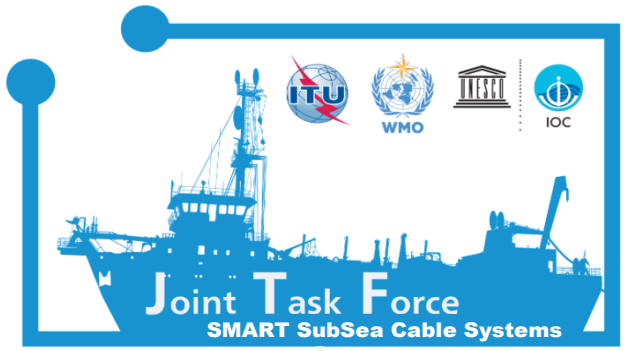
SMART Subsea Cables for Observing the Ocean and Earth:

Update for TT TWO

SMART: Science Monitoring And Reliable Telecommunications



Bruce M. Howe
ITU/WMO/IOC Joint Task Force
University of Hawai'i at Mānoa

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

TOWS-WG Task Team on Tsunami Watch Operations (TT TWO)
21-22 February 2022

SMART, Tsunami, and IOC

PLAYERS

ITU WMO UNESCO-IOC Joint Task Force SMART Subsea Cables
UNESCO-IOC Tsunami Program, TOWS-WG
UNESCO-IOC ICG/PTWS, ICG/NEAMTWS, ICG/IOTWMS, ICG/CARIBE-EWS
UNESCO-IOC Global Ocean Observing System (GOOS)
UN Decade for Ocean Science for Sustainable Development 2021-2030

IOC Dec A-31/3.4.1: Warning Mitigation Systems for Ocean Hazards (July 2021)

- Decides that the Draft 10-Year Research, Development and Implementation Plan for the UN Decade Tsunami Programme is dedicated to achieving transformational advances in tsunami detection, measurement and forecasting, including tsunamis generated by non-seismic sources. The programme includes the following focus areas related to tsunami warning capabilities:
- **… deploy new technologies to address observational gaps** that cannot be covered by existing networks embracing. This would include the **widespread implementation of scientific instrumentation on deep-ocean telecommunications cables as developed by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF) SMART Subsea Cables effort**; and submission of a Programme to the UN Decade of Ocean Science for Sustainable Development;

SMART, Tsunami, and IOC

Inclusion of SMART Cables in the 10-Year Research, Development and Implementation Plan for the UN Decade Tsunami Programme.

via

The IOC Tsunami Programme Science Committee (SC) is developing this plan, to deliver to TOWS-WG XVI in February 2023.

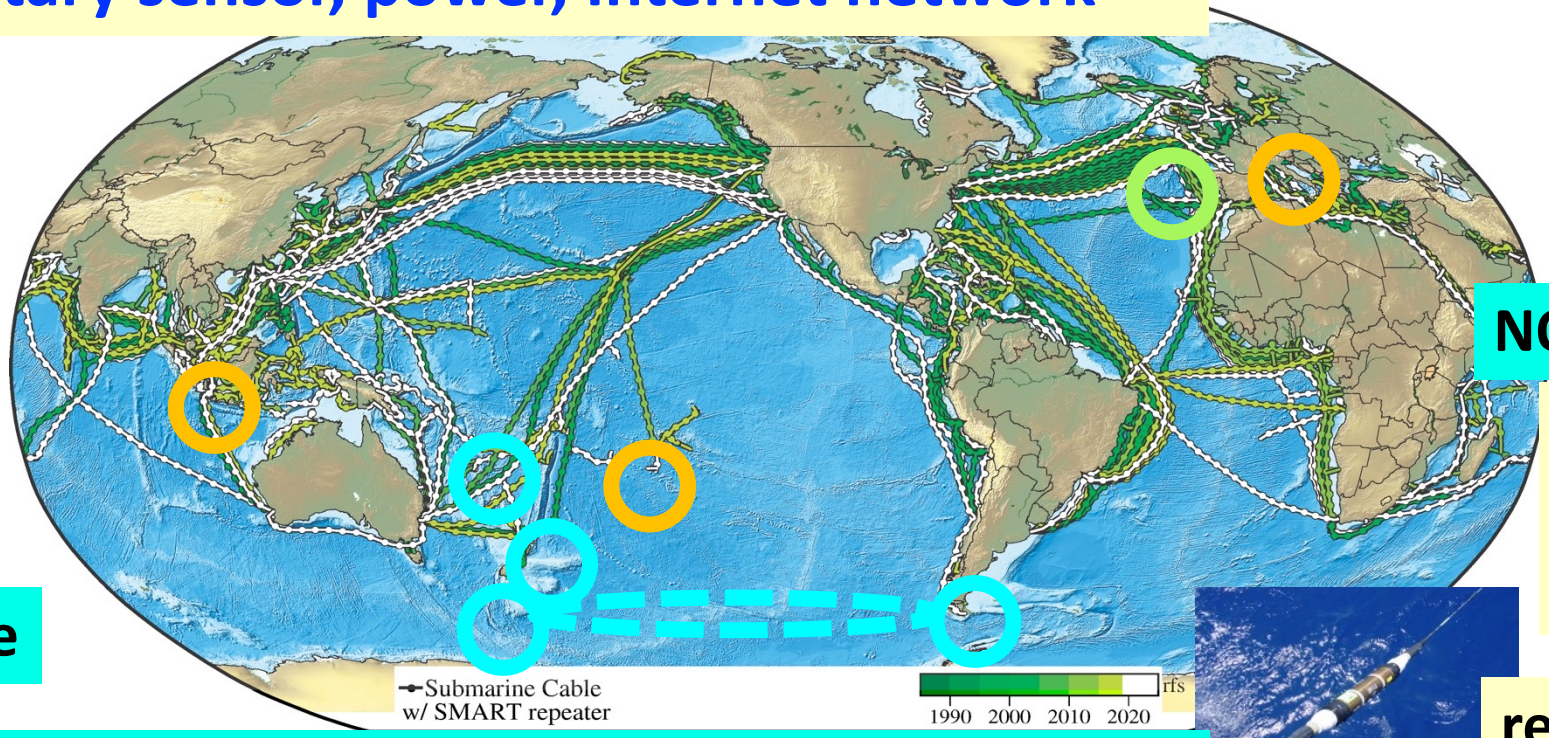
Assuming endorsed, TOWS-WG will present to the IOC Assembly in June 2023.

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

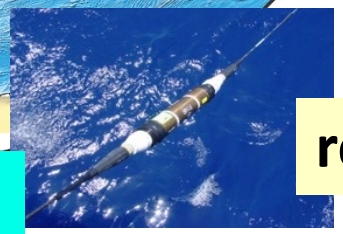
↓€$

NO Interference

1.2+ Gm

~20,000 repeaters

20 year refresh



repeaters ~70 km

UN Decade

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Know the environment – protect the network

CAM: 3700 km, Gov't, install 2025 ➜ SMART Continent/Lisbon-Azores-Madeira ring

Bottom temperature, pressure, seismic acceleration

WMO

ITU

L'alerte précoce de tsunami : des programmes déployés à partir de 2004

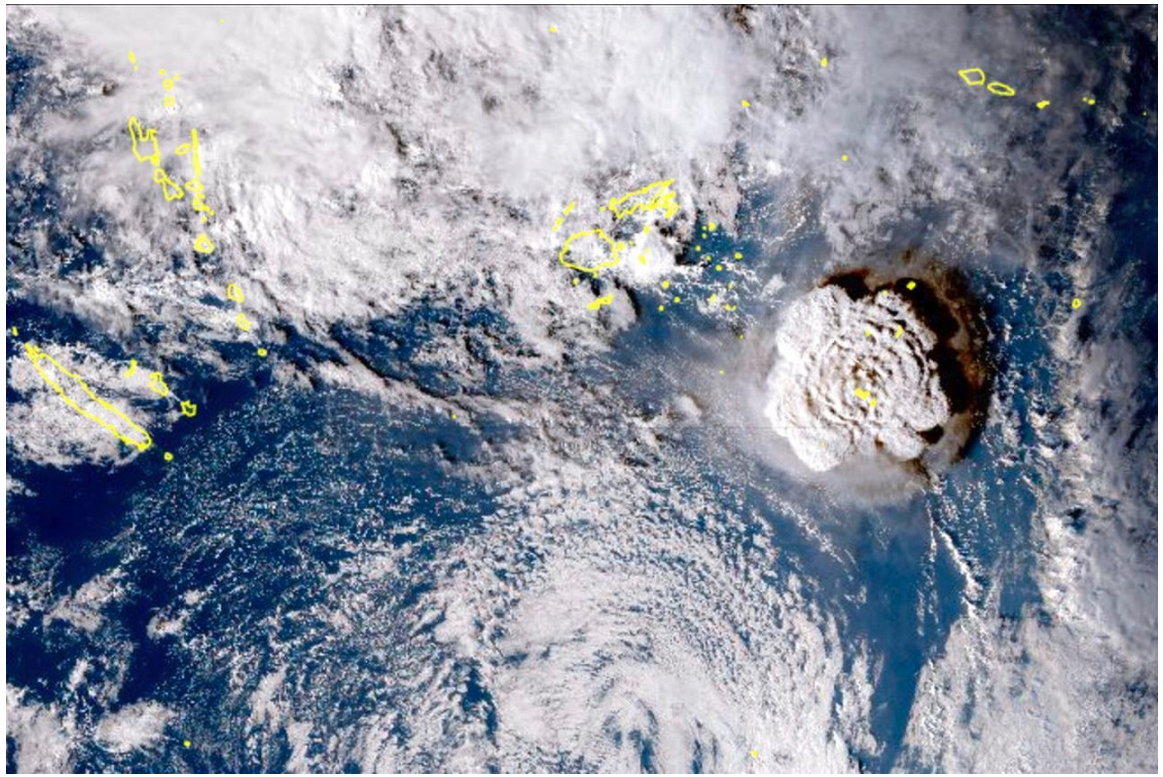
Place	Year	Mag	H (m)	Deaths
Chile	1960	9.5	25	6000
Alaska	1964	9.2	30	132
Mindinao	1976	7.9	9	7,800
Tumaco	1979	8.1	6	350
Hokkaido	1993	7.8	30	250
Papua New Guinea	1998	7.1	15	2200
Sumatra	2004	9.2	33	230,000
Solomon Island	2007	8.1	12	52
Samoa	2009	8.1	14	189
Maule, Chile	2010	8.8	3	525
Tohoku	2011	9.0	10	19,000
Palu	2018	7.5	7	~2000?

Le 26 décembre 2004 : magnitude de 9,1 - **l'océan Indien - 220 000 personnes** trouvent la mort dans plusieurs pays

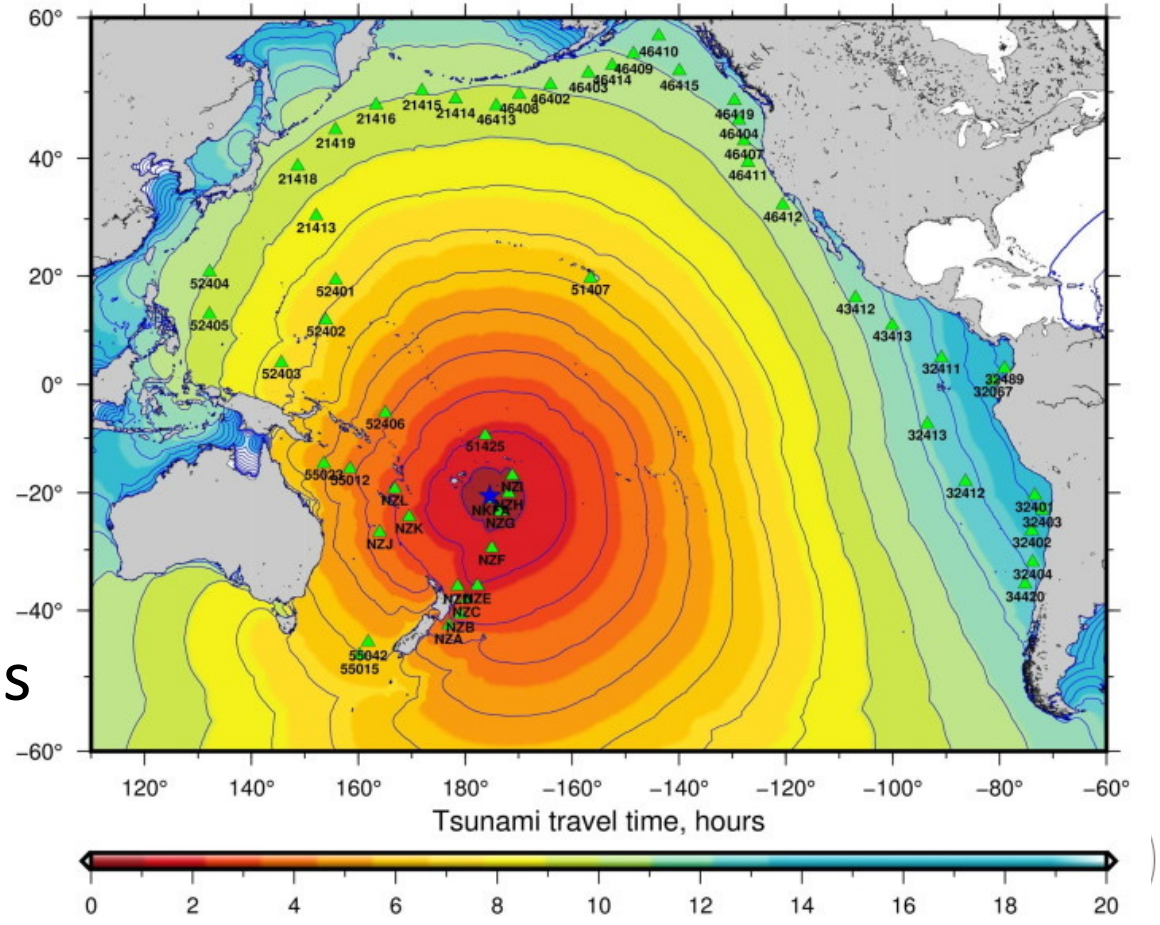
Le 11 mars 2011 : magnitude de 9 - **Japon** - 19 000 personnes périssent - inondation de la centrale nucléaire de Fukushima le **pire accident nucléaire** depuis celui de la centrale soviétique de Tchernobyl en 1986

From Alcatel Submarine Networks

Tonga Event



Global Scale

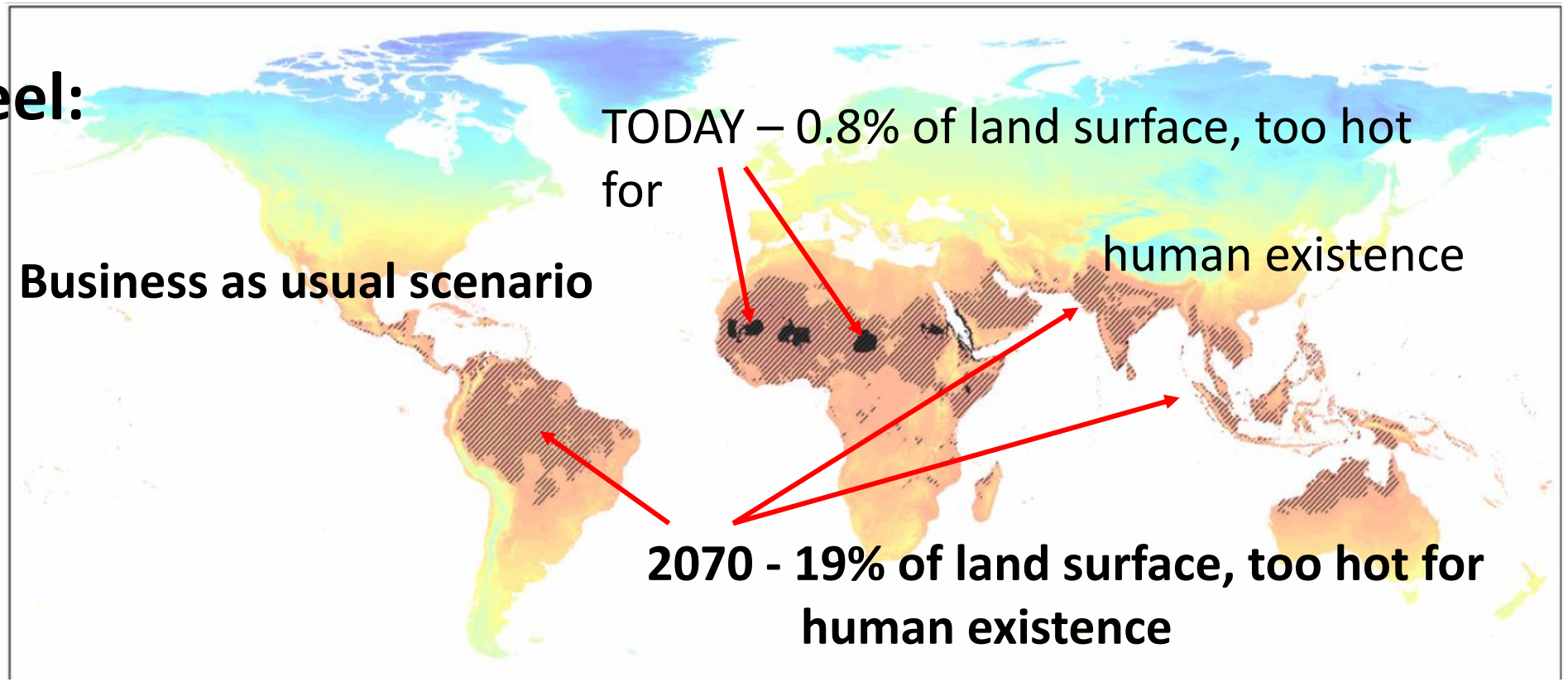


The earth is always presenting new surprises
– the unknown
Truly global network

Why SMART?

1 billion displaced for every 1°C of additional **global warming**

Ocean is Climate Flywheel: Stores Heat, CO2 Determines future Temperature



Xu, C., et al. (2020) Future of the human climate niche, *PNAS*, May 2020, 201910114; DOI:10.1073/pnas.1910114117

Courtesy C. Fletcher

Societal Benefits

Climate change – humanity's greatest existential threat

Societal and environmental issues

SMART: UN Decade of Ocean Science Project

Climate
SDG 13

– **Climate change** – ocean temperature, circulation
direct impact on societies, short and long term

Ocean
SDG 14

– **Sea level rise** – hazard for coasts, islands, cities

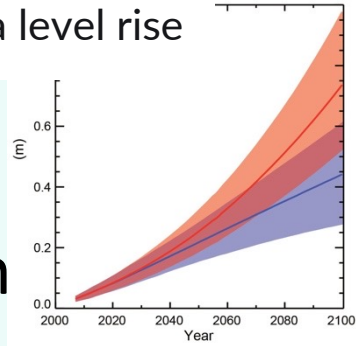
UN
DRR

– **Disaster Risk Reduction** – tsunami
and earthquake monitoring
throughout ocean basins and coastal margins

Infrastructure
SDG 9, 11

– **Societal Connectivity** – Enable progress with
resilient and sustainable telecom infrastructure

Sea level rise



Tsunami

UN Decade of Ocean Science for Sustainable Development 2021 - 2030

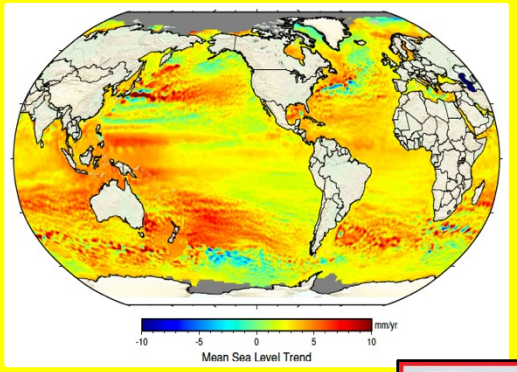
Challenge 5: Ocean-Climate nexus

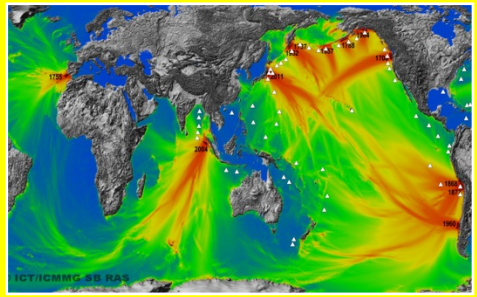
- Contribute to monitoring the atmosphere-ocean-climate-Earth system
- Ocean heat, circulation, time/space variability
- Secular changes of tidal coefficients

Lives and Infrastructure

Outcome 4: Predicted Ocean

Challenge 6: Early warning services





- Early warning earthquakes and tsunamis
- Mitigate coastal flooding, exacerbated by sea level rise.

Outcome 5: Safe Ocean

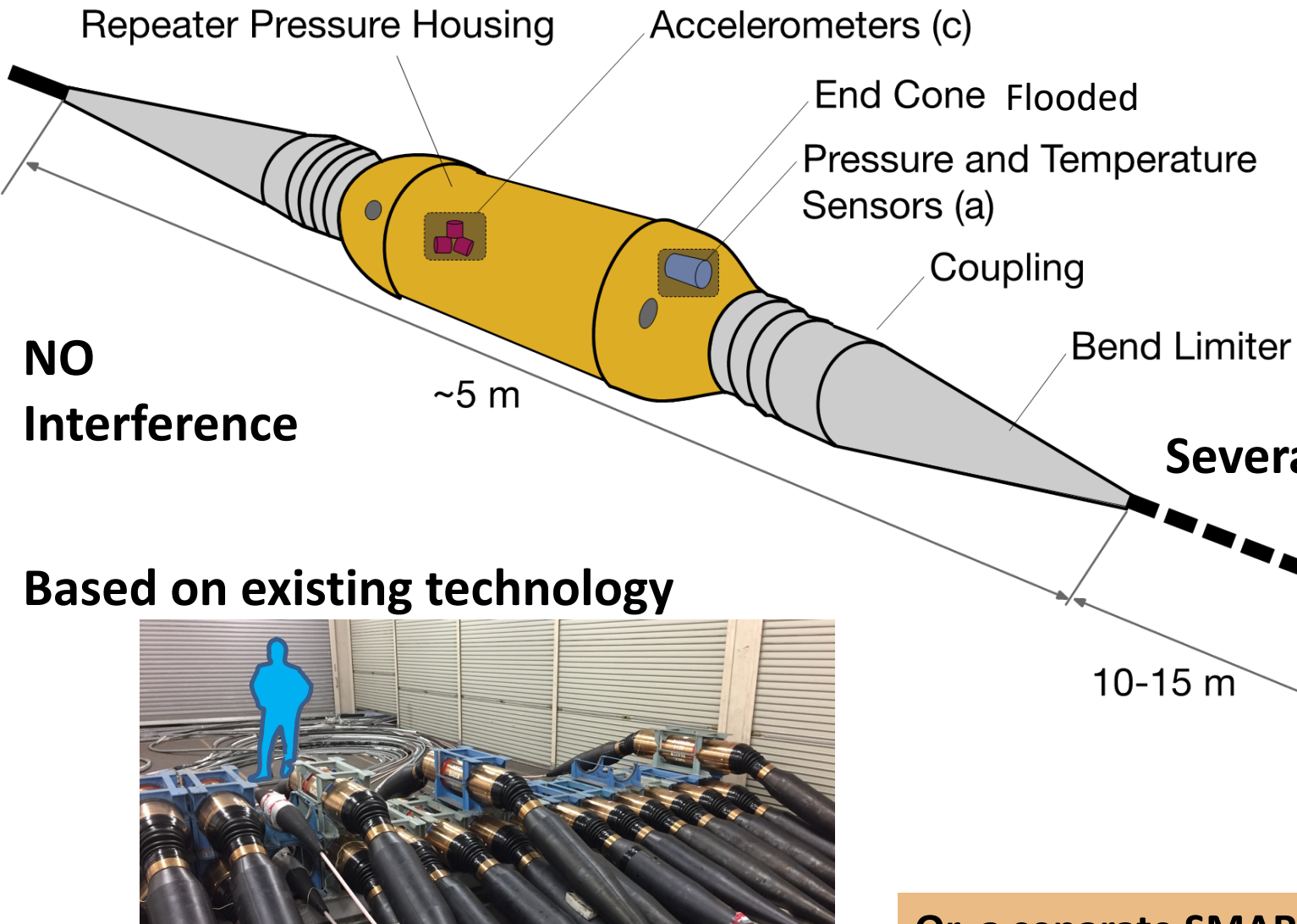
Challenge 7: Sustainable ocean observing system

- Absolutely!
- Potentially 1000s SMART repeaters
- Global, real time, long life, reliable, sustained, maintained, expandable

- QC'ed data to users
- Capacity building
- Programme office - all stakeholders

Outcome 6: Accessible Ocean

SMART Repeaters



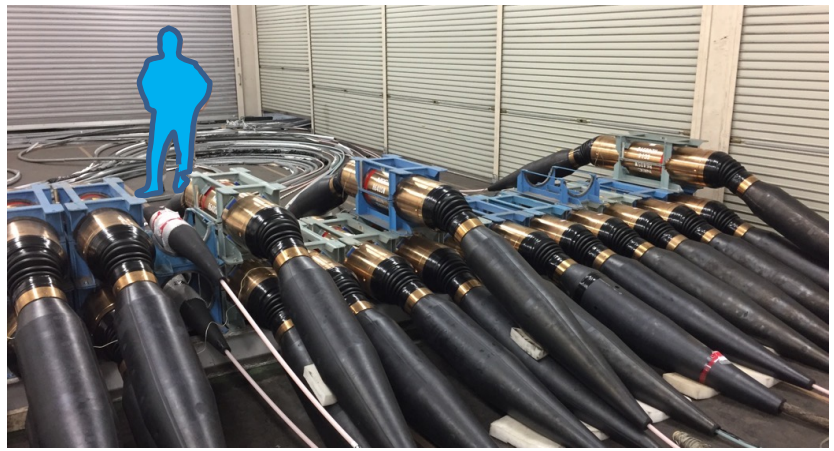
NO Interference

Several approaches

Subsea Data Systems
NSF SBIR - developing
Alcatel ASN will supply – Details TBD

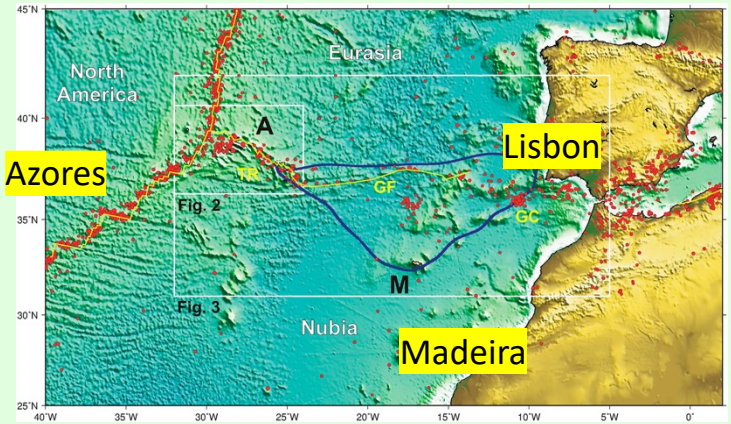
Temperature sensors

Based on existing technology



Or, a separate SMART repeater with Telecom fiber pass-through

SMART Cables - Europe



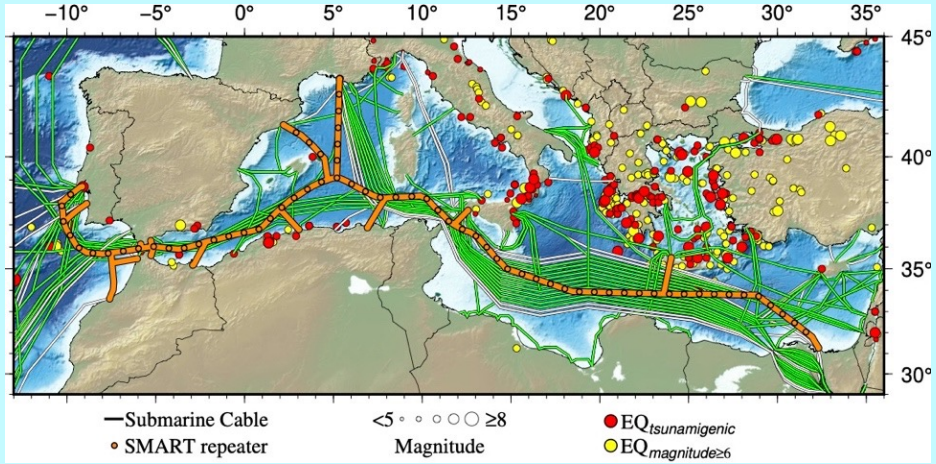
- **Wet Demo**, Install 2022
- Three test SMART repeaters (sans telecom)

- **CAM2**
- Domestic, international connections, Digital hub
- 1755 earthquake tsunami
- Seismic, tsunami, ocean, environment
- 3700 km, 50 SMART repeaters, €120M
- RFP 2022, Ready For Service 2025
- ANACOM connection to telecom

Risk analysis ((V. Silva, pers. comm.)

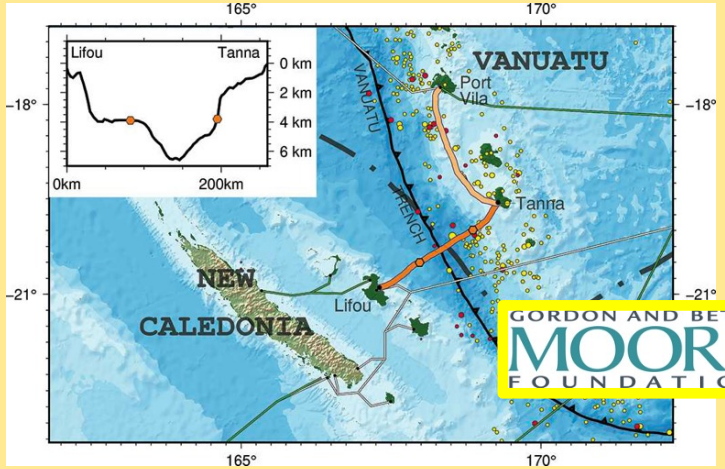
- Improved EEW (10 s) with less loss of life will more than pay for the system
- Next: include infrastructure and tsunami inundation

NEAMTWS



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

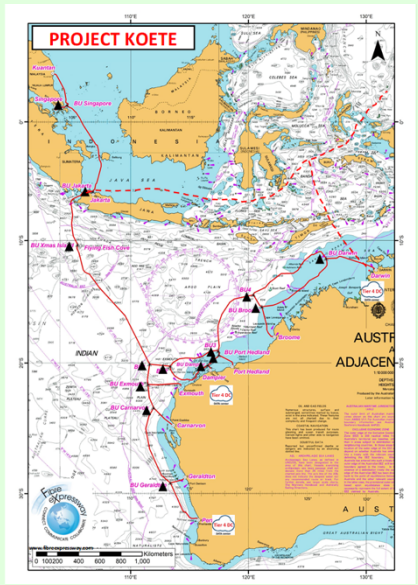
SMART Cables - Pacific



Vanuatu – New Caledonia

SMART, DAS

Partial funding; under gov't review



Project Koete

Perth-Darwin-Malaysia

Communities

SMART integral

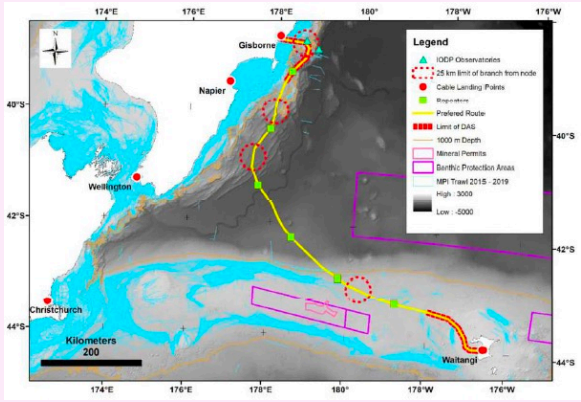
Raising funds

Indonesia

In country development Ina-CBT

Single ended test systems underway

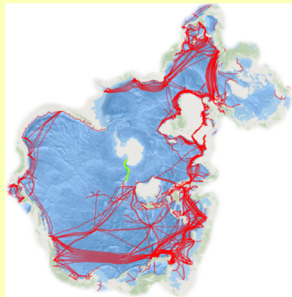
Follow with Makassar Strait, **with telecom**



NZ–Chatham Islands

SMART + DAS + BUs/nodes

Under gov't review (MBIE)



NSF

Antarctica – NZ

Improve connectivity

SMART Cable

Workshops, NSF, NAS, Chile

Arctic Express

14,000 km

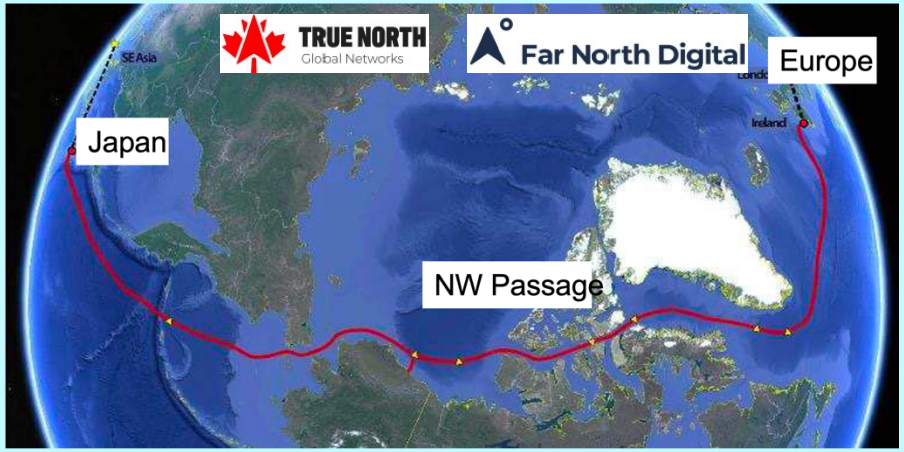
Low latency

Communities

Contract Q1 2022

RFS Q4 2025

SMART integral



SMART Cables – Moore Foundation Project

LEAD

PI Bruce Howe
University of Hawai'i at Mānoa

FUNDING: 2022 – 2026, $7M

GORDON AND BETTY MOORE FOUNDATION

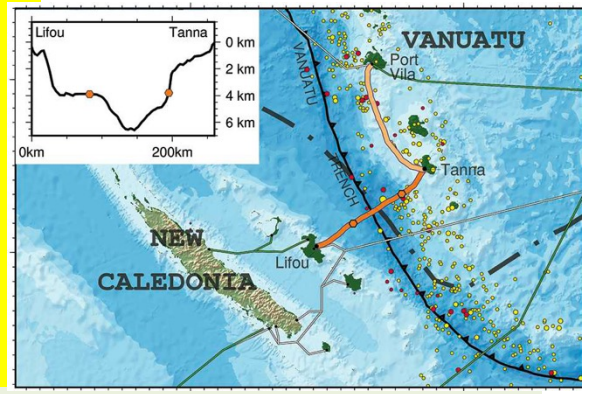
COLLABORATORS

University of Hawai'i at Mānoa
Univ Texas Austin
Louisiana State University (LSU)
University of Otago, NZ
National University of Vanuatu (NUV)
Pacific Community (SPC)
California Institute of Technology
Subsea Data Systems

French Institute for Research and Sustainable Development (IRD)
Vanuatu Meteorology and Geohazards Department (VMGD)

GNS New Zealand – Bill Fry
International Tsunami information Center – Laura Kong

Expect Deploy 2025



GOAL:

SMART cables become the world standard, leading to a global network for sustained ocean observation, geophysical study of earthquakes, and earthquake and tsunami warning in a world with rising sea levels.

Objectives:

- **Lay groundwork for science and early warning use by simulations of the observing system before deployment, data analysis after deployment, and sustained scientific operation.**
- **Apply results to the modest-scale 300 km Vanuatu-New Caledonia system and extract scientific results from this active tectonic subduction zone and dynamic ocean region. Demonstrate SMART earthquake and tsunami early warning.**
- **Establish the international project office for Joint Task Force Scientific Monitoring And Reliable Telecommunications cables to facilitate adoption of scientific sensors in all new telecommunications cables to reach a global scale.**

UN Connections

- **ITU**
  - Host Secretariat, web page, workshops, etc
  - SecGen articles in trade journals
  - Circular letter to member states, cc'ed to suppliers, OTTs, Regulators, Banks, UN hierarchy
  - WTSA-20 SMART Resolution, WTDC-22 and PP-22 amend climate/DRR resolutions, SG15/Q8 Recommendations
- **UNESCO IOC**
  - Part of Tsunami Programme,
  - In process - GOOS Project
- **WMO**
  - Liaise with Data Buoy Coordination Panel (includes DART, fixed moorings)
  - Will help in using GTS, data distribution
- **SMART and the UN Decade of Ocean Science for Sustainable Development**
  - Endorsed as Project of Decade, affiliated with Tsunami and GOOS Co-Design Programmes
  - Example of Blue Economy – leverage $5B/y industry, 170-year experience, "new" funding?
  - Maximize societal benefits from submarine cables

Concluding Remarks

- SMART systems becoming reality
- PTWS WG2 Task Team: Integrated PTWS Sensor Networks for Tsunami Detection and Characterisation:
  - Continue to work together
  - Need to coordinate these activities with other ICGs, internationally, Moore project, etc., and include SMART cables
- UN Decade Tsunami Programme – SMART will be participating as an endorsed Project, affiliated with Tsunami Programme and GOOS
- New paper: SMART Subsea Cables for Observing the Earth and Ocean, Mitigating Environmental Hazards, and Supporting the Blue Economy, FES, 2022.

Recommendation 1 - TT TWO to TOWS-WG

- **Move forward SMART Cable clause from ICG/PTWS-XXIX Executive Summary as is:**
  - The **TT-TWO encourages** the JTF **SMART** Cable project to continue its activities to promote current and future projects for “wet demonstrators,” pilots, and operational SMART cable systems, **further encourages** the IOC to actively participate as a full member in the JTF, **also encourages** IOC Member States to endorse the ITU WTSA-20 SMART Resolution through their ITU focal points.

Recommendation 2 - TT TWO to TOWS-WG

- **Move forward SMART Cable clauses from Recommendation ICG/PTWS-XXIX.3 Tsunami Detection, Warning and Dissemination, adding EOV clauses:**
  - **Further and considering** the crucial role ocean bottom pressure observations play for tsunami detection, and
  - **Considering** that the Global Ocean Observing System has established Essential Ocean Variables (EOVs) with attributes of relevance, feasibility and cost effectiveness, and
  - **Considering** further that ocean bottom pressure meets such criteria as an EOV for tsunami detection, and
  - **Noting** that two UN Decade of Ocean Science activities, Project *Science Monitoring And Reliable Telecommunications (SMART) Subsea Cables: Observing the Global Ocean for Climate Monitoring and Disaster Risk Reduction, ID 94*, and Programme *Deep Ocean Observing Strategy (DOOS)*, are actively working together to advance ocean bottom pressure as an EOV in the GOOS Framework of Ocean Observing and within the Ocean Decade Tsunami Programme,
  - **Recognizing** that by establishing ocean bottom pressure as an EOV, this variable will be observed more ubiquitously for the benefit of all sectors and stakeholders of the ocean observing community, including the IOC Tsunami Programme,
  - **Recommends** IOC Member States to endorse the efforts of JTF SMART Cable and DOOS to establish ocean bottom pressure as an Essential Ocean Variable within GOOS.