Observing the Ocean and Earth with

SMART CABLES

SMART Cables: Update and Tsunamis

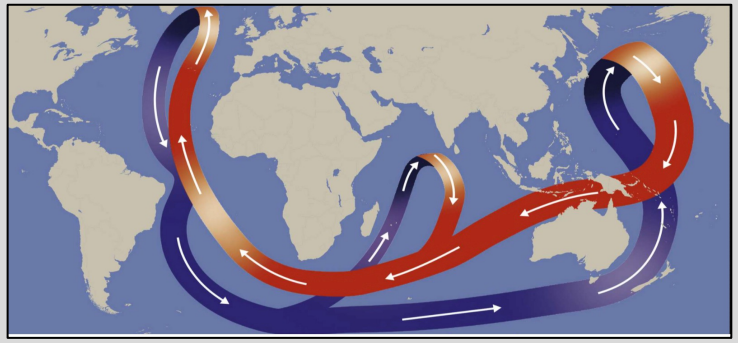
Bruce M. Howe
JTF SMART Cables Initiative
International Programme Office
University Hawai'i at Mānoa

ICG/PTWS Steering Committee
18 September 2024
Honolulu, Hawaii

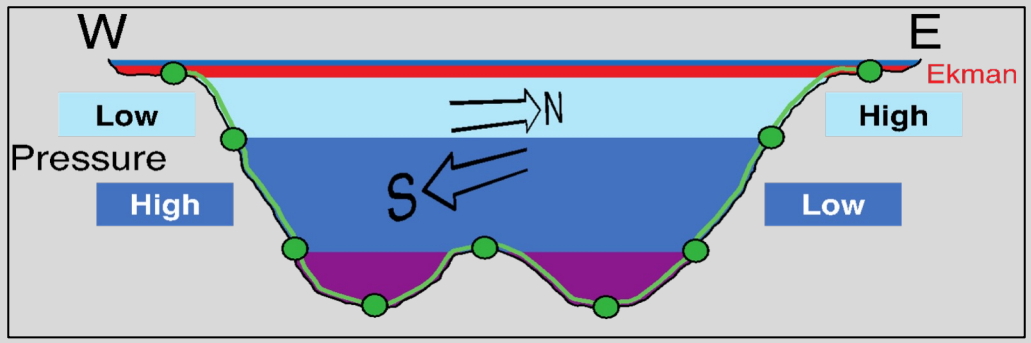
ITU/WMO/UNESCO-IOC JTF SMART Cables

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

Ocean general circulation – all scales

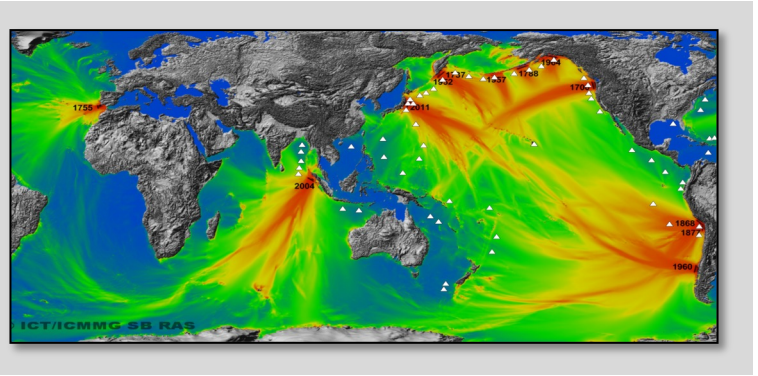


Climate Change



Ocean heat and circulation

Earthquakes and Tsunamis



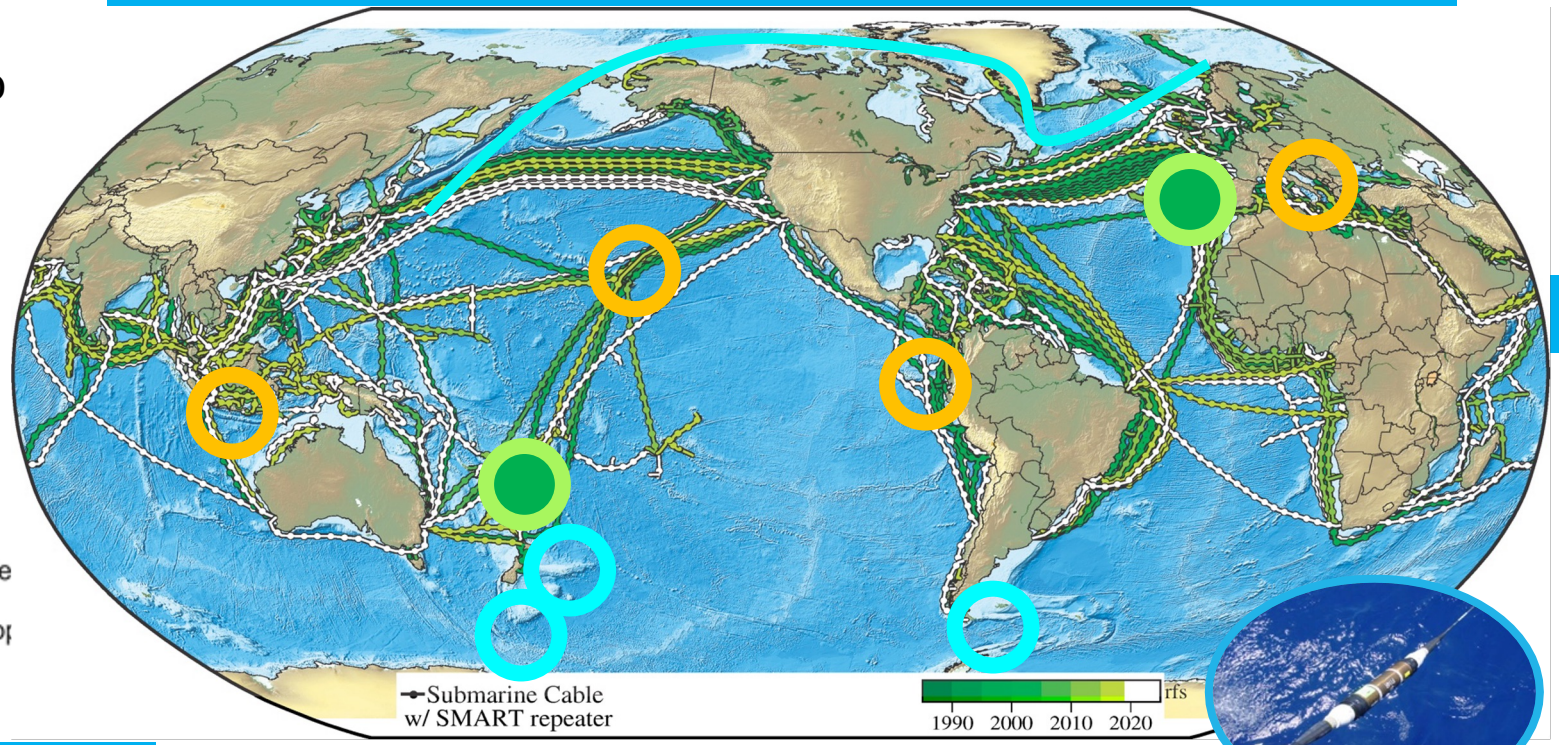
Sea Level Rise

Climate Change and Disaster Risk Reduction

Global Array for 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

repeaters ~100 km

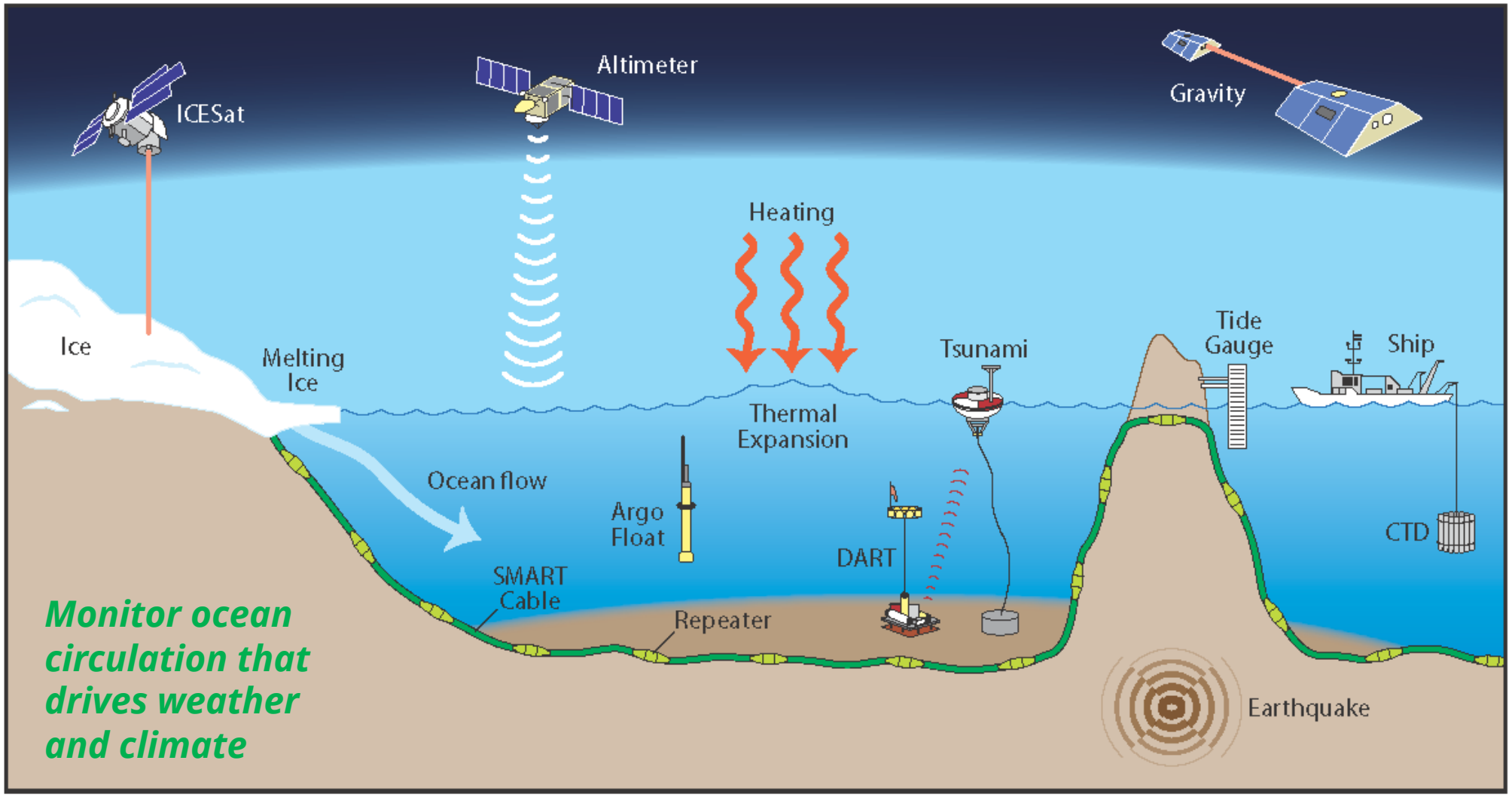
2021 2030 United Nations Decade of Ocean Science for Sustainable Develop

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

Know the environment protect the network

Bottom temperature, pressure, seismic motion

Ocean + Climate change – Long term Observation



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

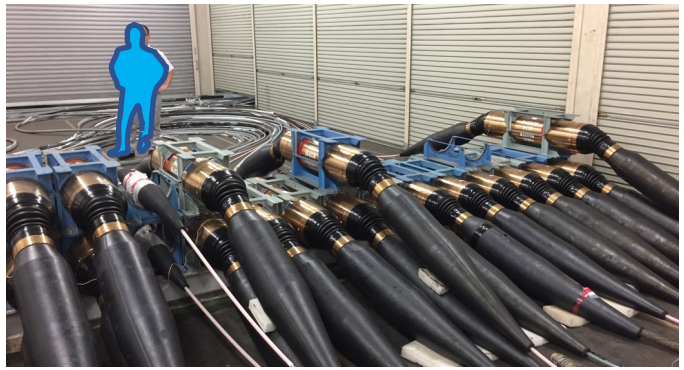
SMART Technical Solution

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

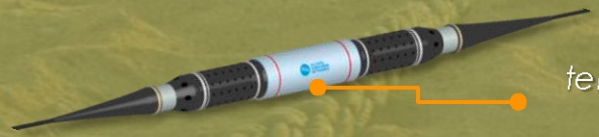
Scientific observation
- Sea bottom movements
- Sea level rise
- Slow drift of sea bottom temperatures
- Sea water currents by temperature & pressure combination

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*

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☆☆	★★☆	✓	✓	✓

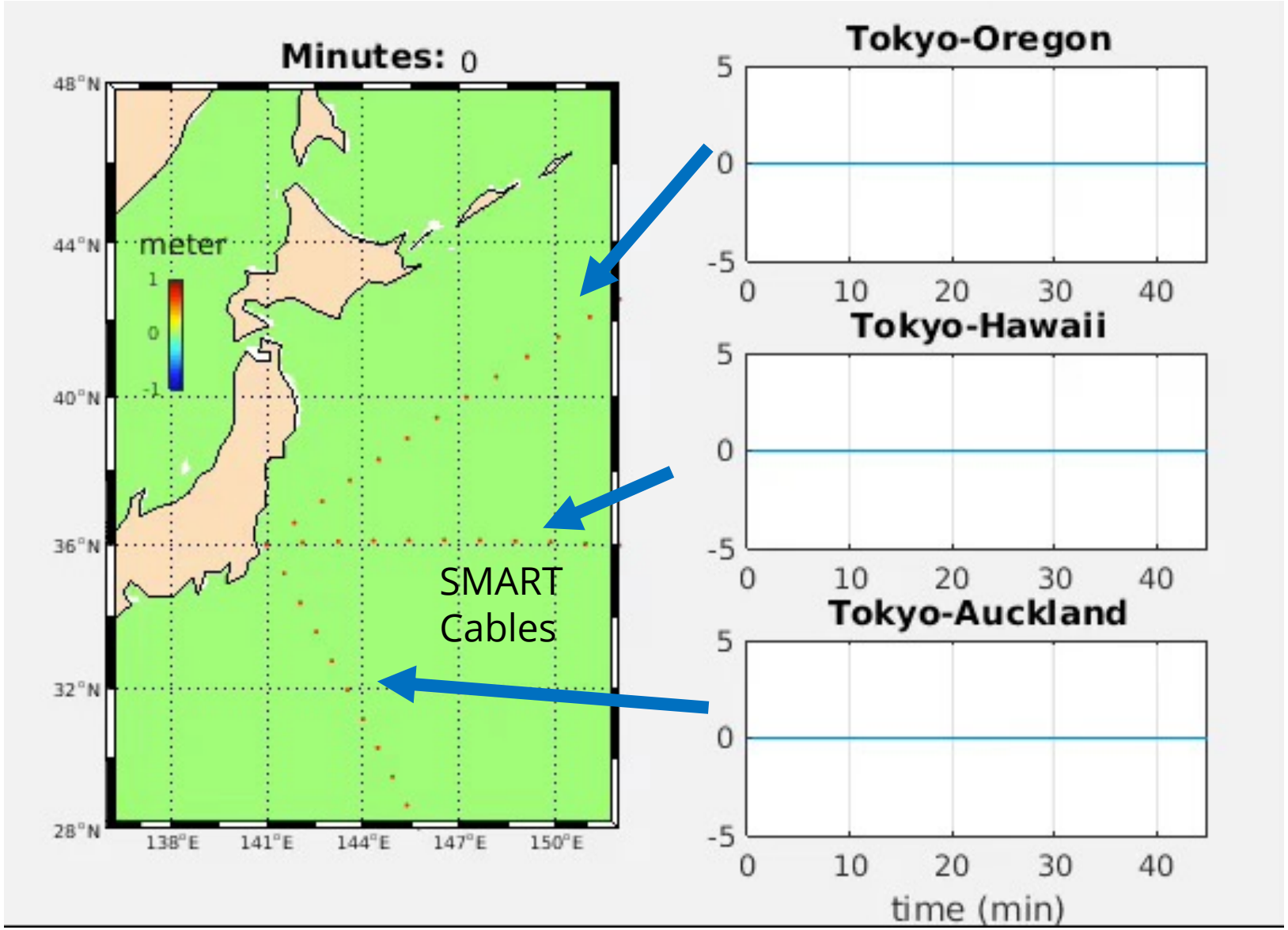
Existing GOOS Networks

SMART Cables

2024: SMART Cables is a GOOS Emerging Network

GOOS Report Card 2023

Simulation – Tsunami Detection



Each dotted line represents pressure and seismic sensors along cable

Realtime!

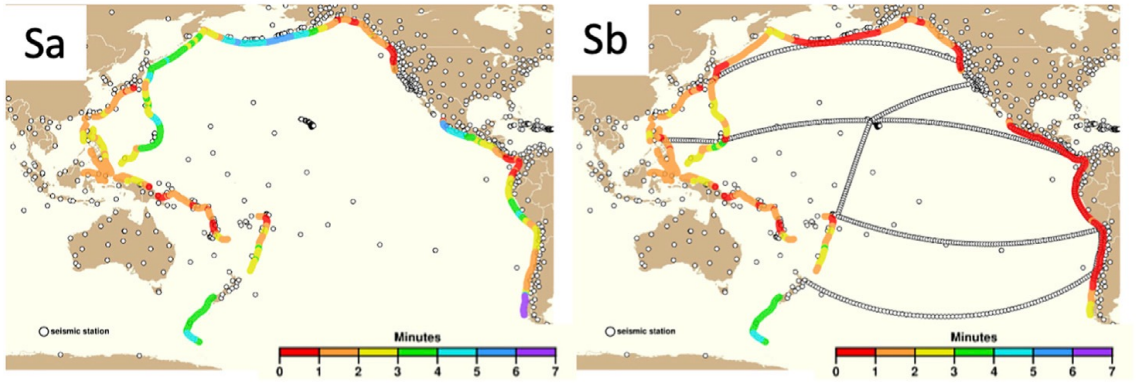
Reliable!

In situ

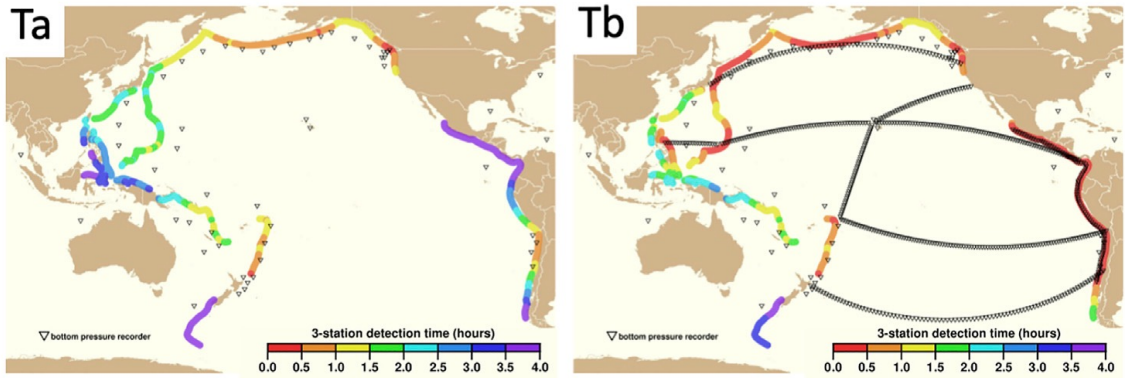
Tony Song,
JPL/CalTech

Earthquake and Tsunami Warning

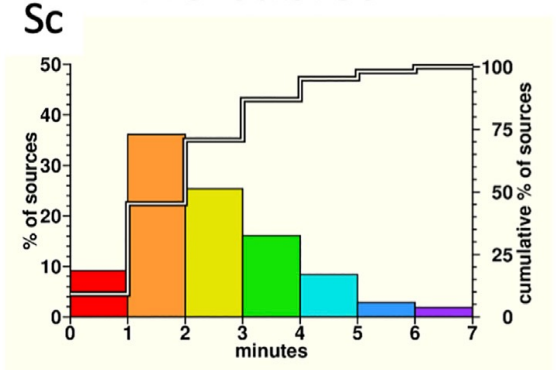
Seismic



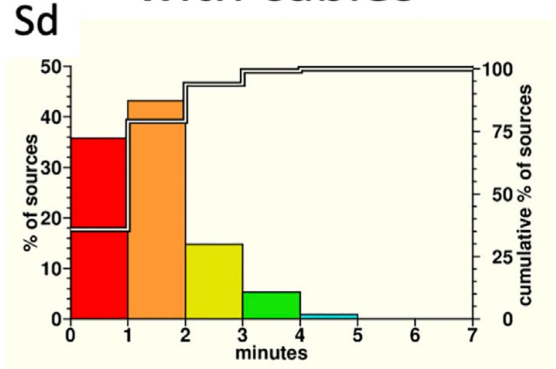
Tsunami



No cables

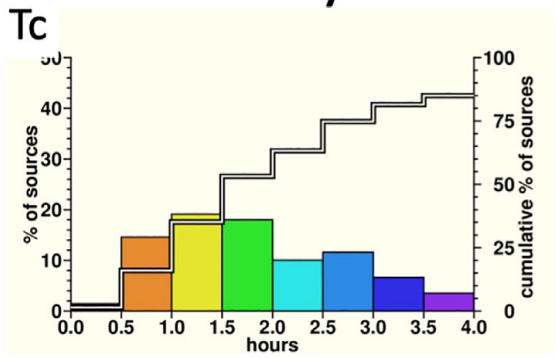


with cables

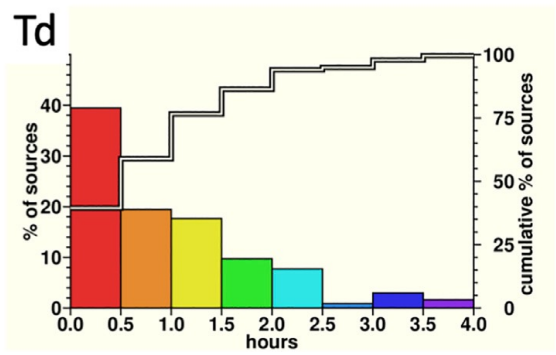


0 - 7 minutes

BPR only



with cables



0 - 4 hours

Simple travel time calculations, assumed source locations (trenches)

Nate Becker, PTWC

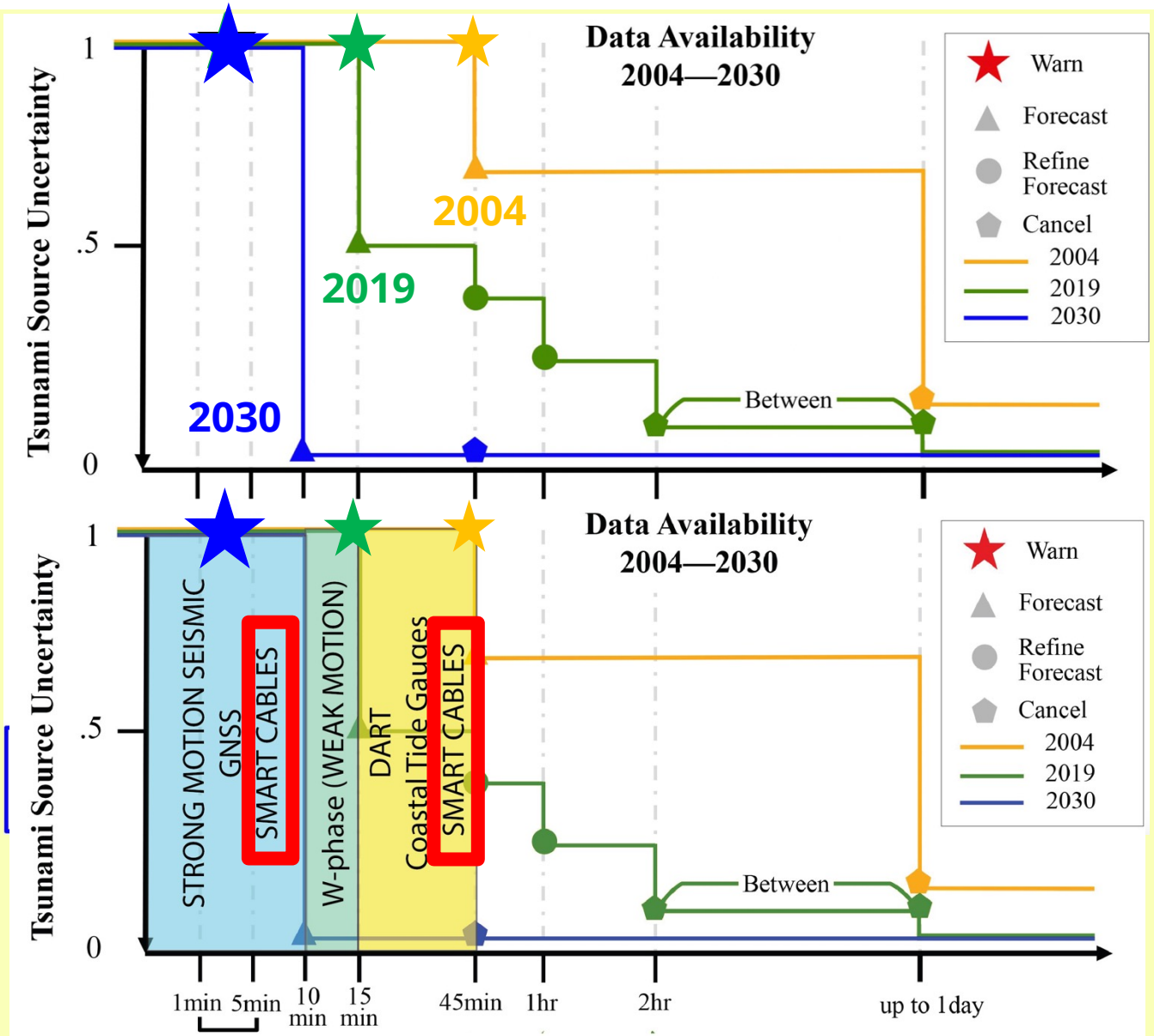
Earthquake detection time reduced
2.44 to 1.42 min, ~42%.

Time dropping from
2.4 to 1.0 h, ~ 57%

Improvement in Early Warning (SMART, GNSS)

UN Ocean Decade Goal:

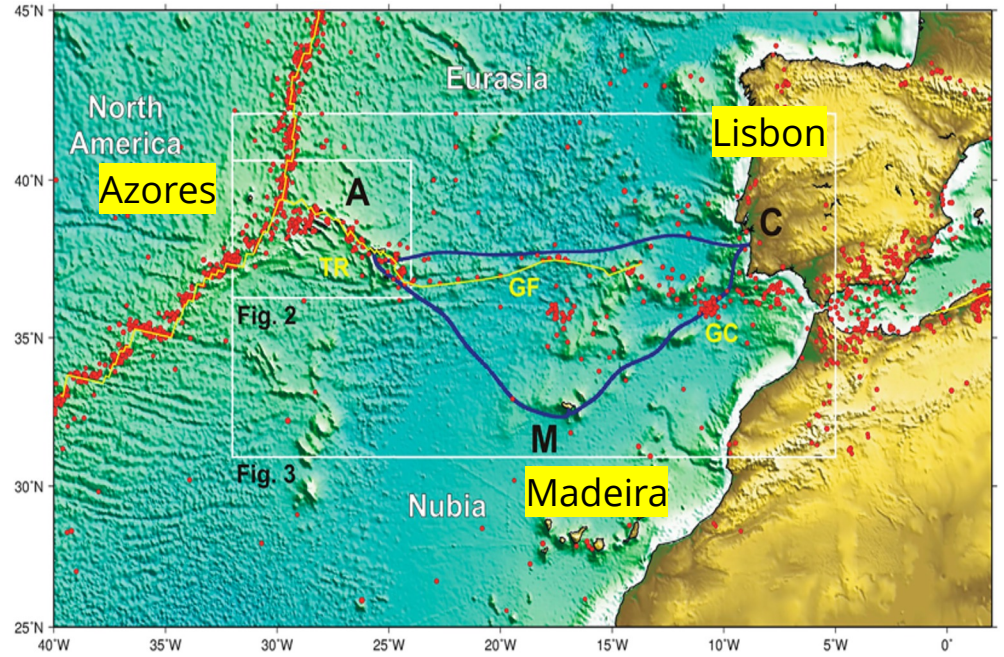
Integrate SMART Cable technology into innovative early warning systems



2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Funded SMART Cable Systems

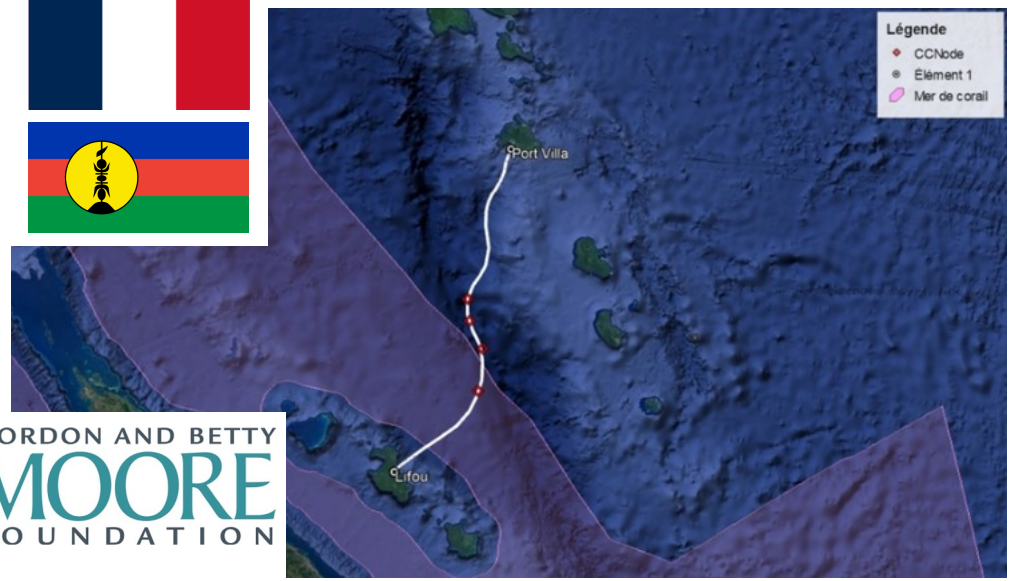
Portugal SMART Atlantic CAM



- 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



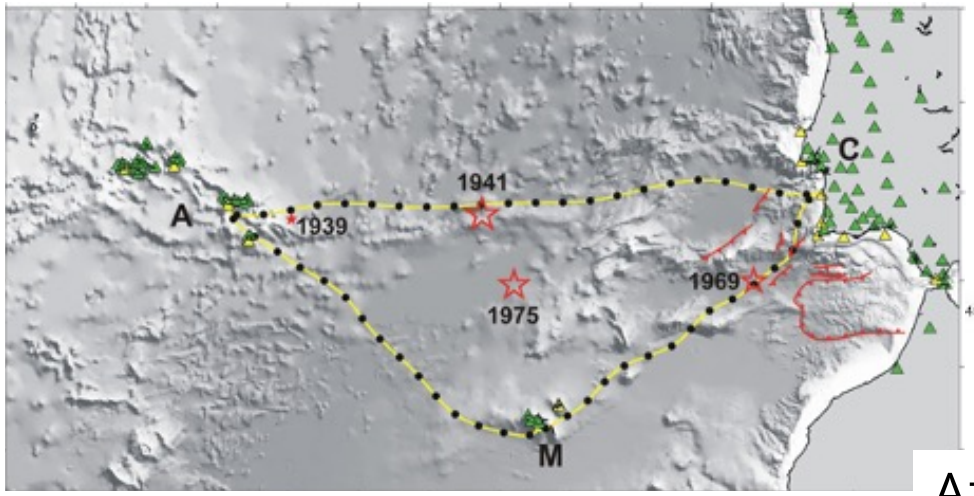
GORDON AND BETTY MOORE FOUNDATION

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

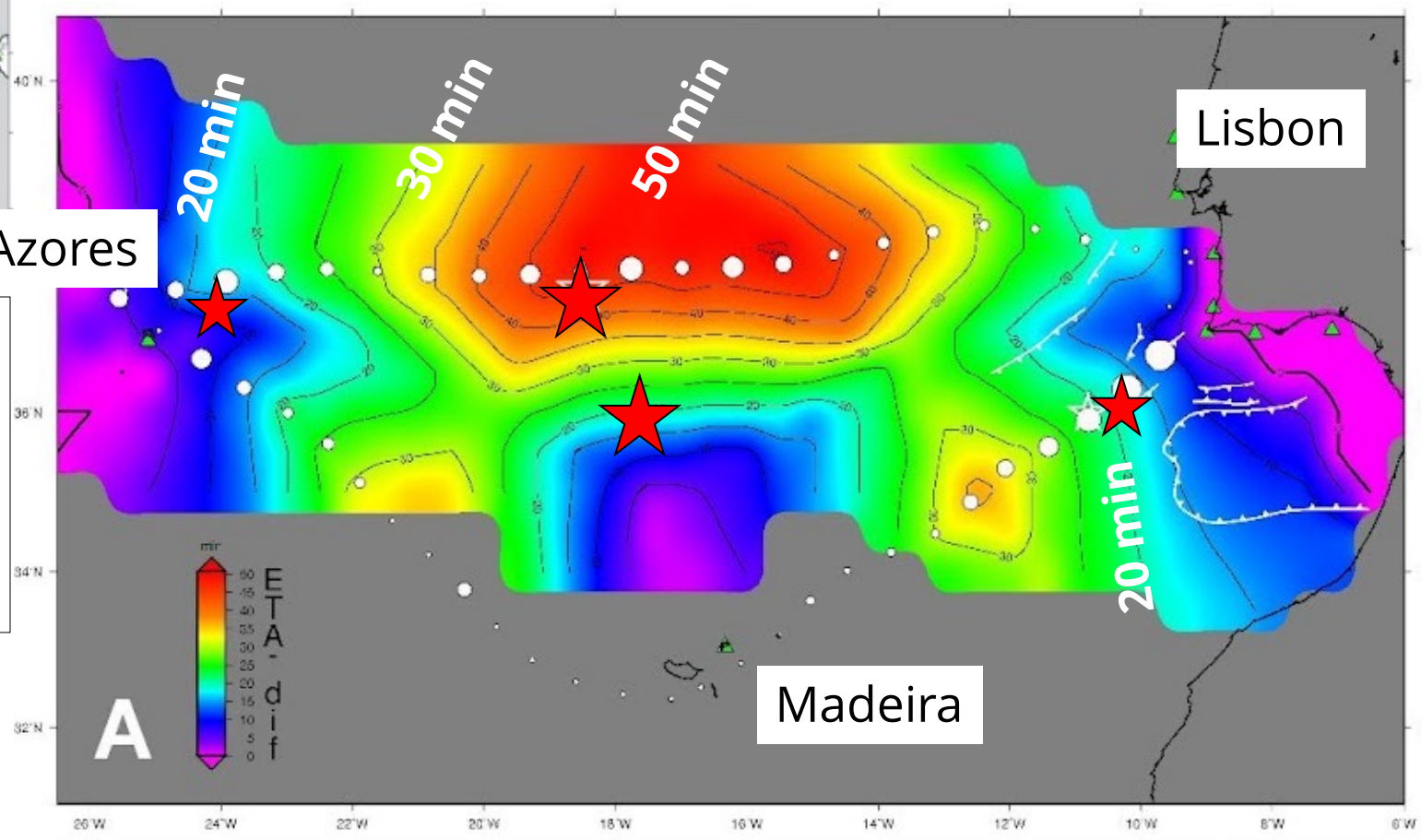
- 25+ year life, reliable, low lifetime cost
- Leverage $5B/y industry, 170 y

Optical Fiber Sensing in both

Portugal – Continent/Azores/Madeira (CAM)



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



CAM submarine cable (SMART repeaters every ~70 km)

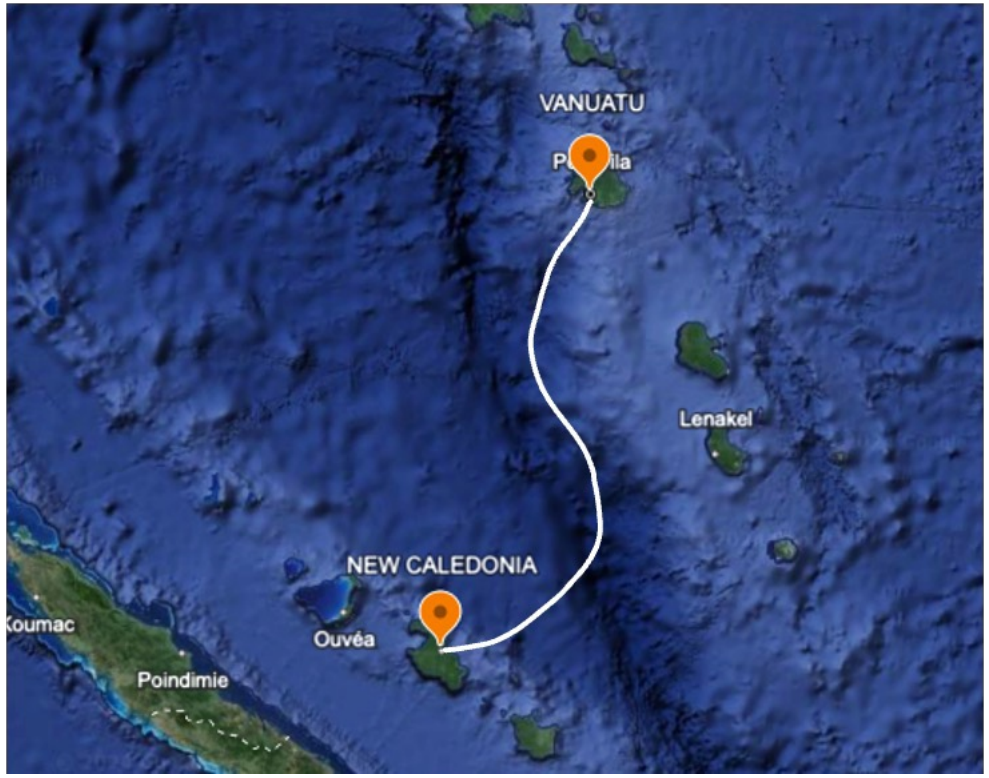
Green triangles - seismic stations (Instituto Português do Mar e da Atmosfera (IPMA)

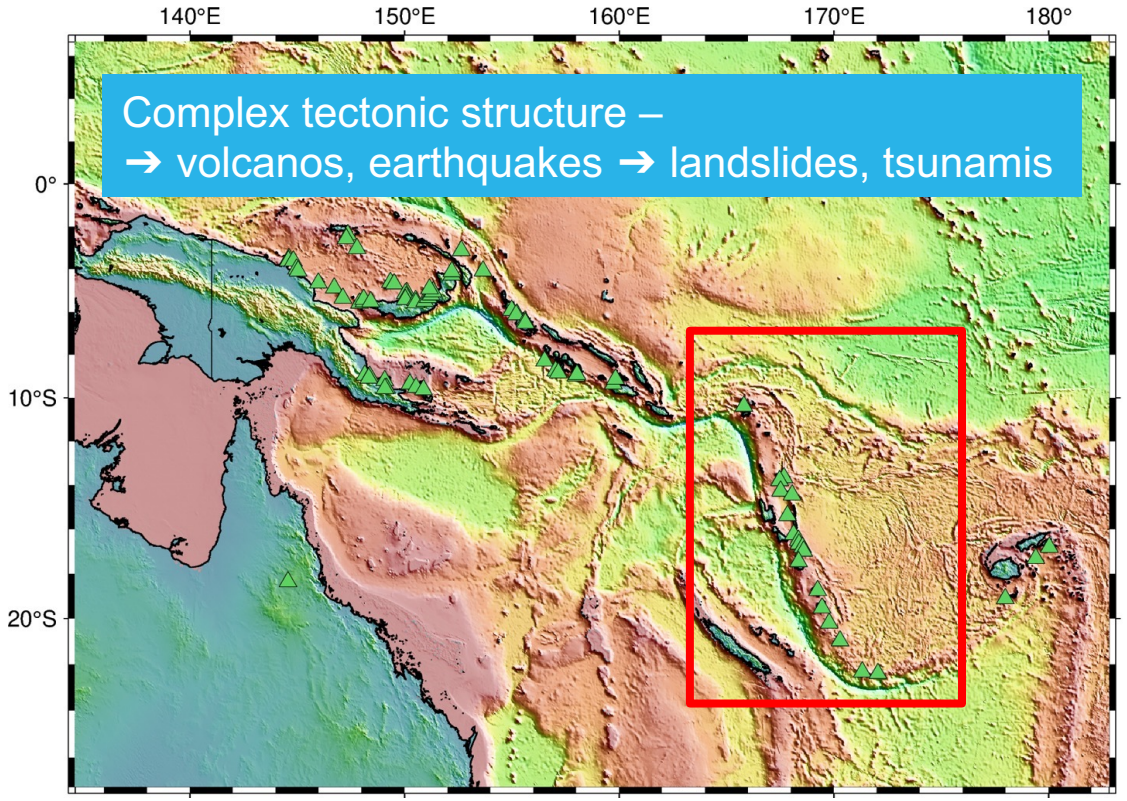
Yellow triangles - coastal tide-gauges monitored (IPMA)

Red stars - M > 7.7 large tsunamigenic earthquakes

LEA; Matias et al., 2021

Tamtam SMART Cable System

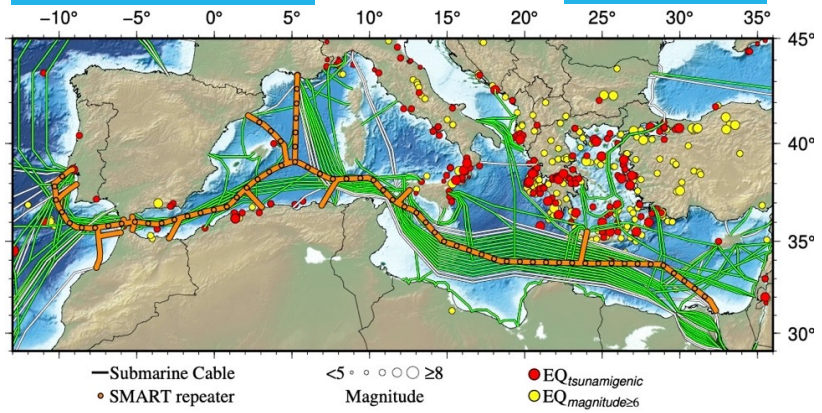




Vanuatu – more natural disasters than any other country
– typhoons, earthquakes, tsunamis, and volcanos – significant sea level rise.
SMART crucial to improve understanding and earthquake and tsunami EW.

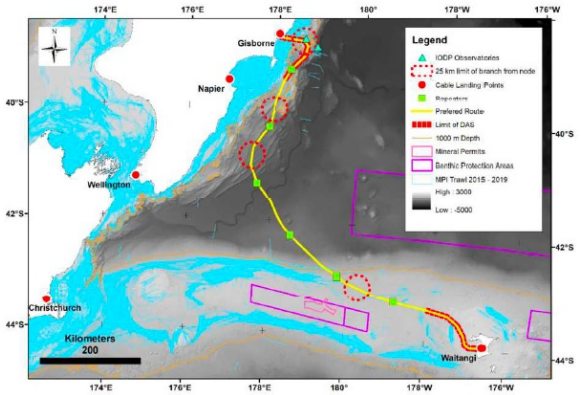
Systems in Play

Medusa



MISTS

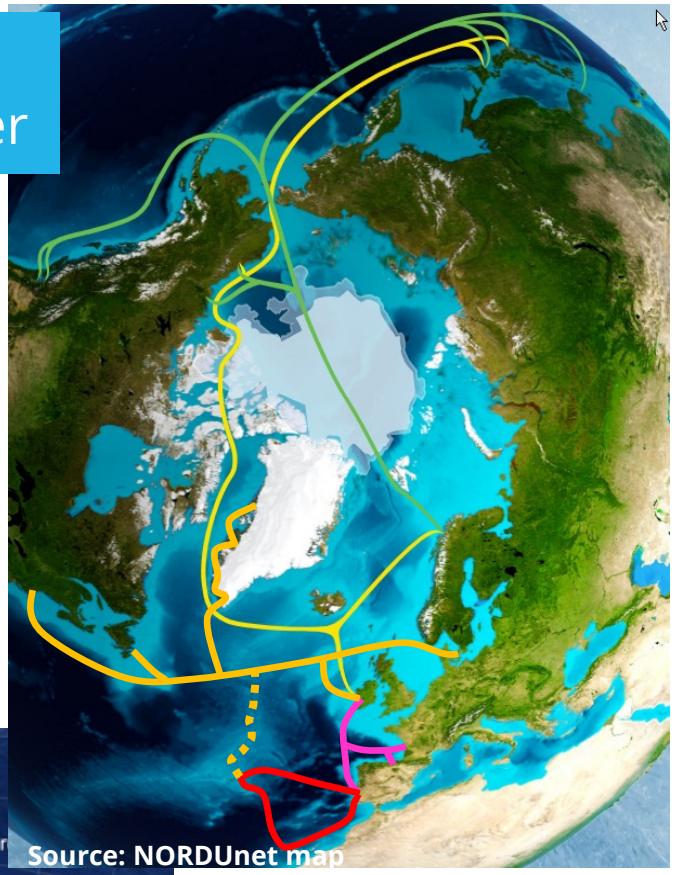
NZ - Chathams



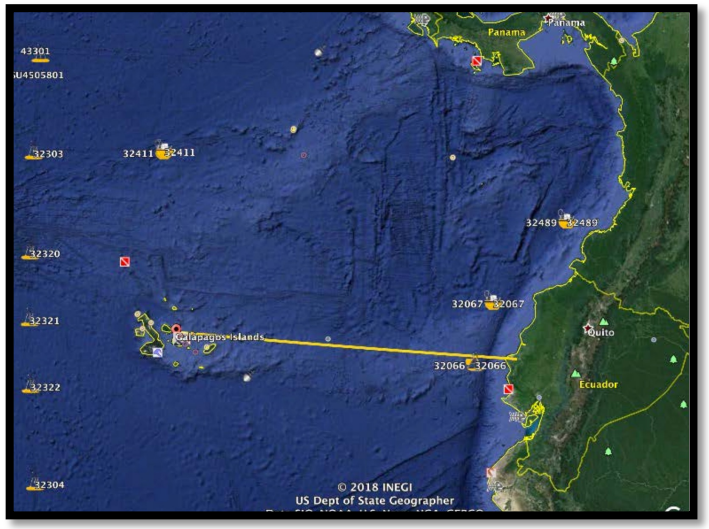
Polar Connect
Far North Fiber

Pisces
CAM

4 October
Lisbon!

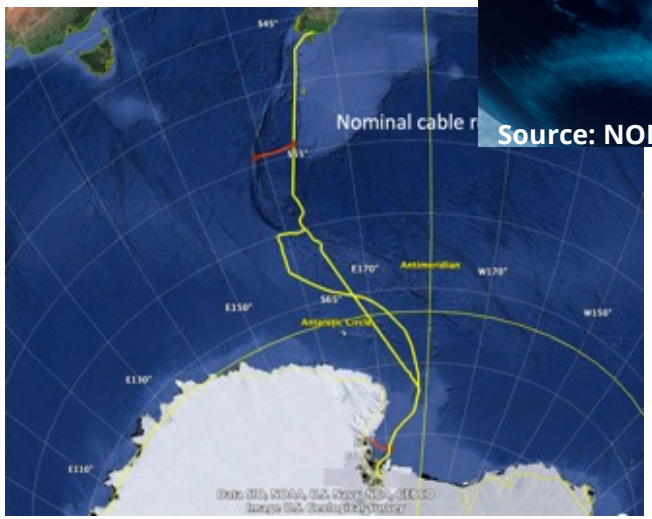


Galapagos



Antarctica Chile

Antarctica US



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 tsunami wave height, 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 (El Niño, coastal).
- Improve cable integrity – cables no longer “deaf, dumb and blind”
- Provide finance opportunity to the country for research.
- Legal and regulatory

Peru and SMART – CPPS 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.

Joint with South East Pacific Working Group, IOC ICG/PTWS

English version not yet distributed by IOC

Recommendations and Opportunities

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

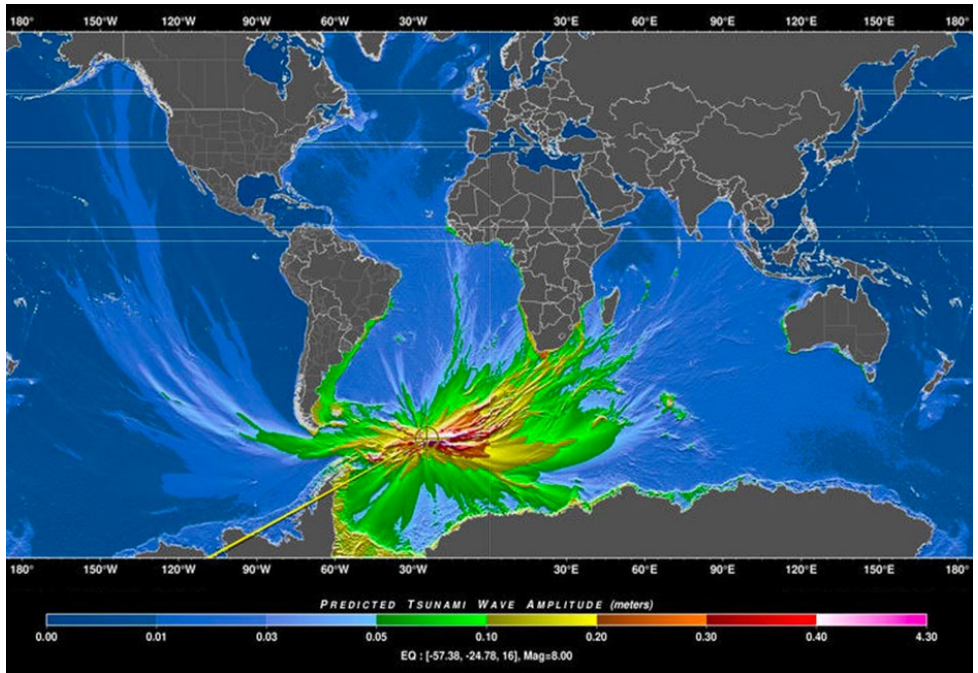
SMART = telecom + science/EW

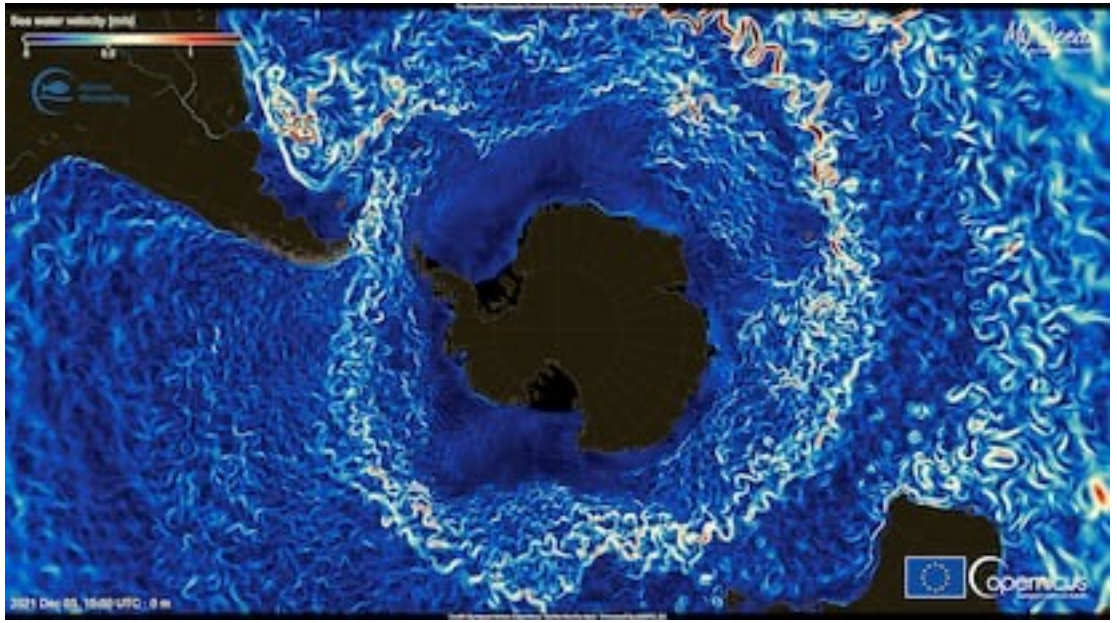
Report – in process – editing and translate

Drake Passage - Antarctica

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

MUST be International!





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

ICG/PTWS

Points:

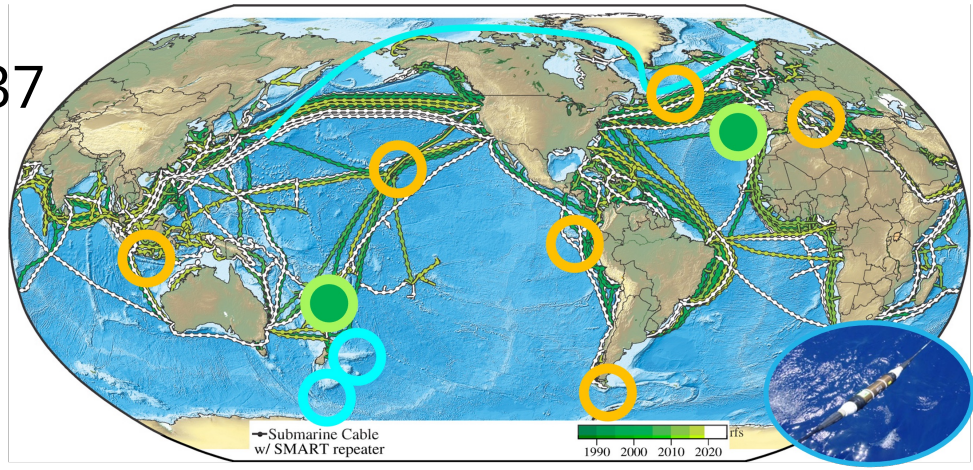
- What are TRL levels for “existing” and “innovative” - Time to operational status? SoPs?
- Essential - Framework for multi-sensor/data utilization and forecasting – synthetic and real data – reduce uncertainty
- Improve interaction with other ICG equivalent groups
- Request help with prospective systems – quantify benefits (e.g., SEPac trench, Galapagos, Drake Passage, AMOC, Indonesia, Vanuatu, Portugal)
- Request proactive IOC support from IOC and Tsunami approaching member states (e.g., circular letters)
- Improve interaction with GOOS – IOC and WMO
- Work with UN, IOC, WMO legal re international real time data availability

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
- Challenges: $, tech, data, permitting, legal, security, …
- EU Funding: Cables w/ SMART
- Working with GOOS, Tsunami, Ocean Decade, DOOS, RENs
- Think globally, act locally!
- Good opportunity for IOC leadership!



Saving Lives

Still much to achieve

SMART CABLES

ICG/PTWS Steering Committee
18 September 2024
Honolulu, Hawaii

SMARTCables.org

ITU/WMO/UNESCO IOC Joint Task Force

Scan to Join!

Danke Gracias Thank you Merci Tankyu tumas
Arigatō Xièxiè Terima kasih Takk Grazie
Mālō 'aupito Kop koon Salamat po S' efharistó