Observing the Ocean and Earth with

SMART CABLES

Observing the Ocean and Earth with SMART Subsea Cables

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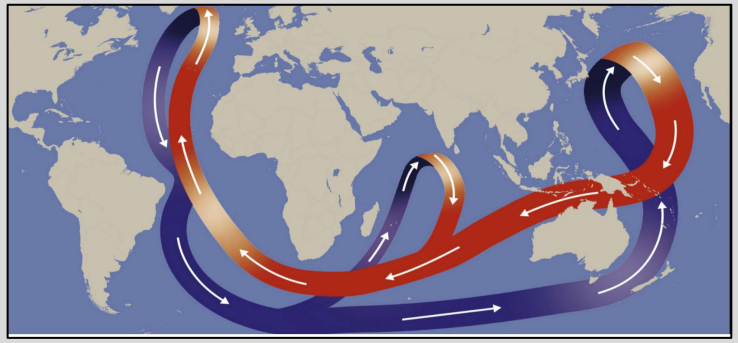
ITIC Training Programme (ITP)
Tsunami Early Warning Systems (TEWS)
Valparaíso, Chile
20 August 2024

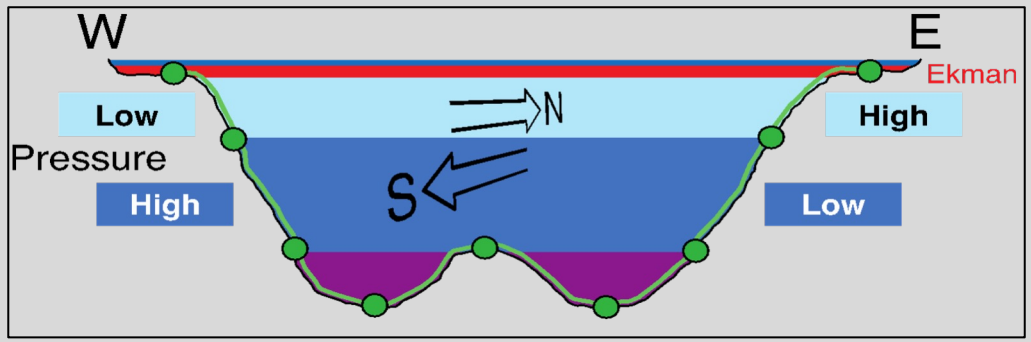
ITU/WMO/UNESCO-IOC JTF SMART Cables

United Nations effort uniting science with the telecom industry to observe the oceans and Earth

Ocean general circulation – all scales

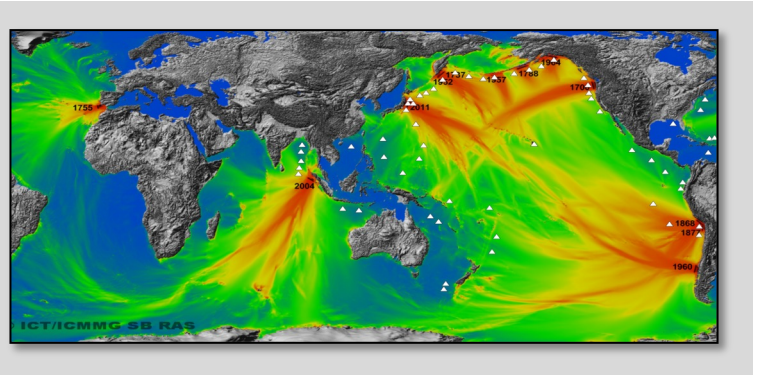


Climate Change



Ocean heat and circulation

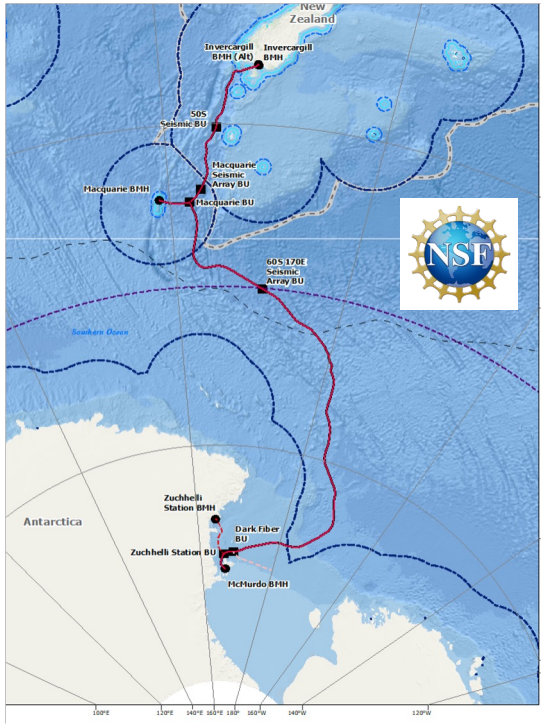
Earthquakes and Tsunamis



Sea Level Rise

Who are we, what do we do?

The United Nations JTF SMART Cables is a global initiative, uniting 300 volunteers and stakeholders from science and society, engineering, marketing, business development, regulatory, and data management.



Facilitate recommendations through ITU, WMO, UNESCO-IOC GOOS, Tsunami Resilience, UN Ocean Decade

We provide guidance to stakeholders and promote a positive environment for discussions

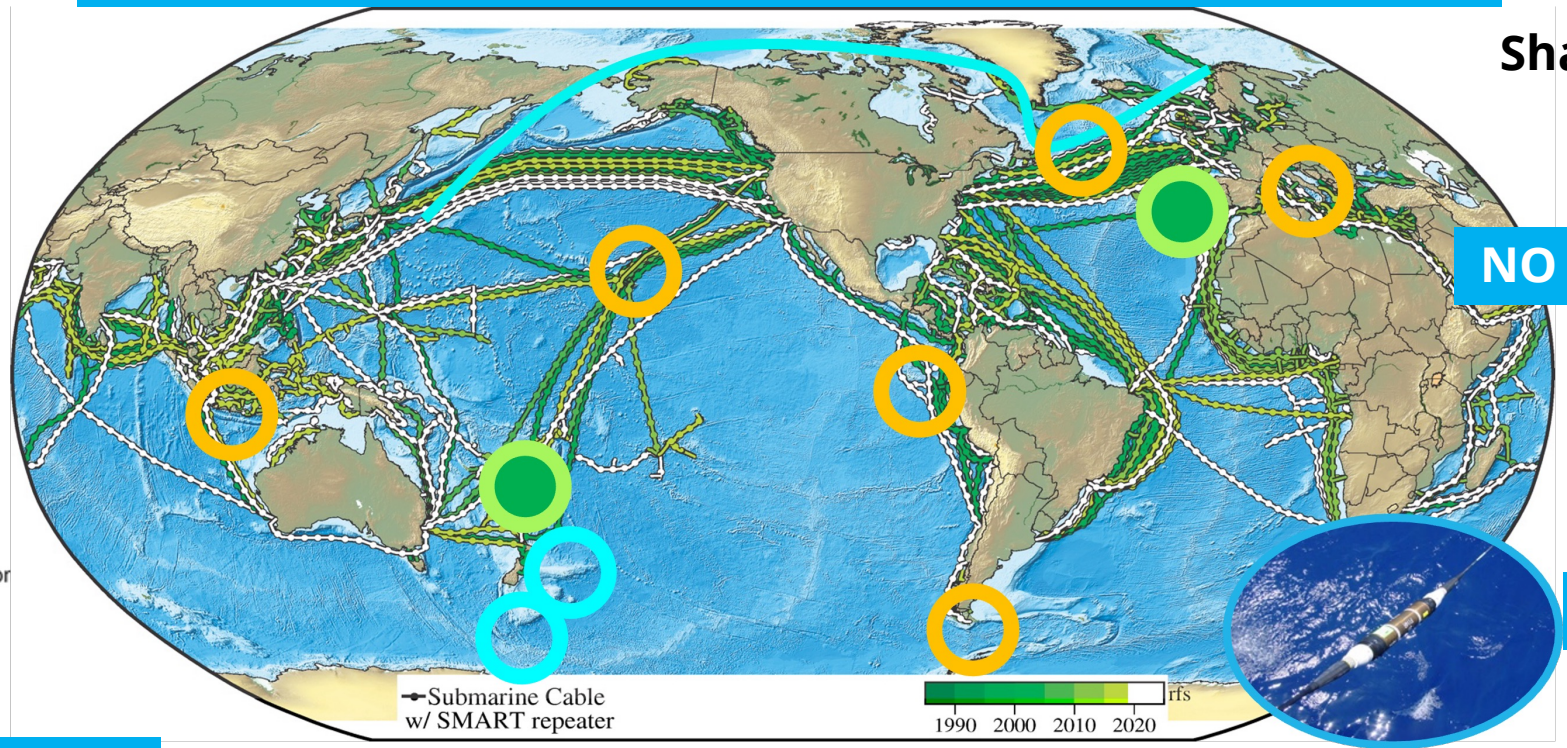
Promote future SMART cable systems

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

1.4+ Gm
~20,000 repeaters
20 year refresh

spacing ~100 km

2021 2030 United Nations Decade of Ocean Science for Sustainable Developr

SMART Atlantic CAM and Tamtam V-NC Funded, install 2026

Know the environment protect the network

Bottom temperature, pressure, seismic motion

Societal Benefits

Climate change – humanity's greatest existential threat

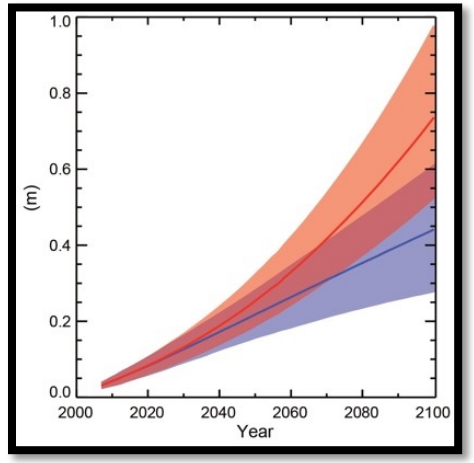
Societal and environmental issues - SDGs +

- **Climate change** – ocean temperature and heat content, circulation
- **Sea level rise** – hazard for coasts, islands, cities
- **Disaster Risk Reduction** – tsunami and earthquake monitoring
- **Societal Connectivity** – Resilient and sustainable telecom infrastructure

UN Decade of Ocean Science for Sustainable Development, 2021-2030

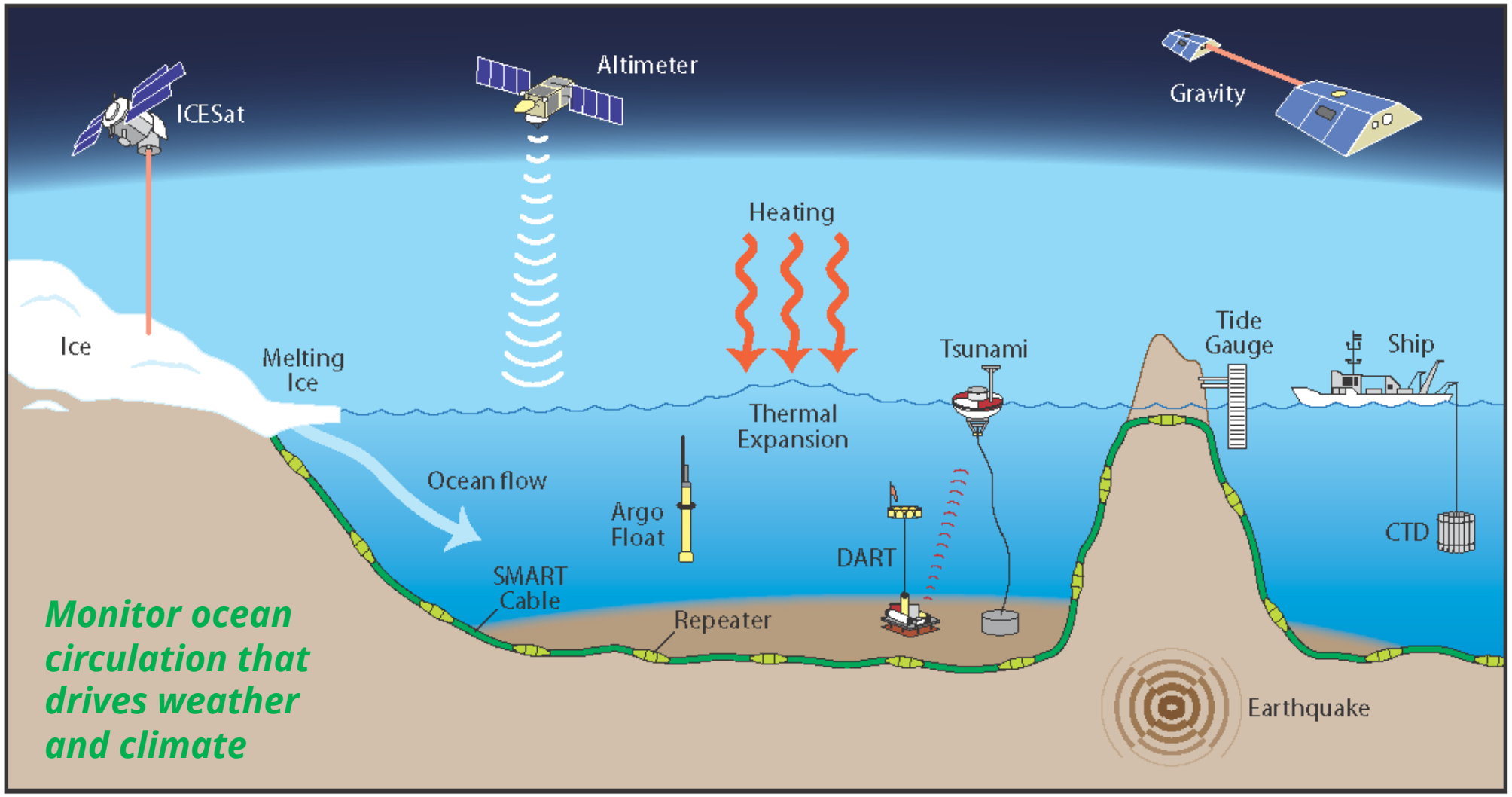
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Sea Level Rise



Tsunami

Ocean + Climate change – Long term Observation



SMART Cables measure Essential Ocean Variables:
Temperature, Pressure; Seismic motion + …

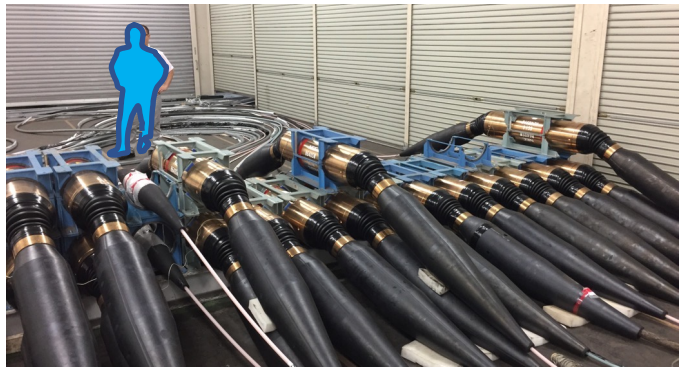
SMART Technical Solution

Shared Cable Infrastructure: Telecom + Science

Repeater

Sensor module on bottom
(INGV Wet Demo)

Existing Technology



No Interference

Sensors:

- Temperature
- Pressure
- Seismic

Key point:

- Essential Ocean Variables, Global Ocean Observing System

Climate Change solution (SMART* technology)

ASN, the key partner for
undersea data acquisition
With scientific sensors

Commercially available

Separate modules:
- **+ Variable spacing**
- **+ More flexible sensors**
- **– ⬆ $/unit**

Key applications

Risk monitoring
- Earthquake detection
- Tracking of tsunami wave
- Tsunami warning

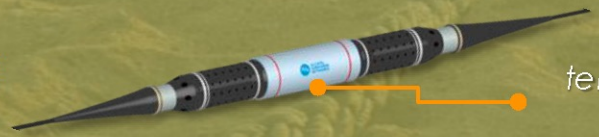
Scientific observation
- Sea bottom movements
- Sea level rise
- Slow drift of sea bottom temperatures
- Sea water currents by temperature & pressure combination

ASN solution based on CC-Nodes

New generation of submarine networks integrating sensors for Climate Change observation

dual use (telecom + CC) & dedicated CC systems

CC-NODE



temperature | accelerometer
pressure | specific sensors

ASN, part of the Ocean Decade
"Science we need for the ocean we want"

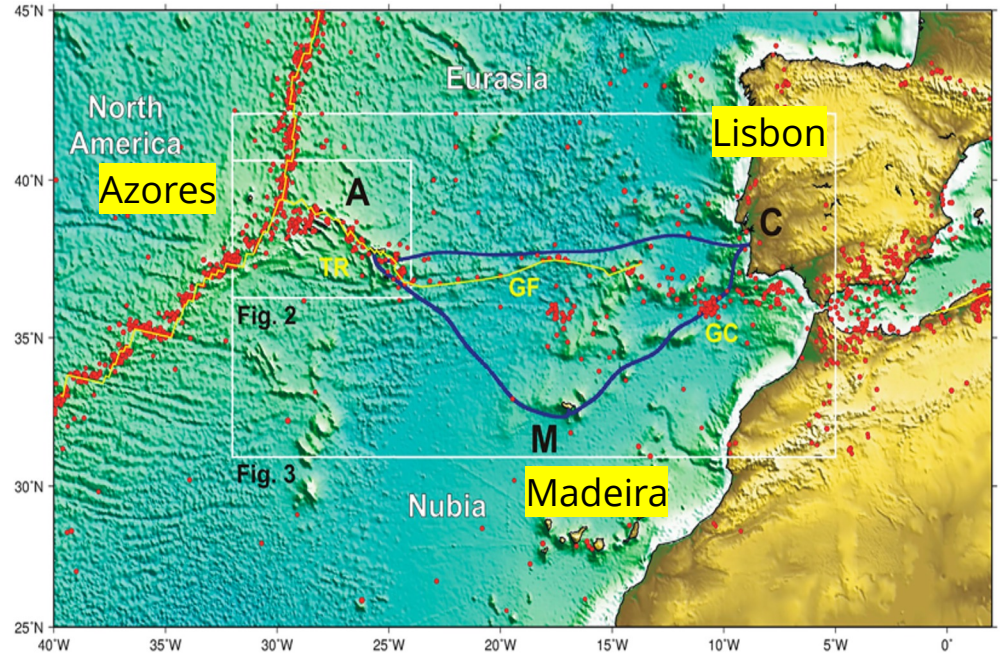
2021 2030 United Nations Decade of Ocean Science for Sustainable Development

First SMART projects planned for 2025 / 2026
- South Pacific
- Atlantic
- Asia

* *Scientific Monitoring And Reliable Telecommunications*

Funded SMART Cable Systems

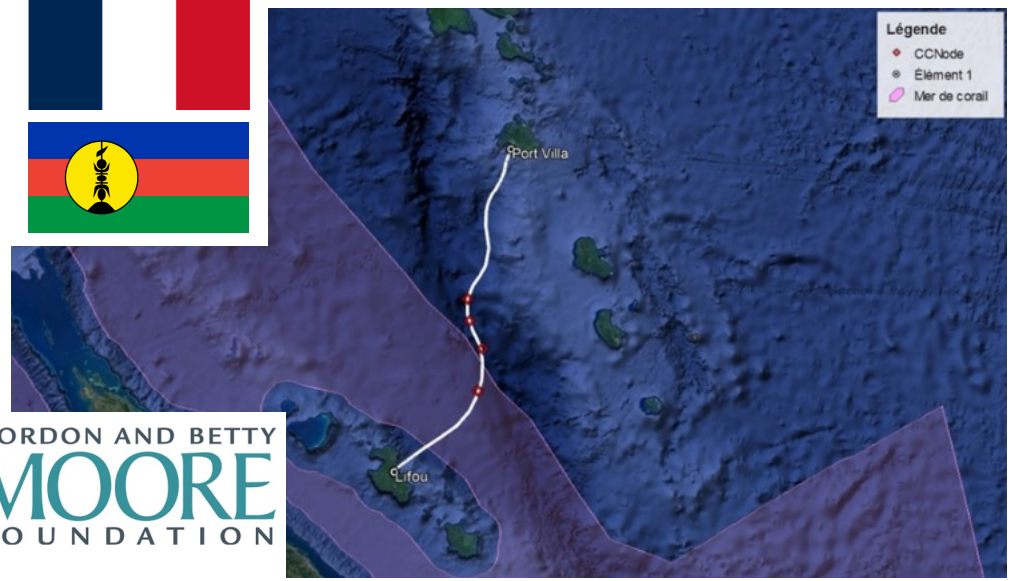
Portugal SMART Atlantic CAM



- 3700 km, ~20 SMART modules
- Gov't €154M. EU support €56M
- SMART 15% ➔ €22M ~ €2/citizen/25 y
- ~ 2 Tsunami buoys, 25 year (unreliable, no seismic, not real time)

Contracts signed
ASN
RFS 2026

TAMTAM SMART Cable System



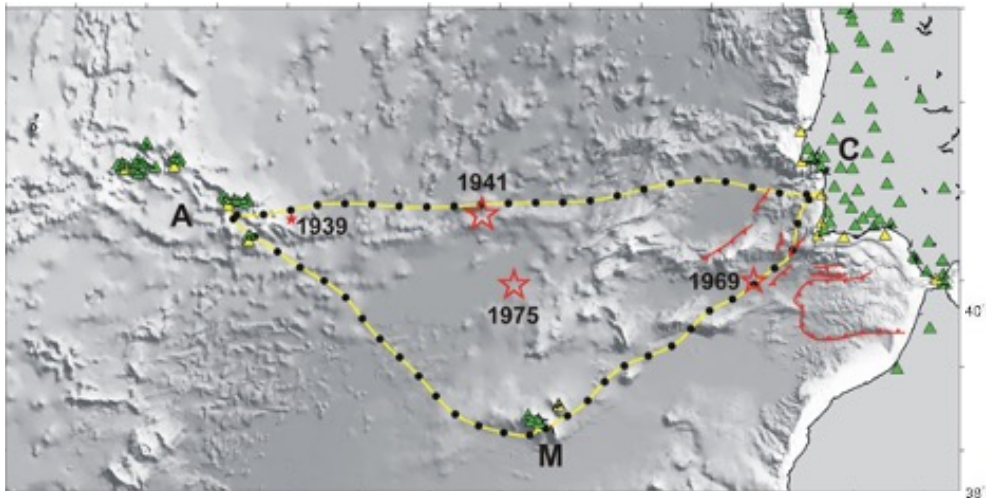
GORDON AND BETTY MOORE FOUNDATION

- 450 km long, 4 SMART repeaters,
- France funding SMART (telecom: AFD, ADB)

- 25+ year life, reliable, low lifetime cost
- Leverage $5B/y industry, 170 y

Optical Fiber Sensing in both

Portugal – Continent/Azores/Madeira (CAM)



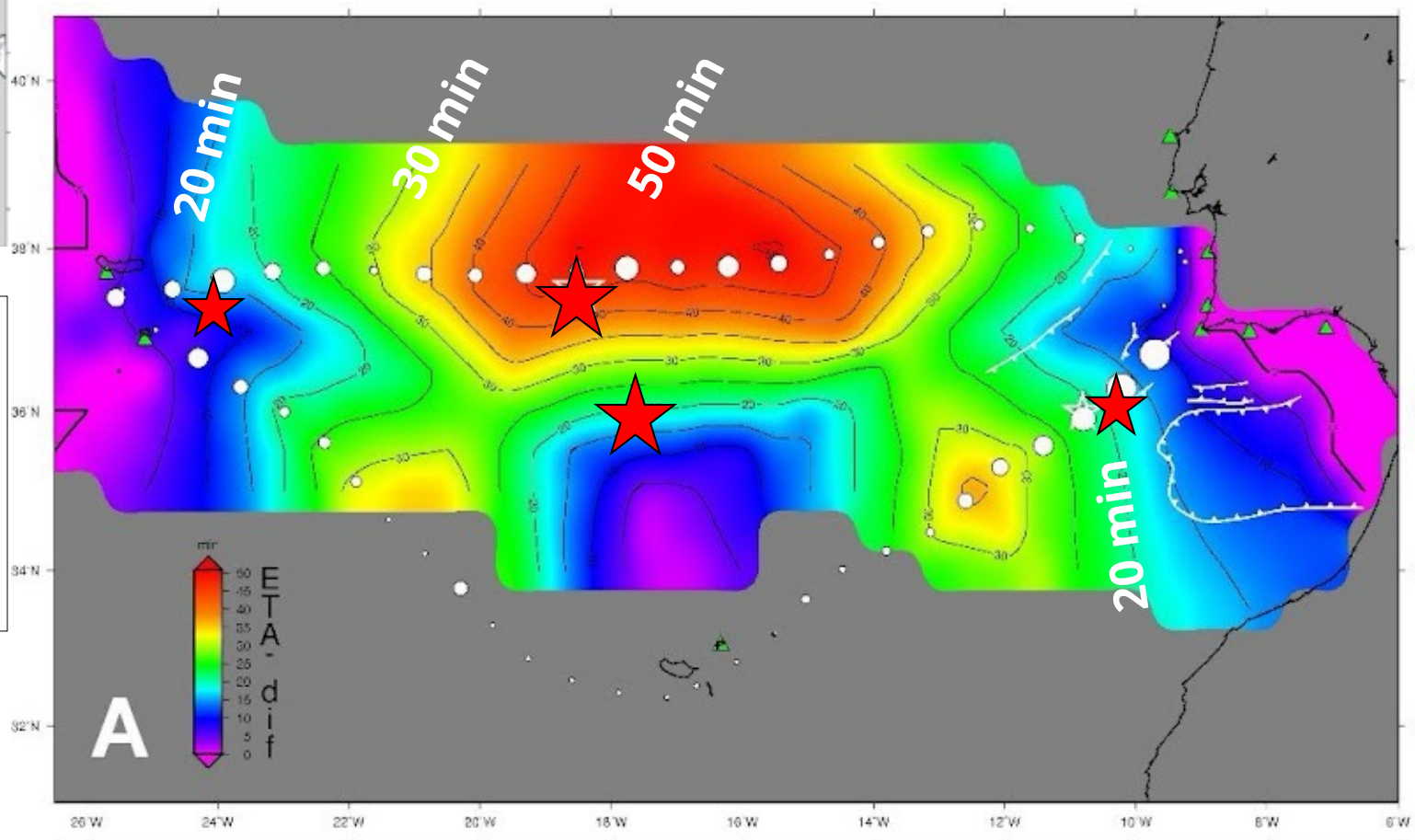
CAM submarine cable (SMART repeaters every ~70 km)

Green triangles - seismic stations (Instituto Português do Mar e da Atmosfera (IPMA)

Yellow triangles - coastal tide-gauges monitored (IPMA)

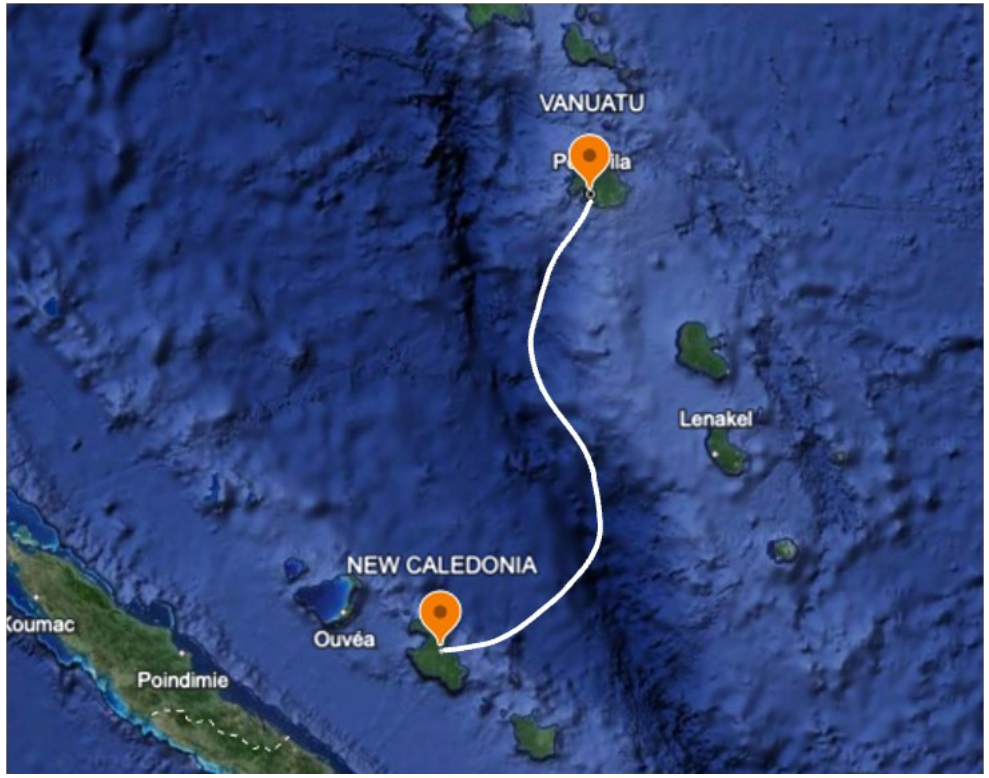
Red stars - M > 7.7 large tsunamigenic earthquakes

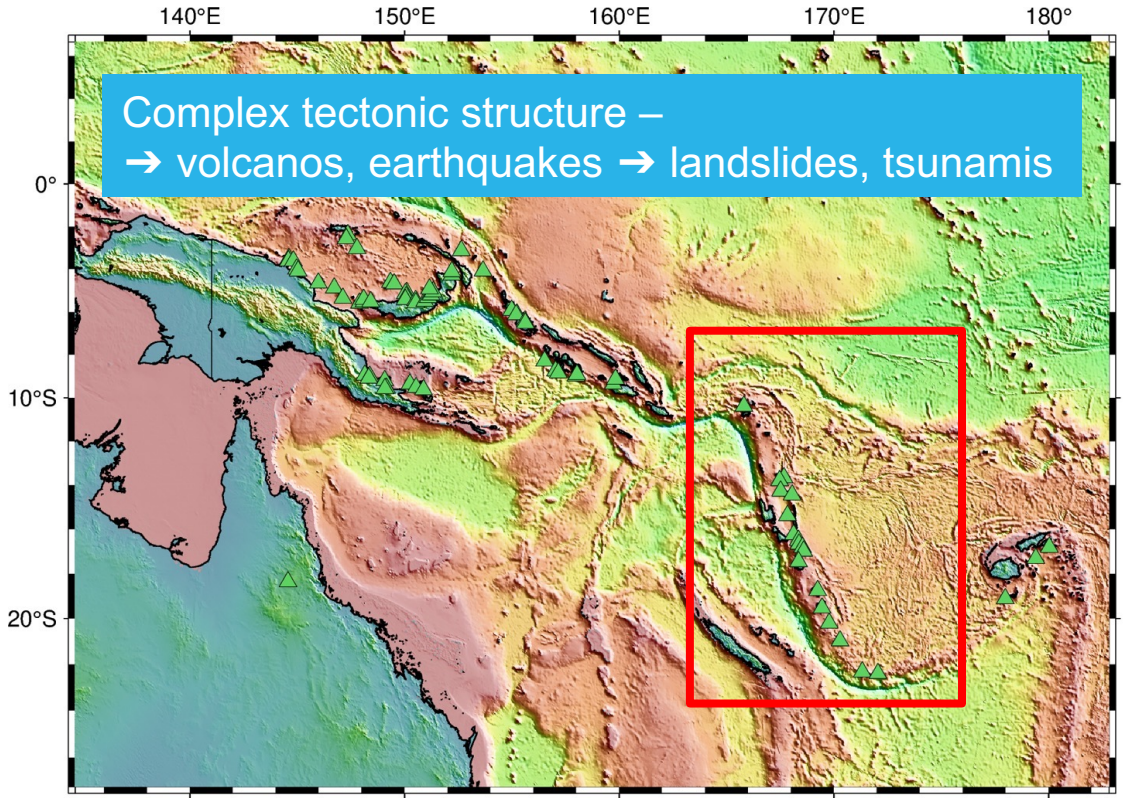
Tsunami warning time improvement obtained by CAM-2 sensors (white circles) compared to coastal tide gauge network (**green** triangles).



LEA; Matias et al., 2021

Tamtam SMART Cable System

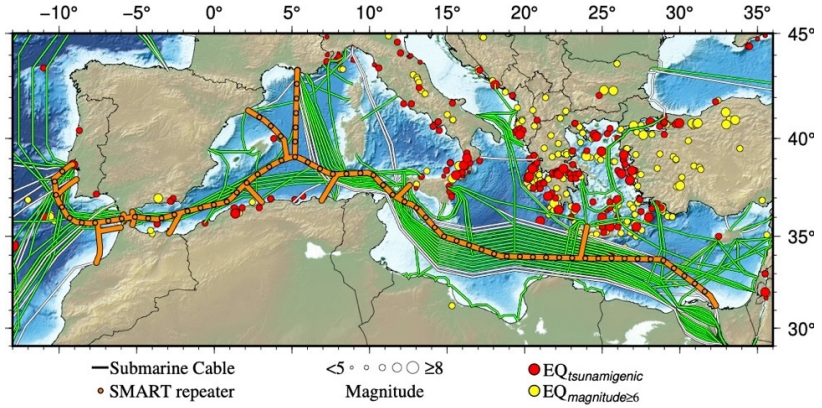




Vanuatu – more natural disasters than any other country
– typhoons, earthquakes, tsunamis, and volcanos – significant sea level rise.
SMART crucial to improve understanding and earthquake and tsunami EW.

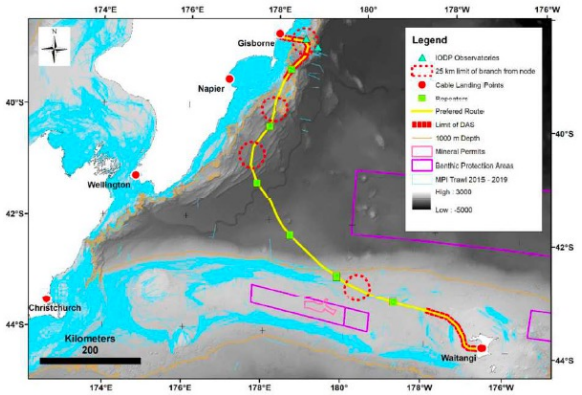
Systems in Play

Medusa



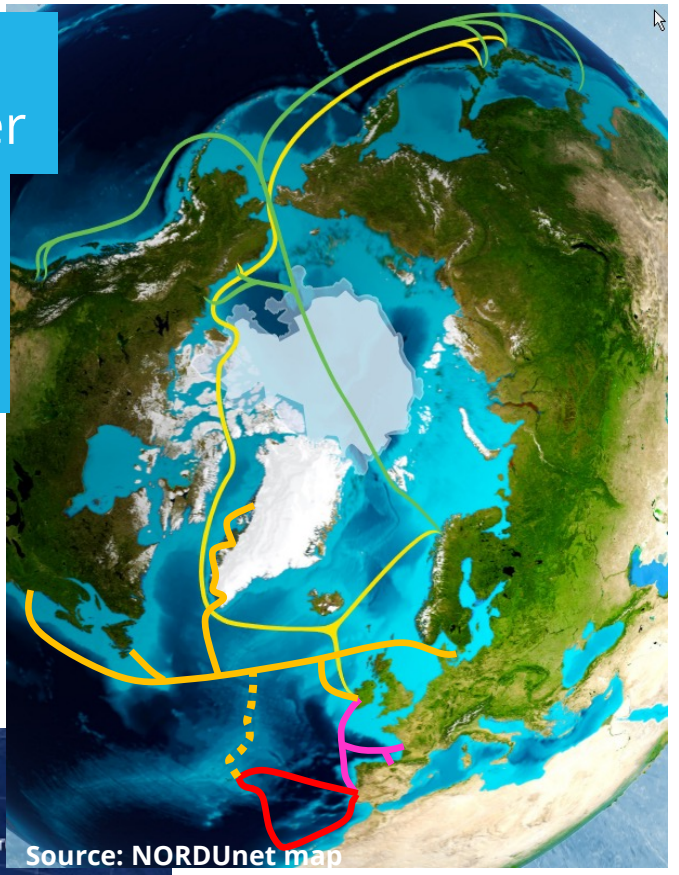
MISTS

NZ - Chathams



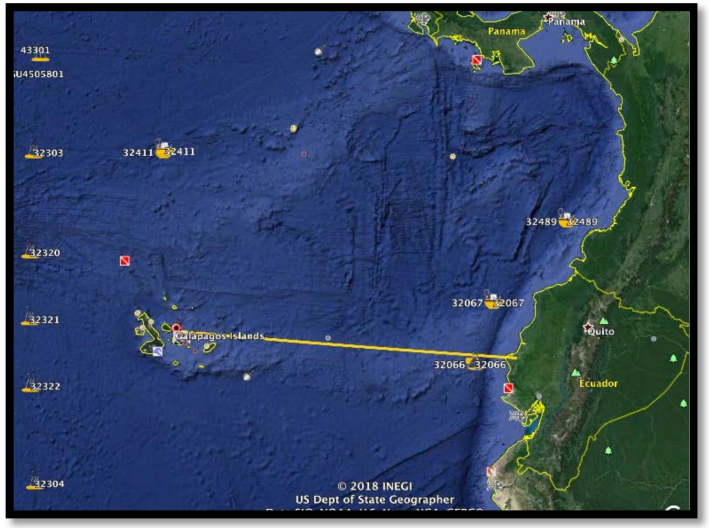
Polar Connect
Far North Fiber

Tusass
Pisces
CAM



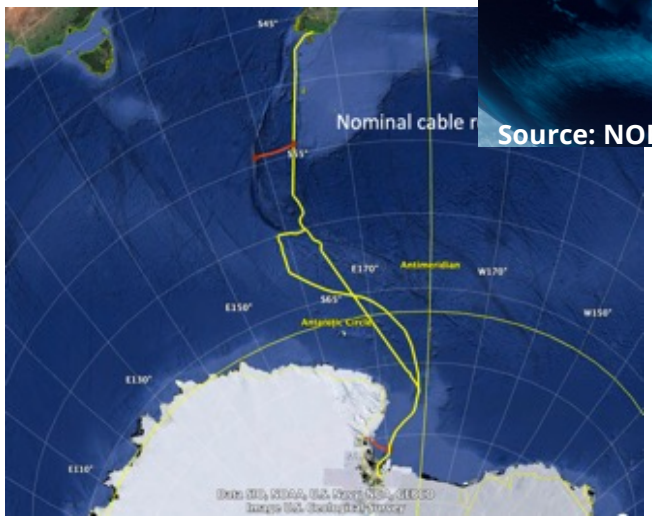
Source: NORDUnet map

Galapagos



Antarctica Chile

Antarctica US



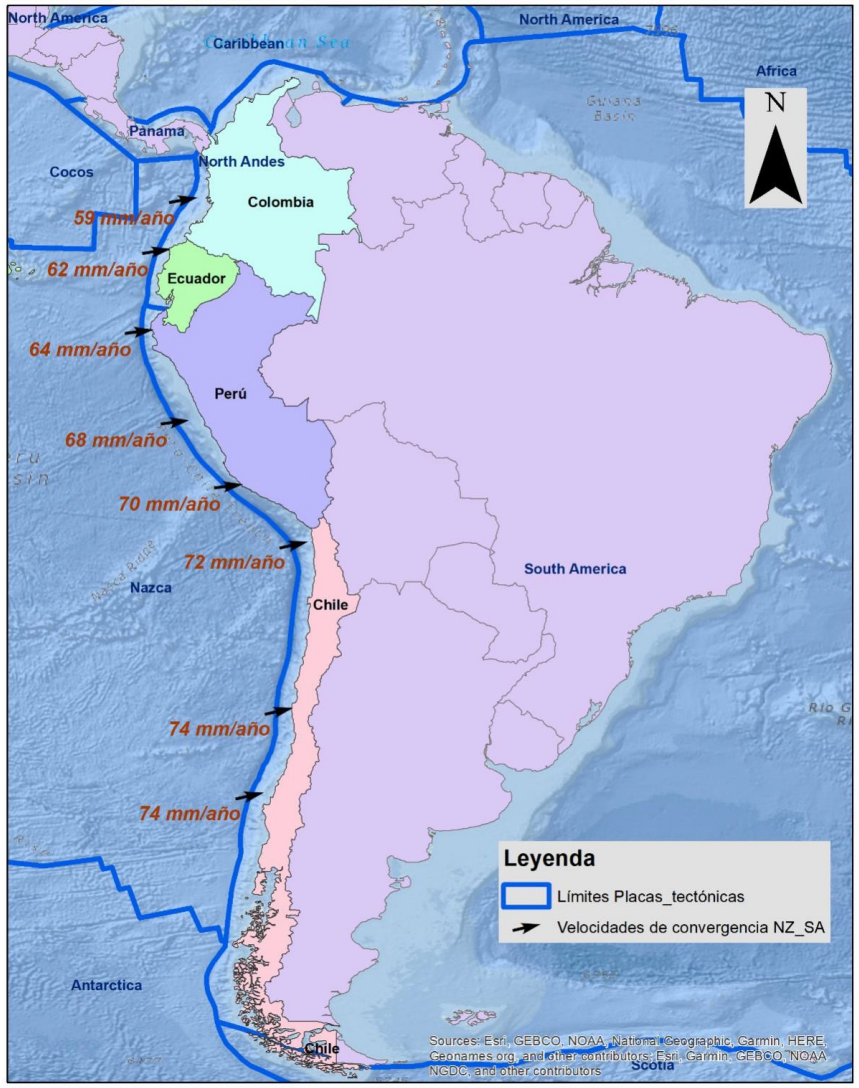
Chile and SMART – GT-ATPS Report

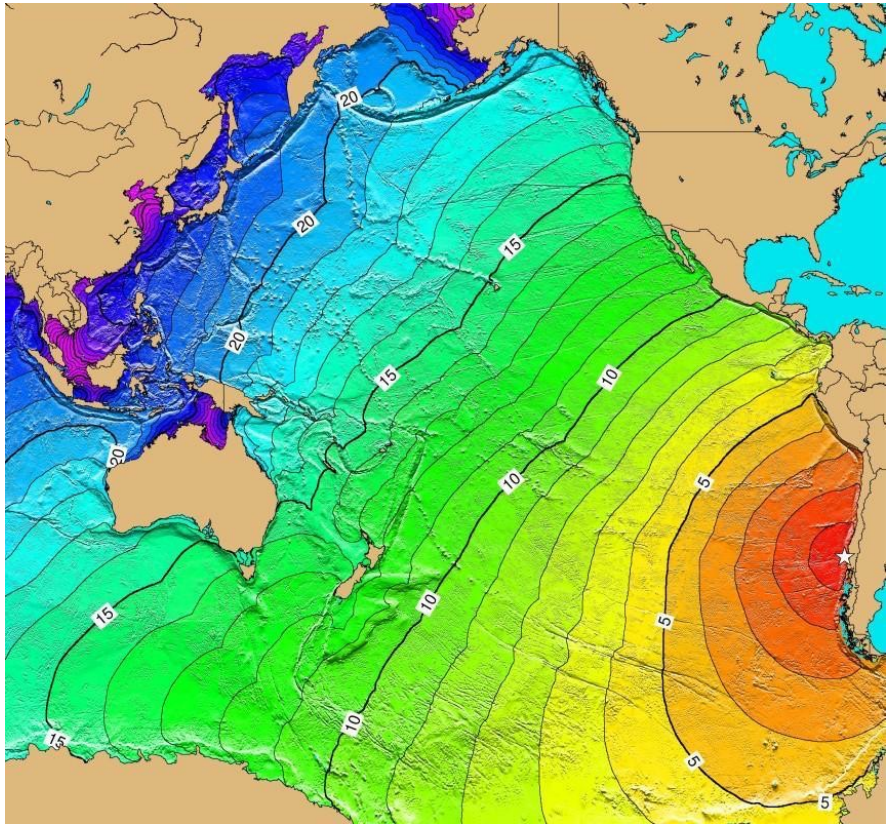
Capabilities for the evaluation of the threat of tsunamis for members of GT-ATPS and the exploratory proposal of opportunities and challenges for the incorporation of SMART cable technology. 2022

… implementation of oceanographic sensors in new underwater telecommunications cables, under the SMART concept (Scientific Monitoring and Reliable Telecommunications), is a promising solution to obtain a greater amount of data in real time that is essential to understand and manage urgent environmental issues such as climate change and the effects of tsunamis. Such sensors can provide important environmental data from sites in the deep ocean that would otherwise be difficult and expensive to obtain in real time and over large time scales.

English version not yet distributed by IOC

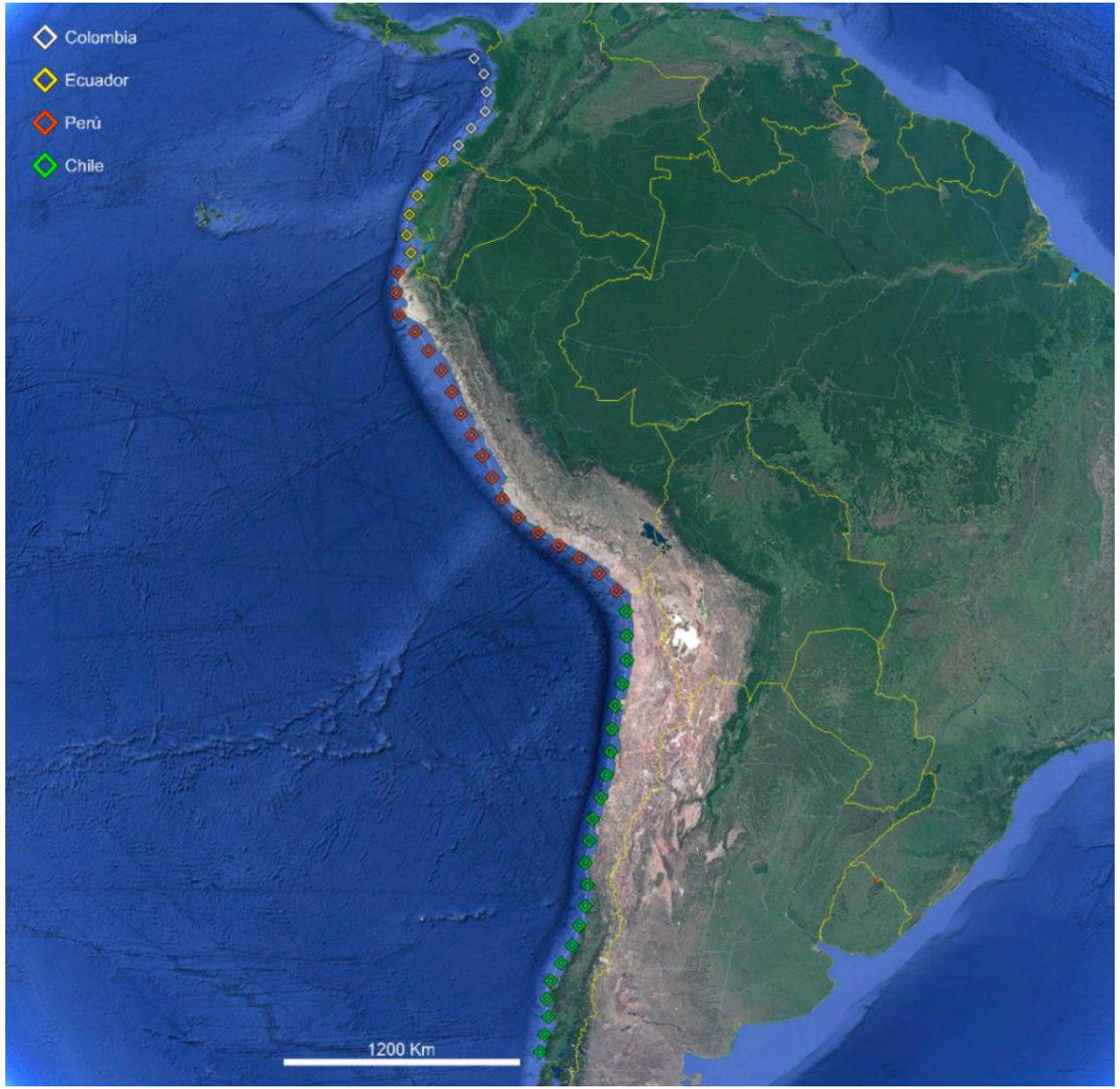
Tectonics and Tsunamis





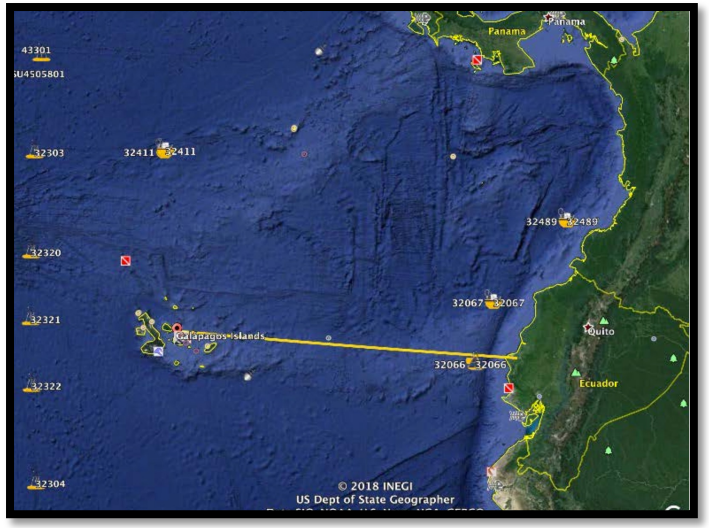
- Travel times from Chile 1960 M 9.5.

Recommendations and Opportunities



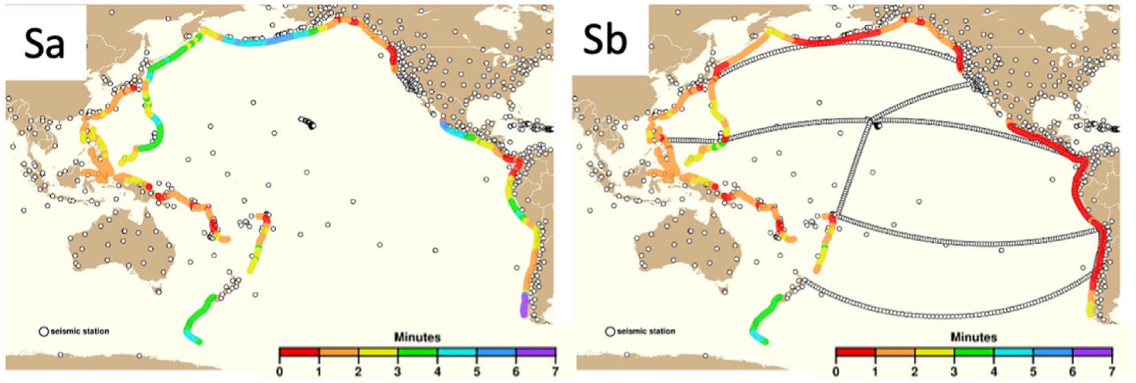
- From GT-ATPS Report
- Regional, multi-national
- SMART Cable
- 52 Sensor modules
- Spacing 120 km
- 5900 km
- Cost – cf Portugal

- Galapagos
- 1200 km
- On hold
- Supplier Xtera

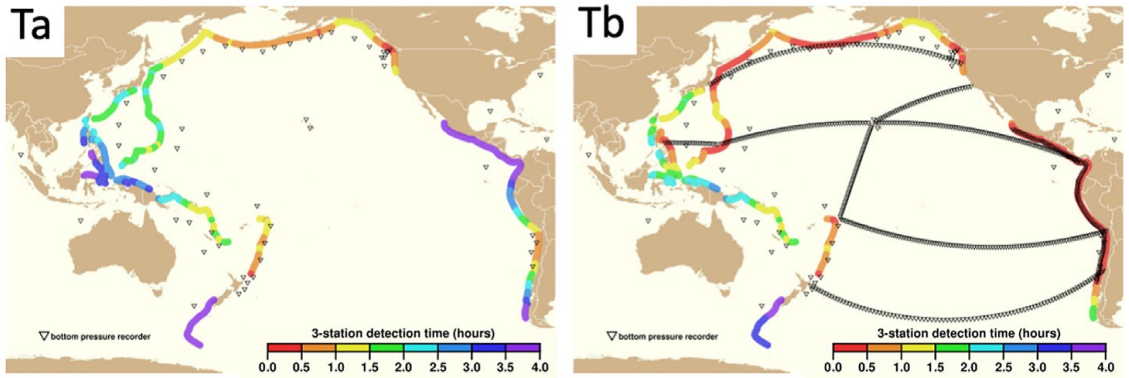


Earthquake and Tsunami Warning

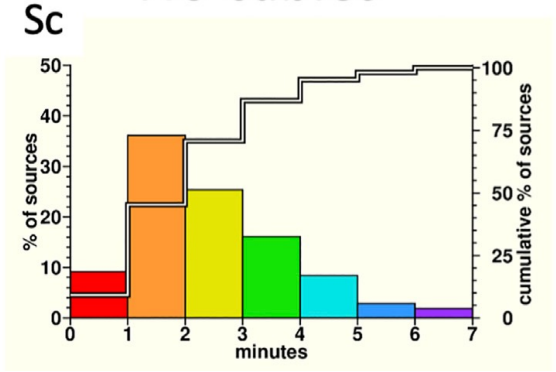
Seismic



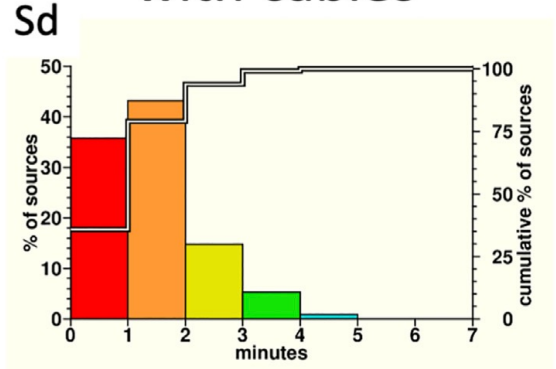
Tsunami



No cables

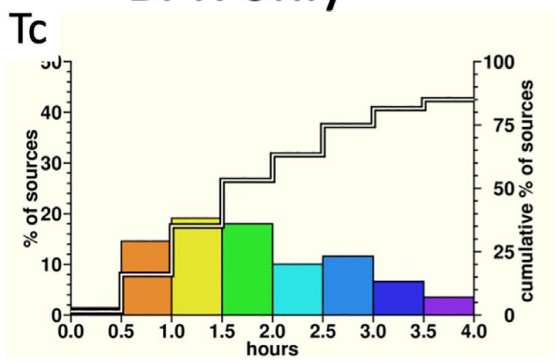


with cables

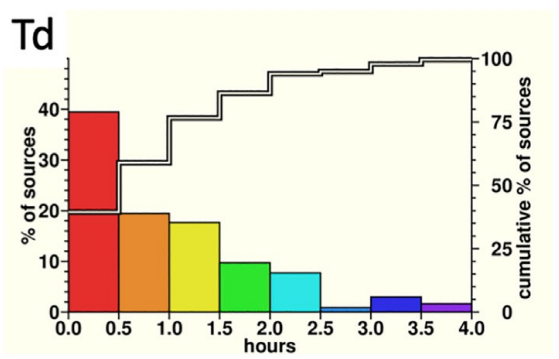


0 - 7 minutes

BPR only



with cables



0 - 4 hours

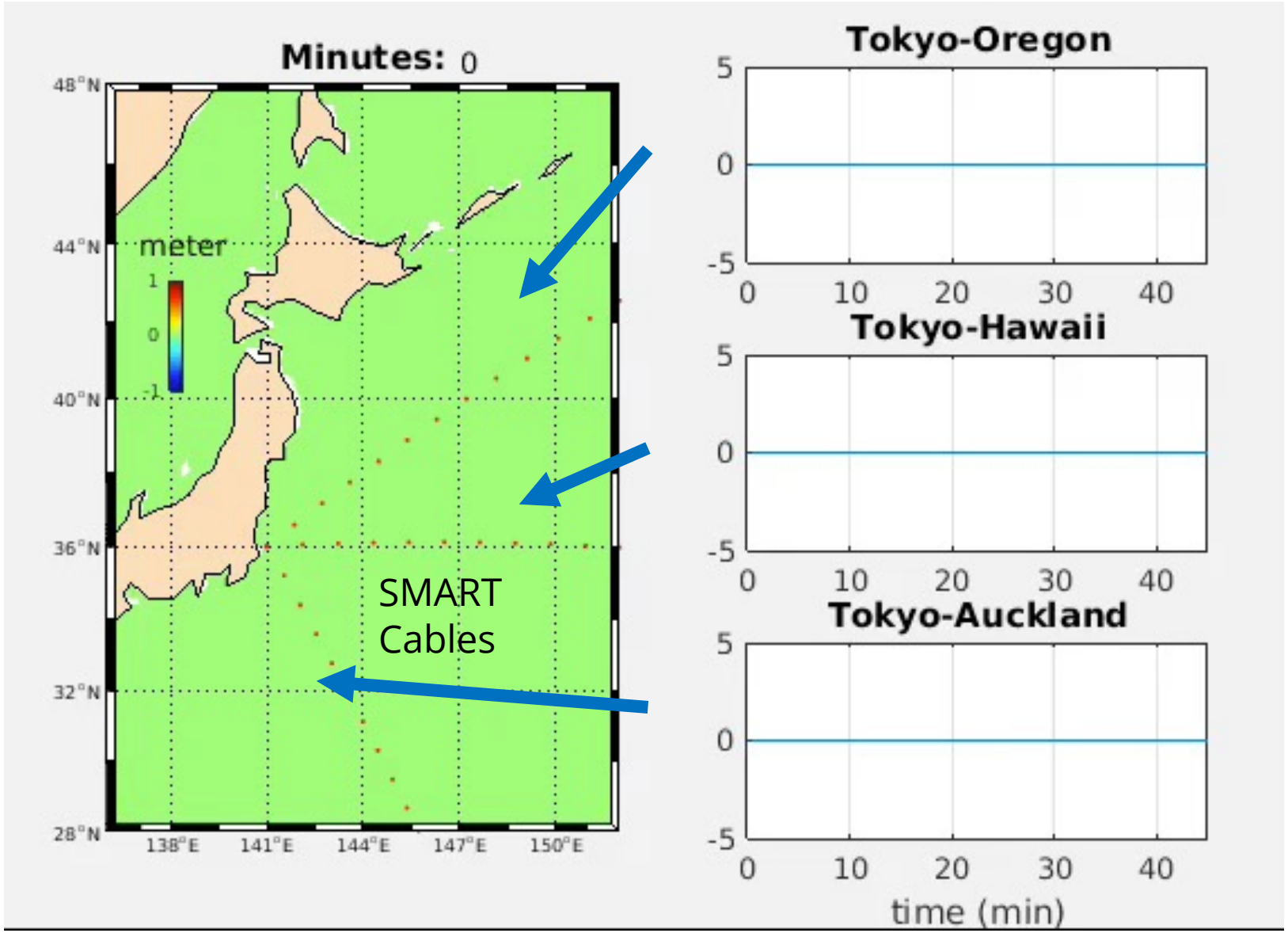
Simple travel time calculations, assumed source locations (trenches)

Nate Becker, PTWC

Earthquake detection time reduced
2.44 to 1.42 min, ~42%.

Time dropping from
2.4 to 1.0 h, ~ 57%

Simulation – Tsunami Detection



Each line represents pressure sensor along cable

Realtime!

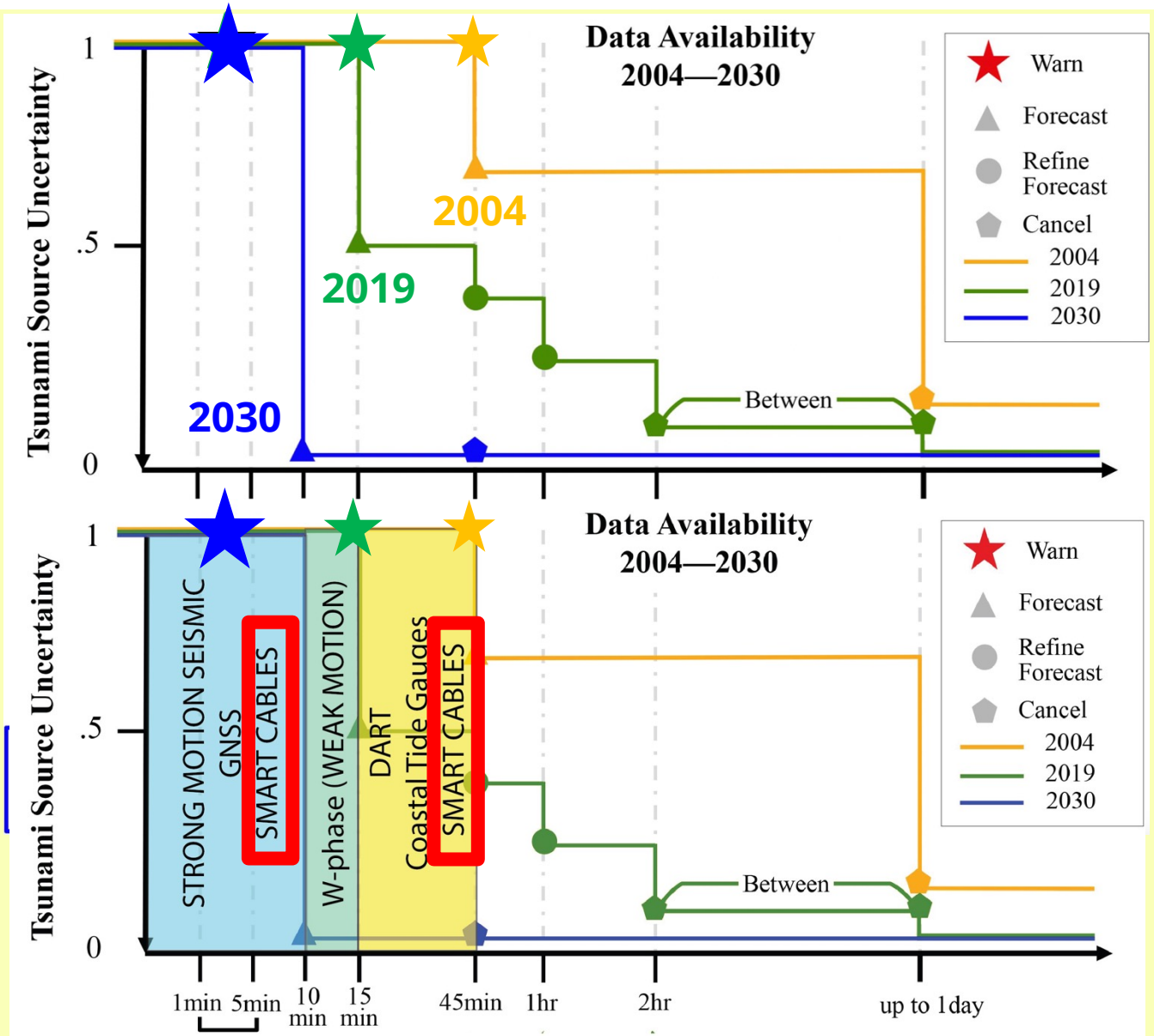
Reliable!

In situ

Tony Song,
JPL/CalTech

Improvement in Early Warning (SMART, GNSS)

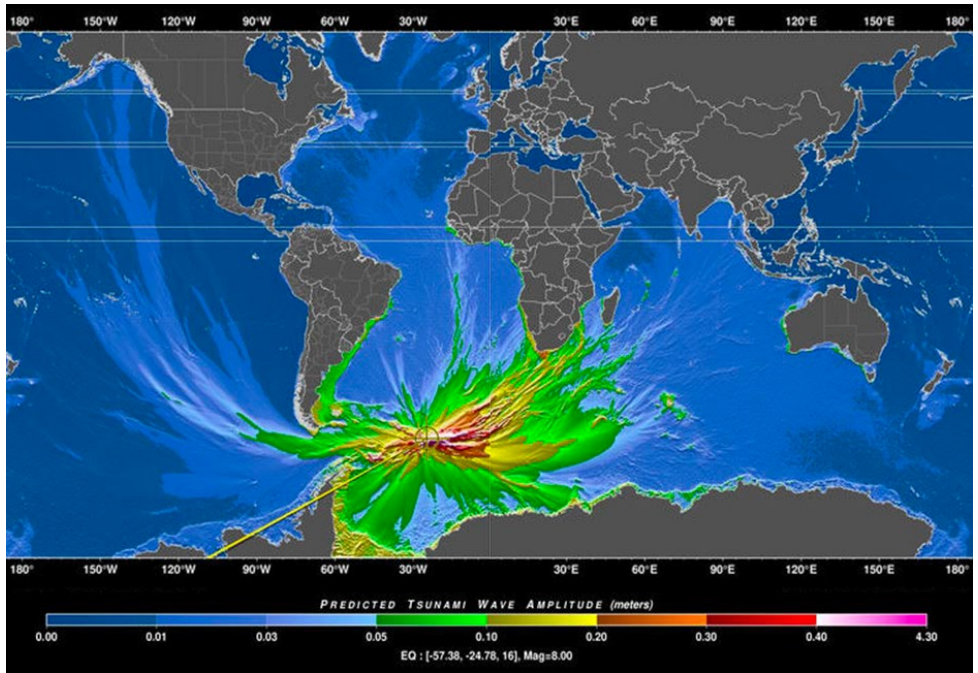
UN Ocean Decade Goal:
Integrate SMART Cable technology into innovative early warning systems

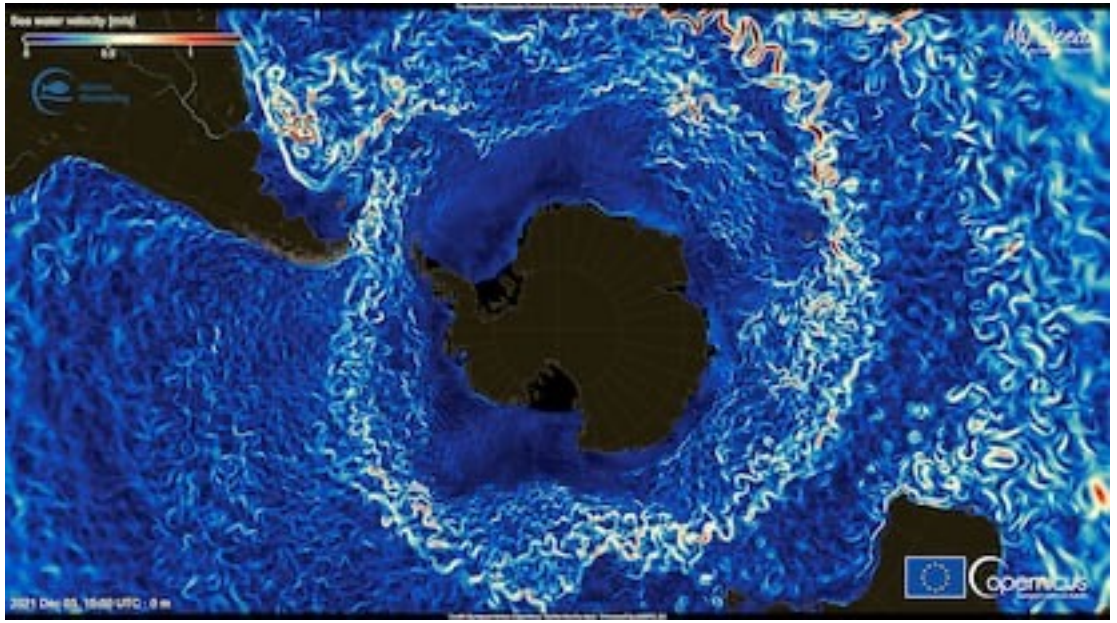


2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Drake Passage - Antarctica

- Chile - Proposals for Drake Passage cable started 2018
- Subtel RfT for new Feasibility Study – 2025?
- The #1 location in the world for a SMART cable for climate
- Antarctic Circumpolar current – VERY important for climate
- Tsunami risk, local and regional





2021 Antarctic Subsea Cable Workshop
High-Speed Connectivity Needs to Advance US Antarctic Science

National Science Foundation

DESKTOP STUDY

Exploring the Feasibility of a Science Monitoring And Reliable Telecommunications (SMART) Fiber Optic Cable System Connecting

ANTARCTICA
AUSTRALIA
NEW ZEALAND

August 2022

SMART Cables in WMO and IOC: GOOS

GOOS *in situ* networks [1]	Implementation	Data & metadata			Best practices [6]	GOOS delivery areas [7]		
	Status [2]	Real time [3]	Archived high quality [4]	Metadata [5]		Operational services	Climate	Ocean Health
Ship based meteorological - SOT	★★☆	★★☆	★★☆	★★½	★★☆	✓	✓	
Ship based oceanographic – SOT	★★½	★★½	★★★	★★☆	★★★	✓	✓	
Repeated transects - GO-SHIP	★★★	Not applicable	★★★	★½☆	★★★		✓	✓
Sea level gauges - GLOSS	★★½	★★☆	★★★	½☆☆	★★☆	✓	✓	
Time series sites - OceanSITES	★★☆	Not applicable	★★½	★☆☆	★★☆		✓	✓
Coastal Moored buoys – DBCP	★★★	★★★	★★★	★☆☆	★★½	✓	✓	✓
Tsunami buoys - DBCP	★★½	★★★	★★★	★★☆	★★★	✓		
Tropical moored buoys - DBCP	★★½	★★★	★★★	★★★	★★☆	✓	✓	✓
HF radars	★½☆	★½☆	½☆☆	½☆☆	★★★	✓	✓	
Drifting buoys - DBCP	★★★	★★½	★★½	★★½	★★★	✓	✓	
Profiling floats - Argo	★★★	★★★	★★★	★★★	★★½	✓	✓	
Deep & biogeochemistry floats - Argo	★½☆	★★½	★★½	★★★	★★☆	✓	✓	✓
OceanGliders	★½☆	★★☆	★☆☆	★★☆	★★☆	✓	✓	✓
Animal borne sensors - AniBOS	½☆☆	★☆☆	★★☆	½☆☆	★★☆	✓	✓	✓

Existing GOOS Networks

SMART Cables

2024: SMART Cables is a GOOS Emerging Network

GOOS Report Card 2023

ITU/WMO/UNESCO-IOC JTF SMART Cables

JTF SMART Cables has positive impacts:

- Improve earthquake and tsunami early warning
- Reducing time to activate national protocols with better event location parameters and in situ sea surface elevation, and to evaluate the cancellation/updates
- Improve the Global Ocean Observing System with new long-term data
- Improve the understanding of ocean currents and heat content and sea level rise for climate change.
- Improve cable integrity – cables no longer “deaf, dumb and blind”
- Provide finance opportunity to the country for research.
- Legal and regulatory

Opportunities

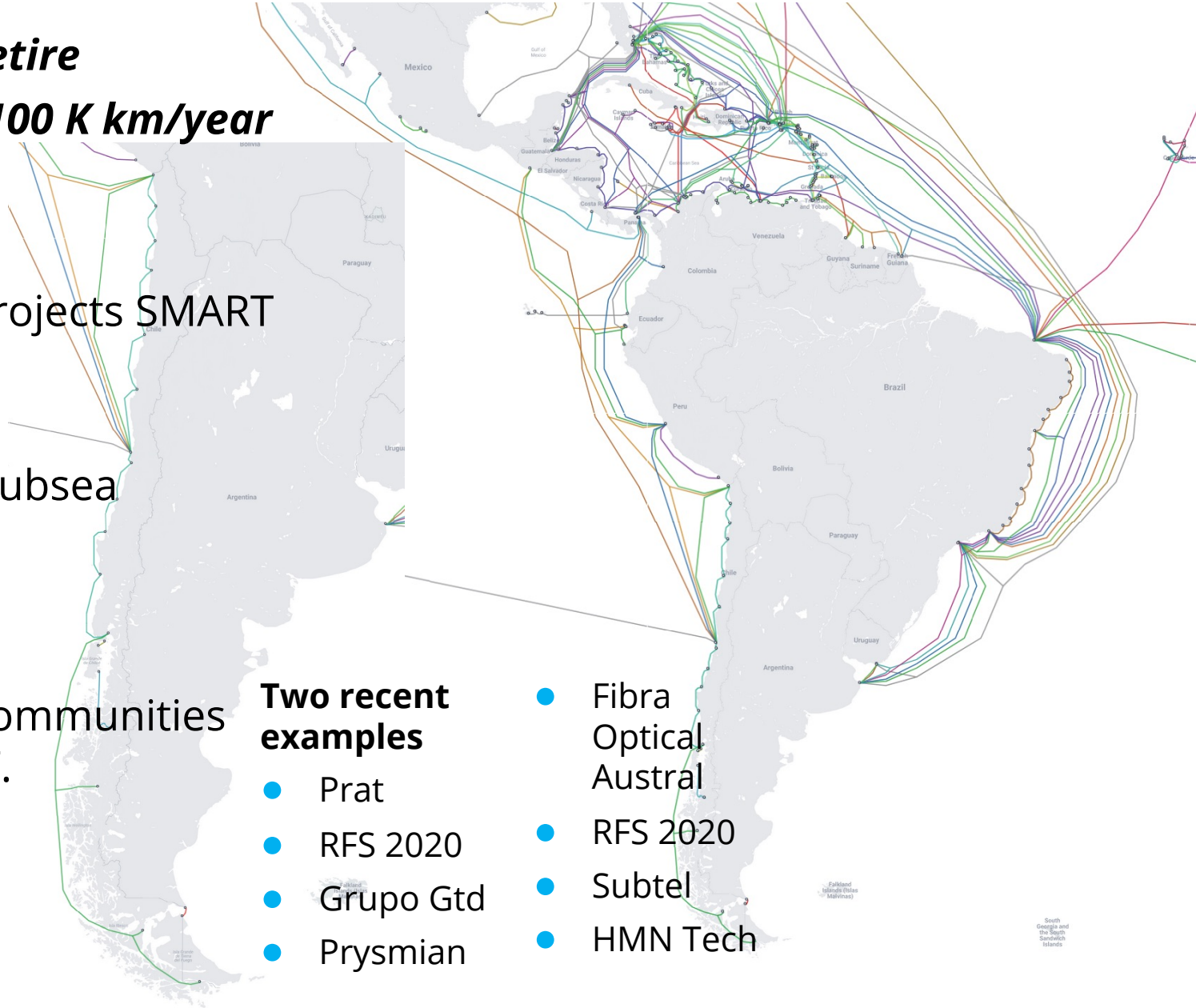
- ***Cable system design life 25 years - retire***
- ***Always new cables, new routes ~50-100 K km/year***
- ***Future cable possibilities globally***
- Working to include SMART capability
- Let's work together to make future projects SMART

What can we do?

- Dialogue between government and subsea telecom industry
- Address mutual benefits between all stakeholders to promote SMART
- Engage local science and academic communities with the global perspective of SMART.

An old cable

- South America Connect, installed 2000, due for replacement



Two recent examples

- Prat
- RFS 2020
- Grupo Gtd
- Prysmian

- Fibra Optical Austral
- RFS 2020
- Subtel
- HMN Tech

SMART and Tsunami EW Training

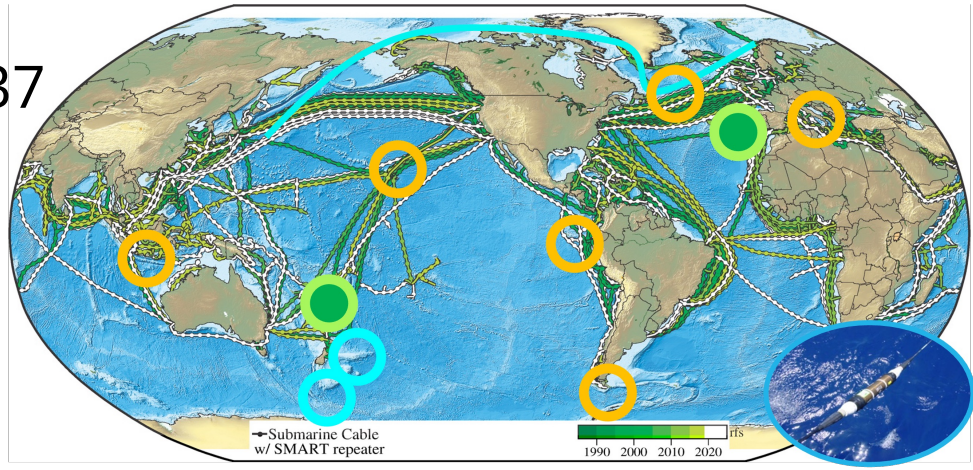
- Warning systems are constantly evolving.
- To achieve the UD Decade Goals (e.g., 5-10 minute warning) and EW4All, need new technology
- Standard Operating Procedures (SoPs) must evolve in parallel to account for new technology and the associated improvement in the warning and cancellation process.
- Warning staff should understand the strengths and weaknesses of the various observing components, and downstream ramifications.
- “Continuing education” essential

Concluding Remarks

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

Create a Planetary sensor, power, Internet network

- SMART – marriage with telecom – connectivity, climate, DRR – three for the price of one – saves on all fronts
- Anticipated additional 1.3 Gm of cable in water by 2037
- Leverage annual investment ~ $ 5 Billion
- 25+ year life, highly reliable, low lifetime cost
- Recent successes – set precedents for future systems
- EU Funding: Cables w/ SMART
- Working with GOOS, Tsunami, Ocean Decade, DOOS, RENs
- Challenges: $, data, permitting, legal, security, …
- Think globally, act locally!
- Good opportunity for Tsunami Programme to lead!



Saving Lives

Still much to achieve

SMART CABLES

GORDON AND BETTY MOORE FOUNDATION

Schmidt Marine TECHNOLOGY PARTNERS

SMARTCables.org

ITU/WMO/UNESCO IOC Joint Task Force

Scan to Join!