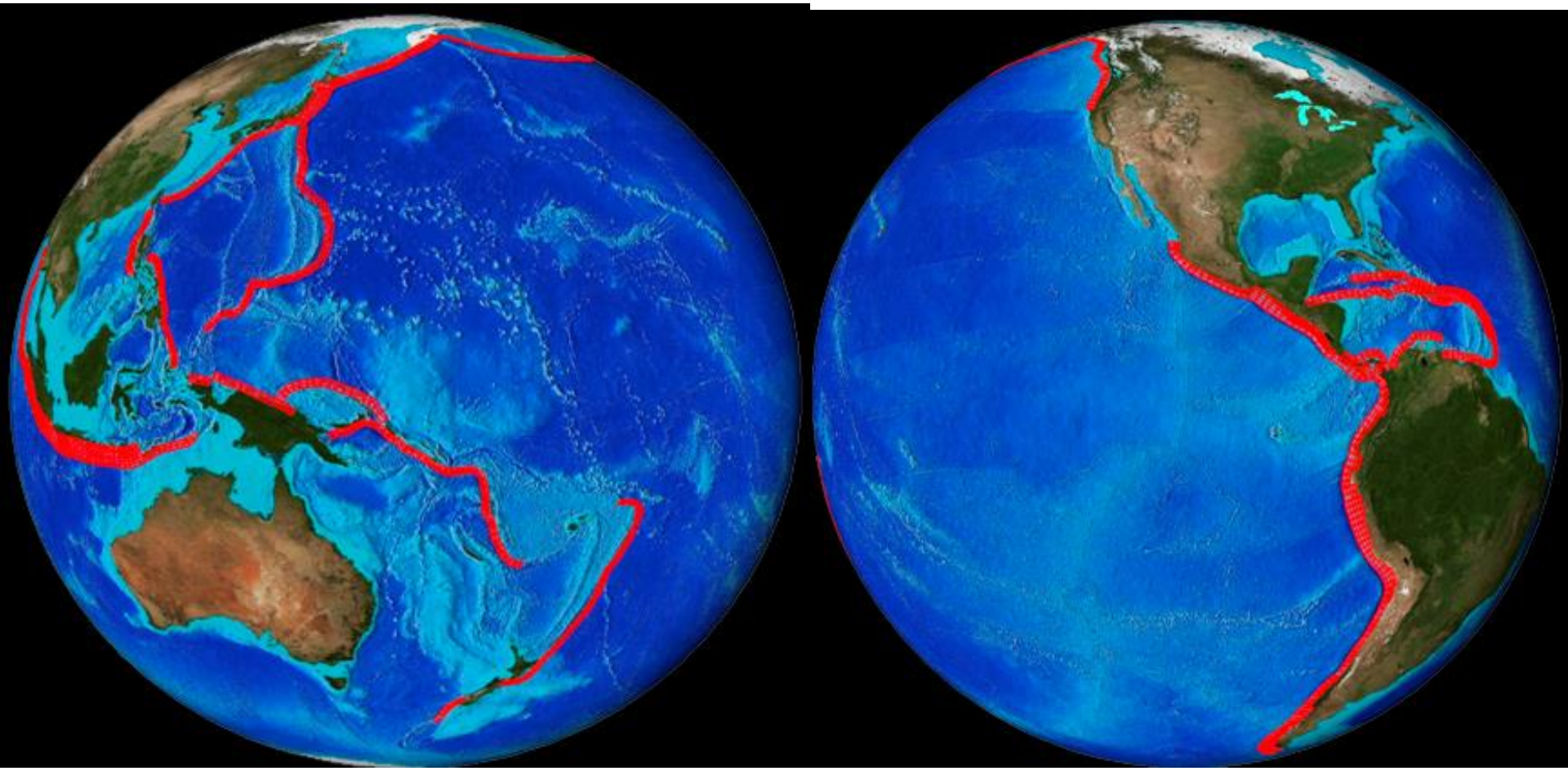


Phases of tsunami for forecasting

- We constrain with the deep-water buoy BPR measurements in forecasting



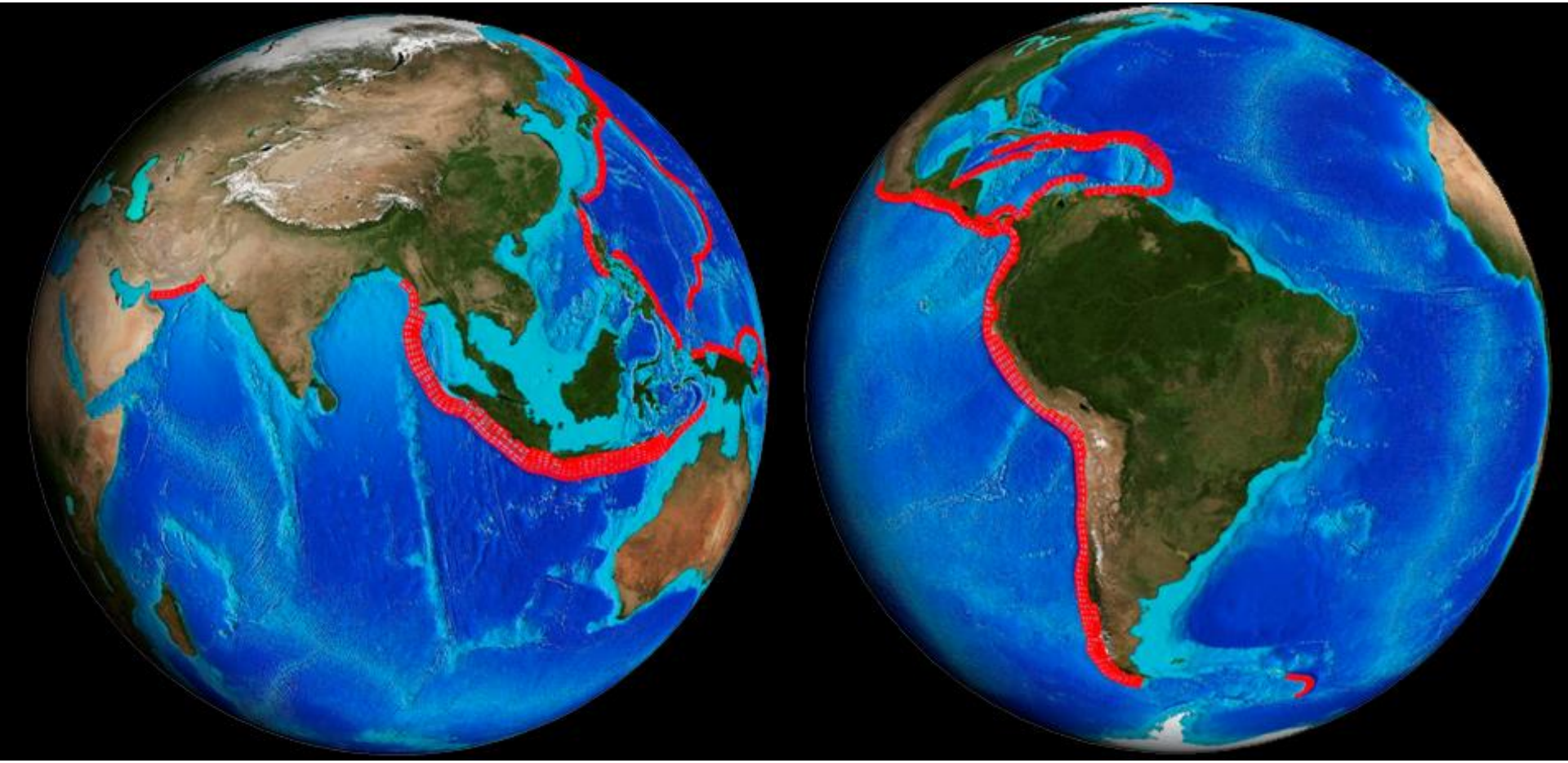
Locations of the unit sources for pre-computed tsunami events.



West Pacific

East Pacific

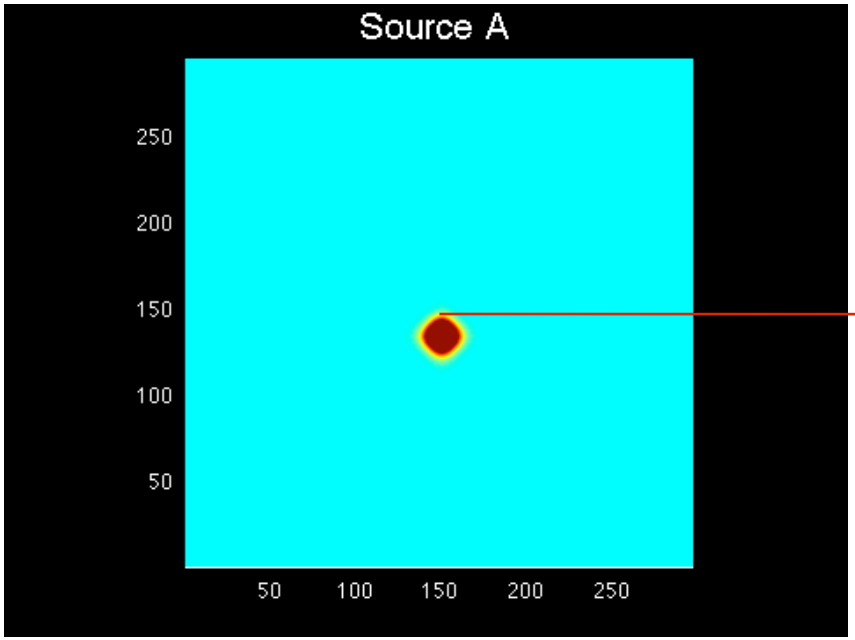
Locations of the unit sources for pre-computed tsunami events.



Indian Ocean

Atlantic Ocean

Illustration of Deep-Water Linearity



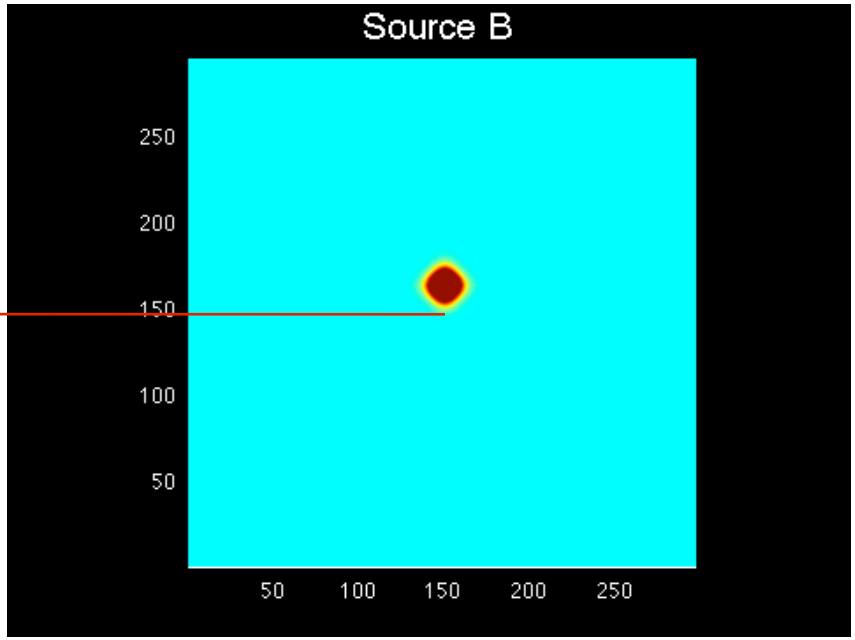


Illustration of Deep-Water Linearity

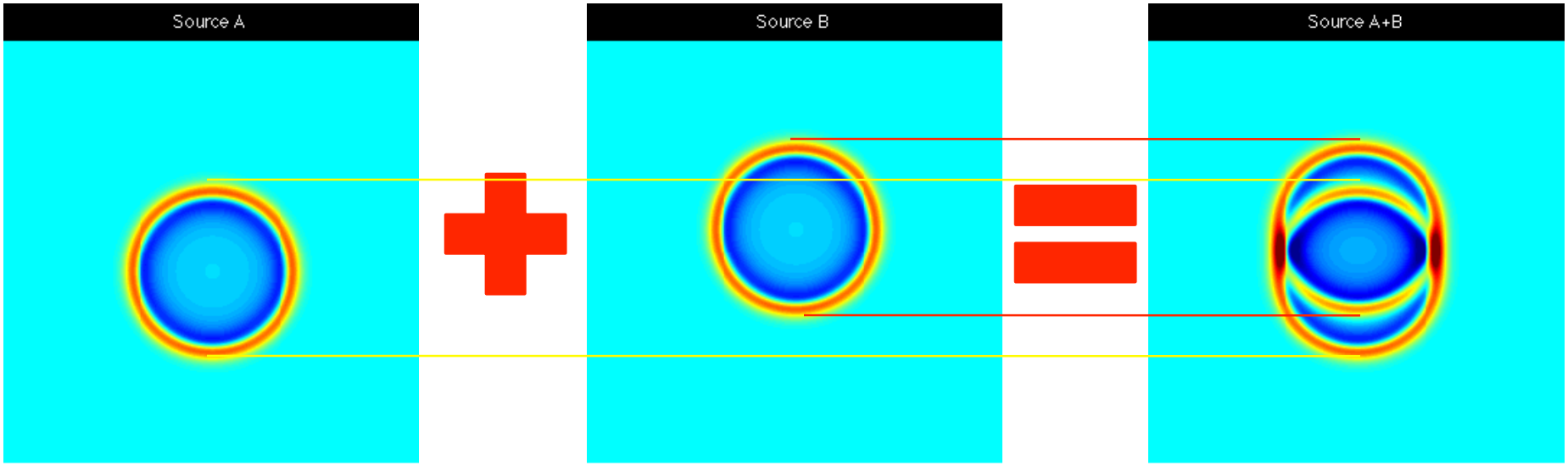
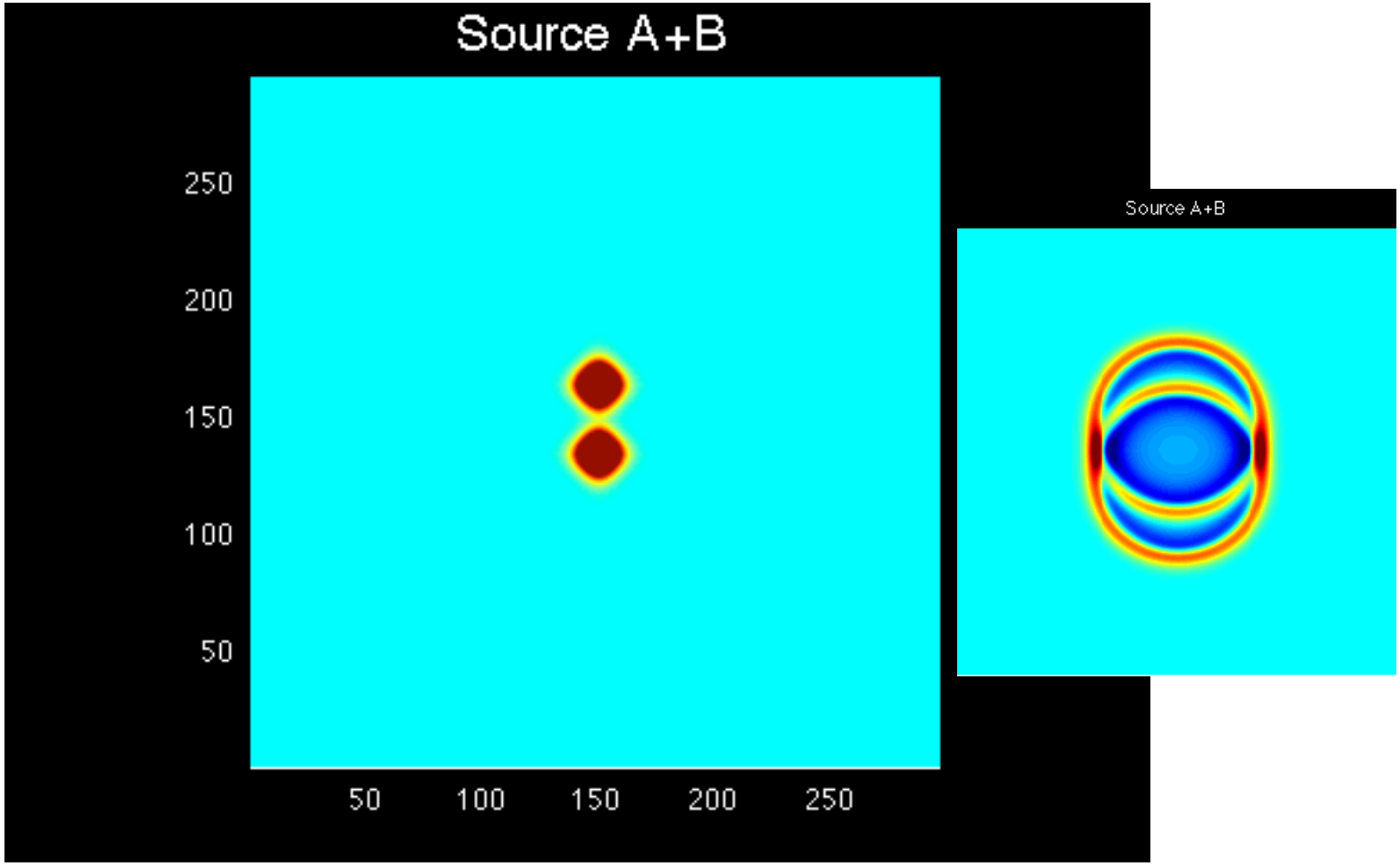
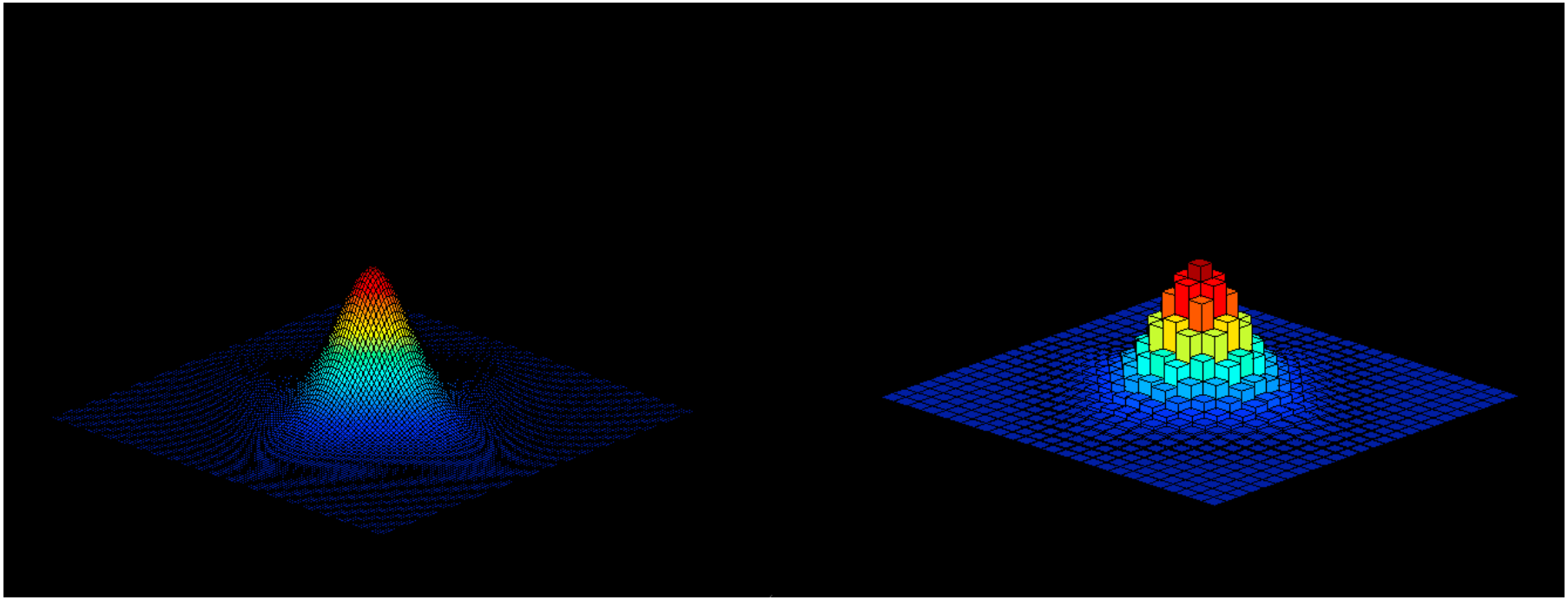
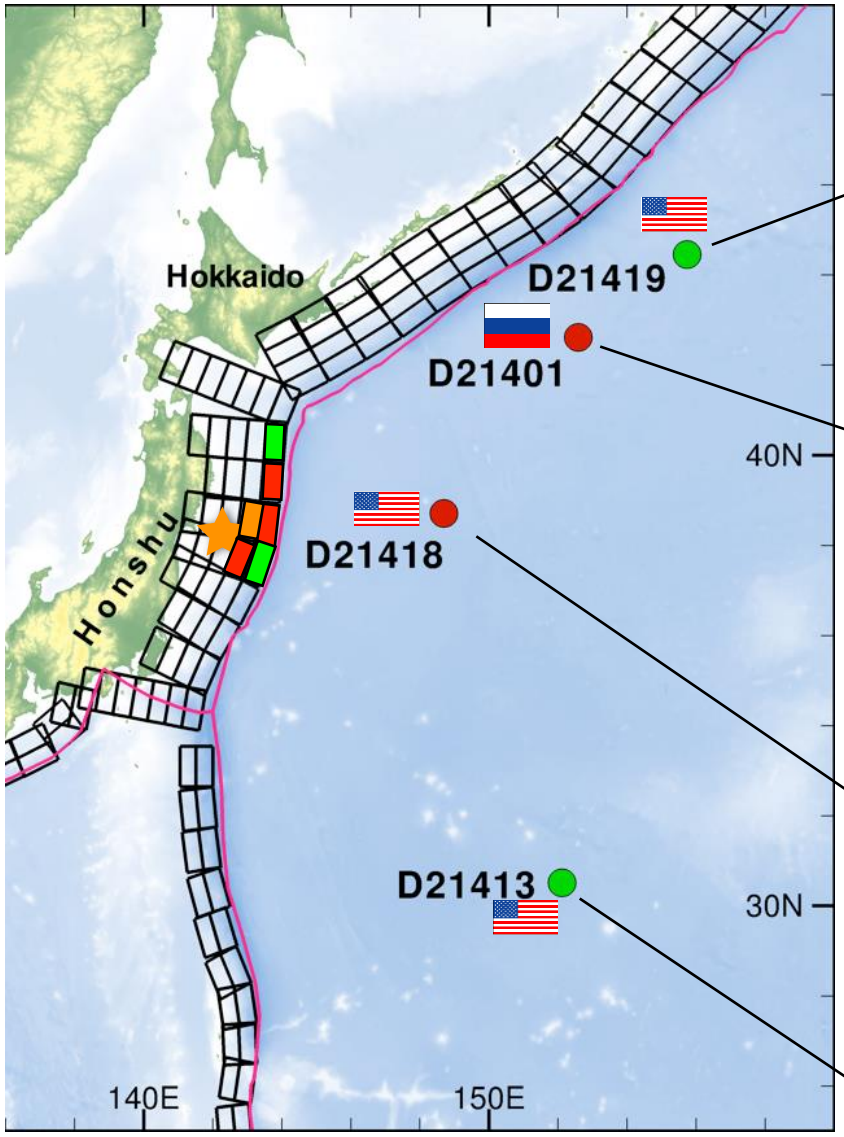


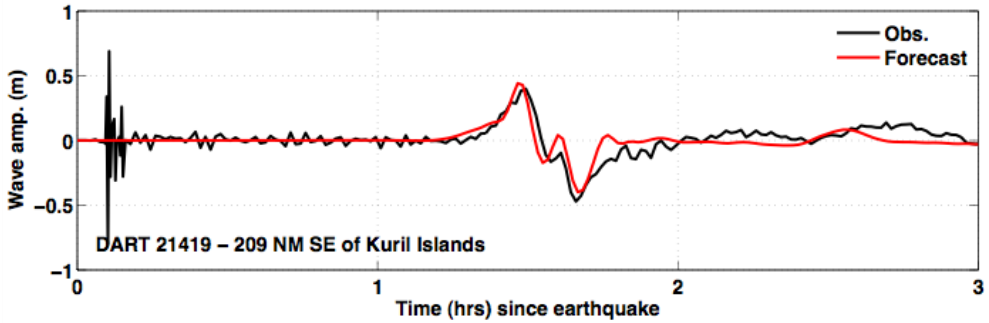
Illustration of Deep-Water Linearity

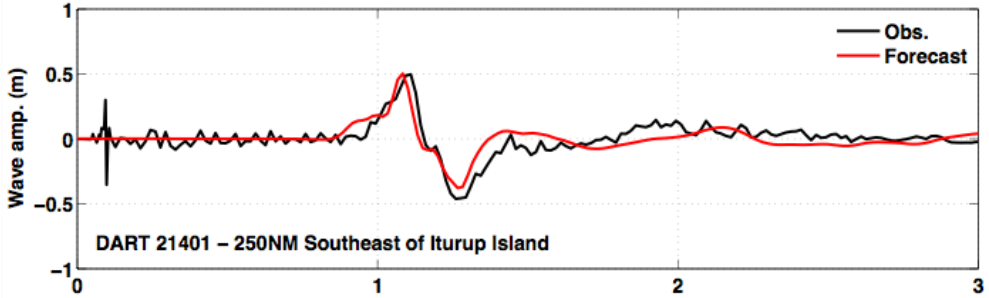


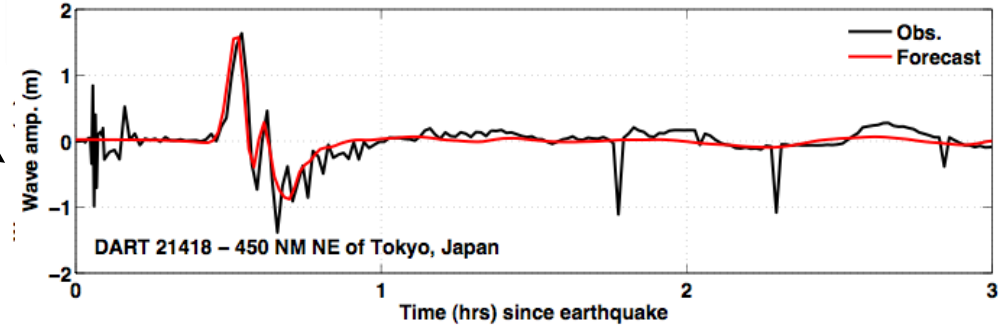
Linearity allows for the reconstruction of an arbitrary tsunami sources using elementary building blocks

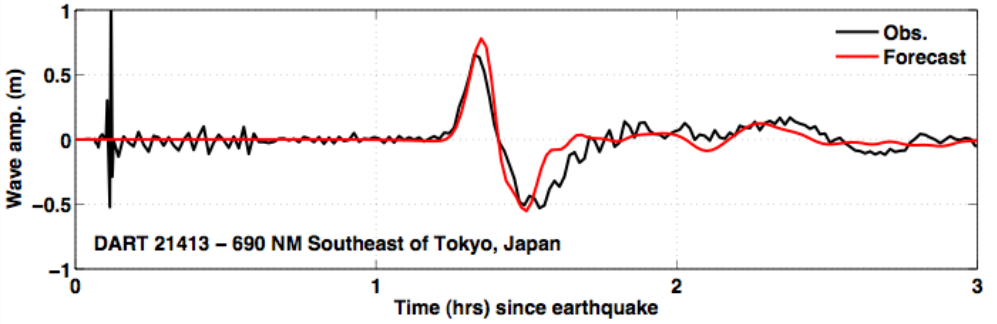




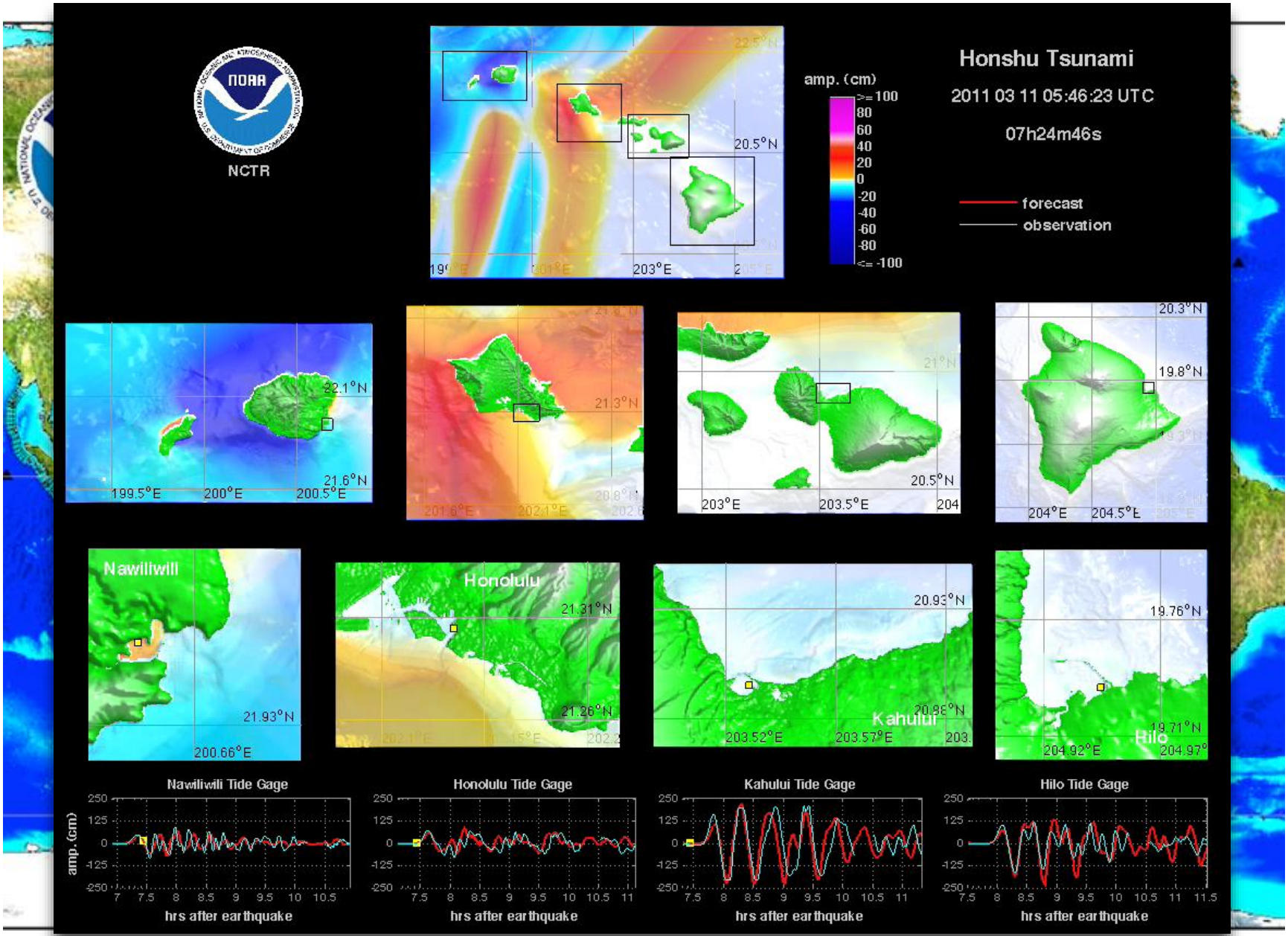








Forecast based on DART measurements


NCTR
Honshu Tsunami
2011 03 11 05:46:23 UTC
07h24m46s
forecast
observation
amp. (cm)
>= 100
80
60
40
20
0
-20
-40
-60
-80
<= -100
20.5°N
203°E
22.1°N
21.6°N
199.5°E
200°E
200.5°E
21.3°N
20.5°N
203°E
203.5°E
20.3°N
19.8°N
204°E
204.5°E
Nawiliwili
21.93°N
200.66°E
Honolulu
21.31°N
21.26°N
20.93°N
Kahului
203.52°E
203.57°E
19.76°N
Hilo
19.71°N
204.92°E
204.97°E
Nawiliwili Tide Gage
Honolulu Tide Gage
Kahului Tide Gage
Hilo Tide Gage
amp. (cm)
250
125
0
-125
-250
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
hrs after earthquake

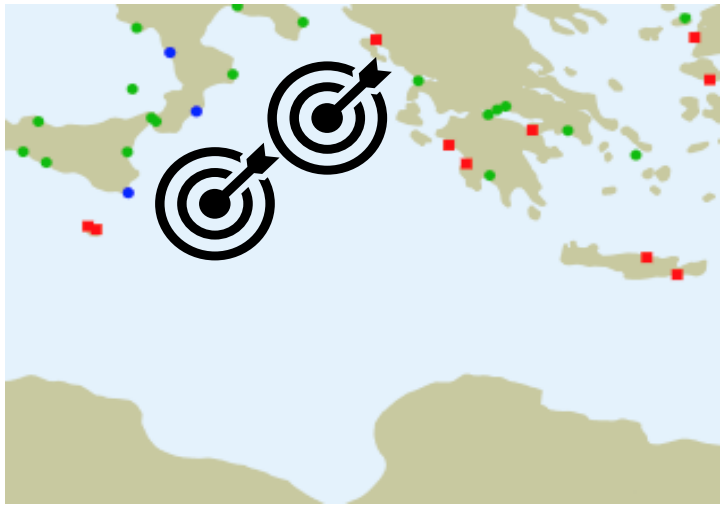
Tsunami sensors in the Mediterranean: Ongoing developments 2022-23

- Two DART-like buoys in the Ionian Sea (TUO project, coord. S. Lorito) in 2023-2024
- One DART-like buoy with INGV-made technology (G. D'Anna, EMSO-MedIt project)
- Pressure sensors on EMSO Observatories and SMART cables
- Pressure sensors on oil/gas offshore platforms (Ionian, Adriatic)
- ISPRA: New generation tide gauges in Italy (and possibly some deep-sea pressure sensors)
- GNSS monitoring for rapid source characterization

Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

- **WP 8 Coordinator: Stefano Lorito, INGV**

TUO: TsUnami Observation

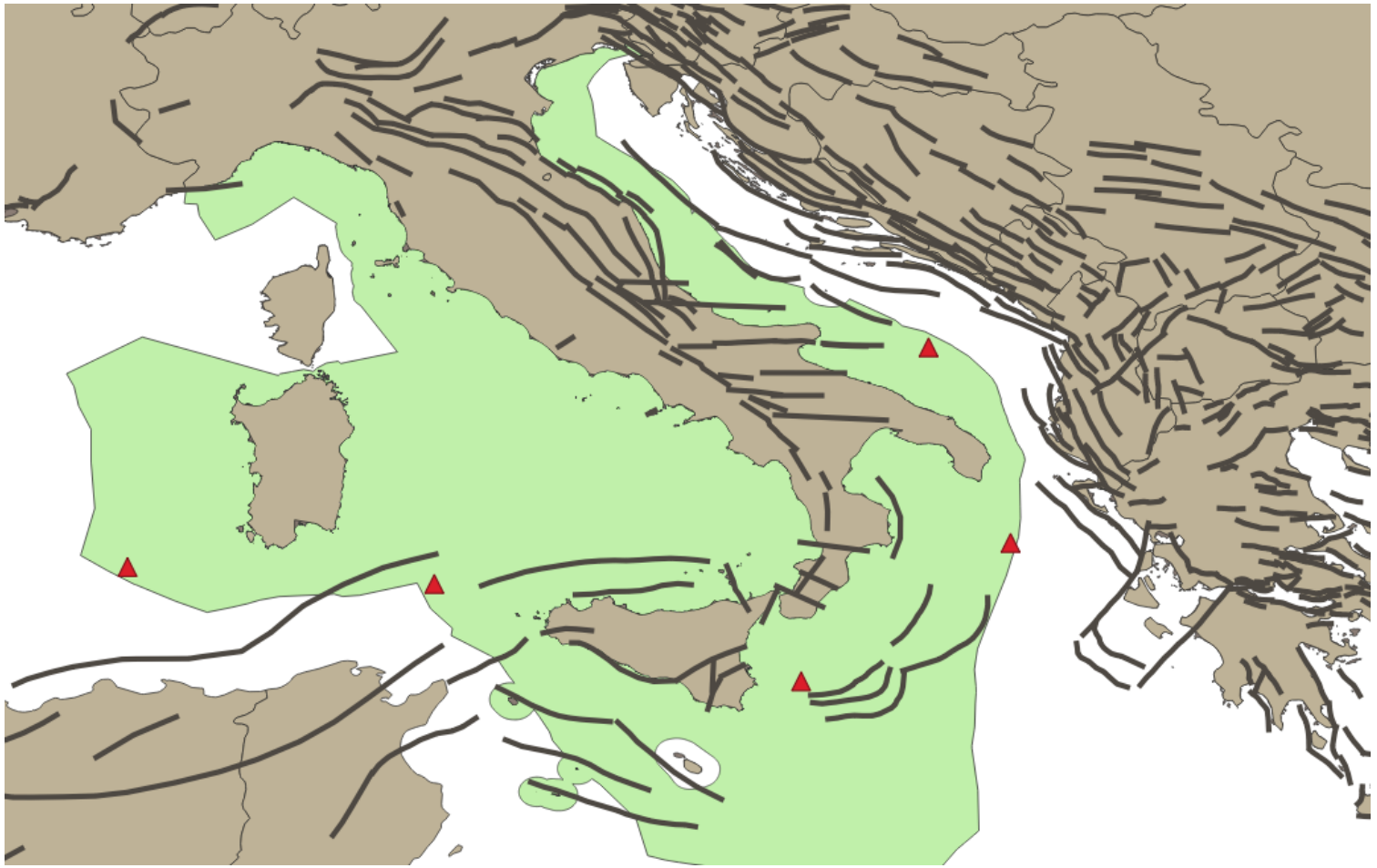


+

2 (+1) DARTs in the Ionian Sea - exact positions to be determined (+ 1)

Assigned Budget: 3 M€

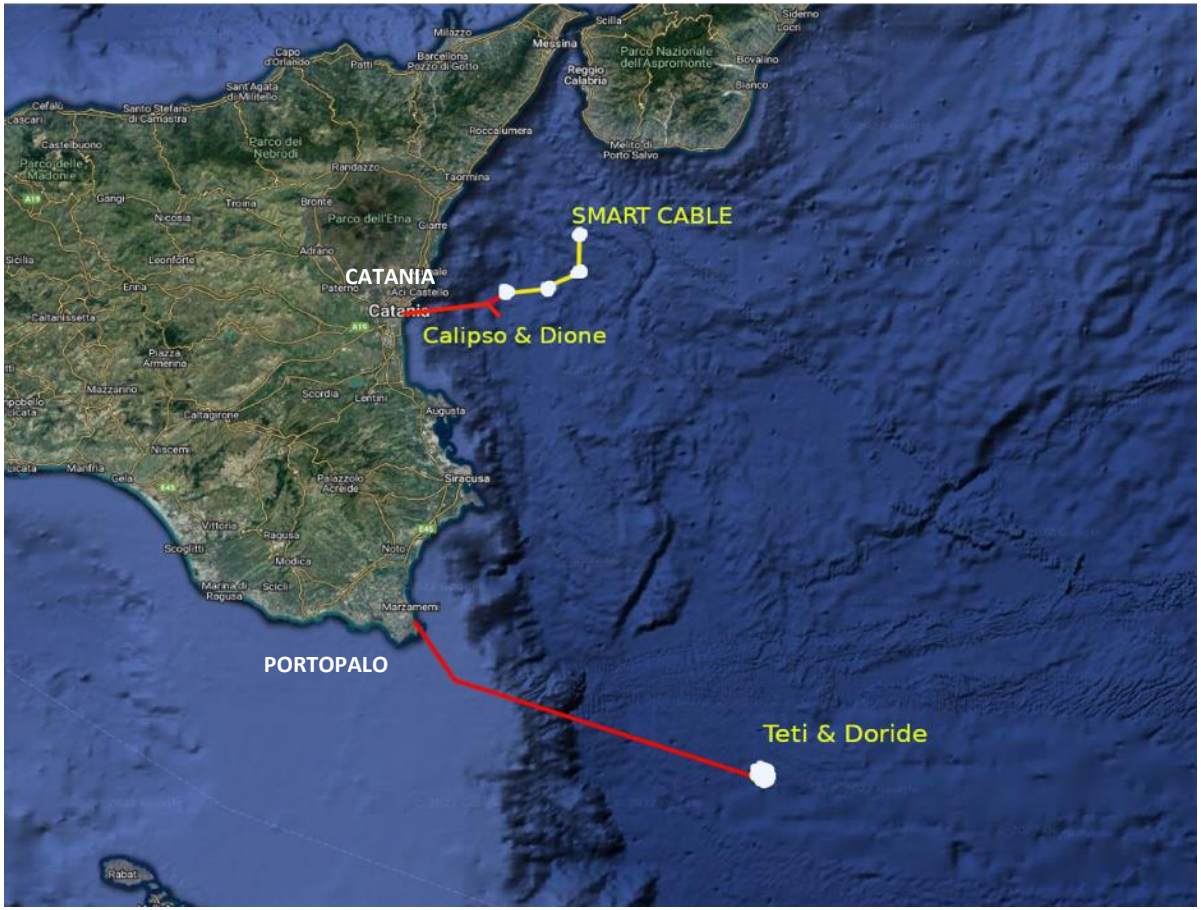
ISPRA buoys 2023-2025



Installations of pressure sensors ongoing in the Ionian Sea at observatories PON INSEA & SMART Cable (G. Marinaro)

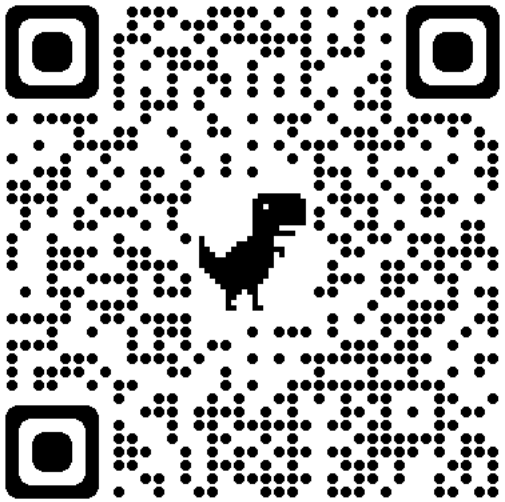
Pressure sensors to be installed on CALIPSO & DIONE (-2100 m)
TETI & DORIDE (-3500 m)

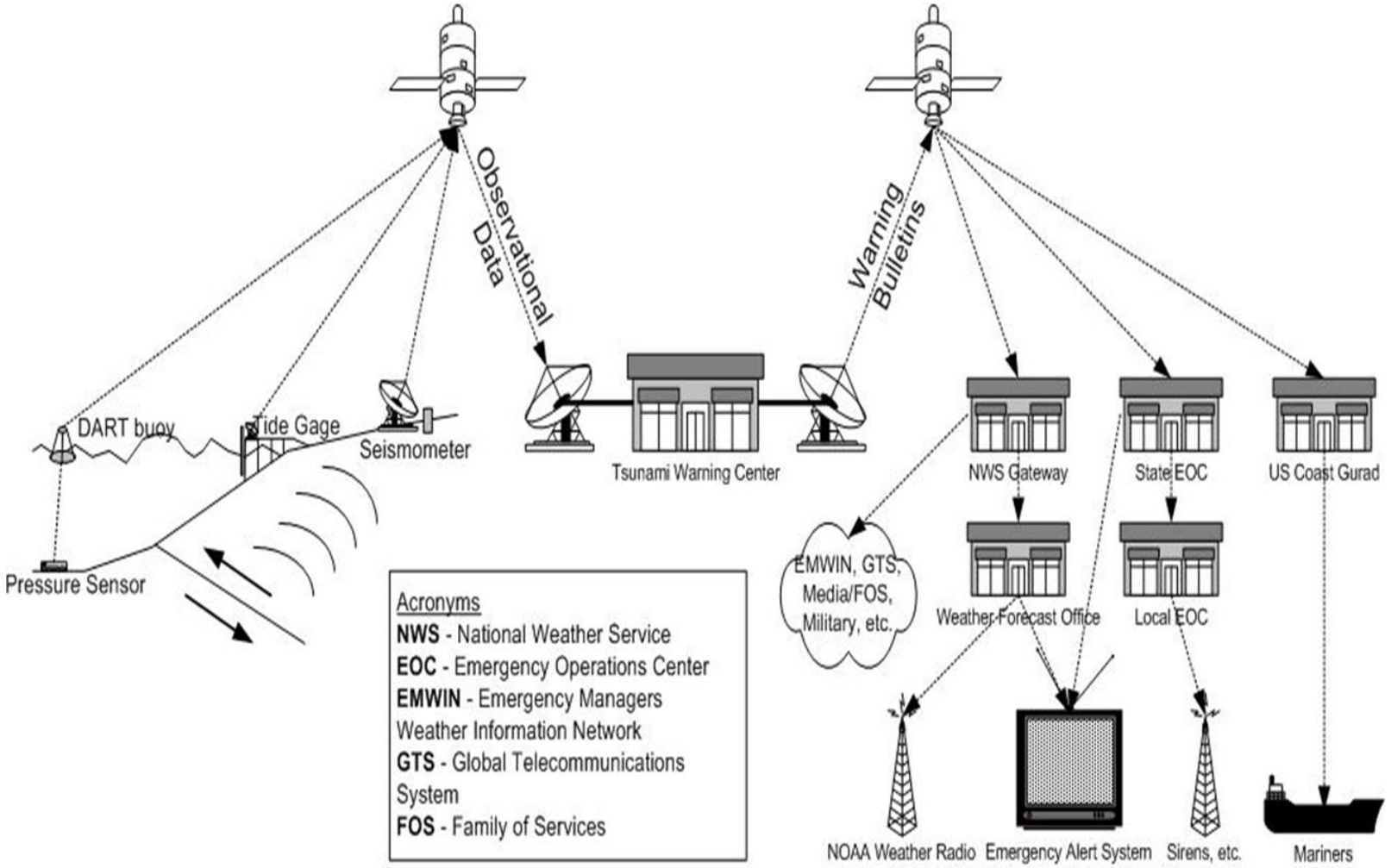
3 Pressure sensors to be installed on the SMART CABLE
(at about 6 km distance)



Thank you!

For more info:
Christopher.Moore@noaa.gov
https://nctr.pmel.noaa.gov




Observational Data
Warning Bulletins
DART buoy
Tide Gage
Seismometer
Pressure Sensor
Tsunami Warning Center
NWS Gateway
State EOC
US Coast Gurad
EMWIN, GTS, Media/FOS, Military, etc.
Weather Forecast Office
Local EOC
NOAA Weather Radio
Emergency Alert System
Sirens, etc.
Mariners
Acronyms
NWS - National Weather Service
EOC - Emergency Operations Center
EMWIN - Emergency Managers Weather Information Network
GTS - Global Telecommunications System
FOS - Family of Services