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to each section

SMART Subsea Cables for Observing the Ocean and Earth

The National
Academies of

SCIENCES
ENGINEERING
MEDICINE

Bruce M. Howe¹, Christopher R. Barnes², David T. Meldrum³,
and Joint Task Force for SMART Cables⁴

Ocean Shot



¹University of Hawaii, USA, ²University of Victoria, Canada, ³Scottish Association for Marine Science,
and ⁴Joint Task Force (JTF), sponsored by the International Telecommunication Union (ITU),
the World Meteorological Organization (WMO), and the Intergovernmental Oceanographic Commission (IOC) of UNESCO



Introduction

Science and
Early
Warning

SMART Subsea Cables Science Monitoring And Reliable Telecommunications

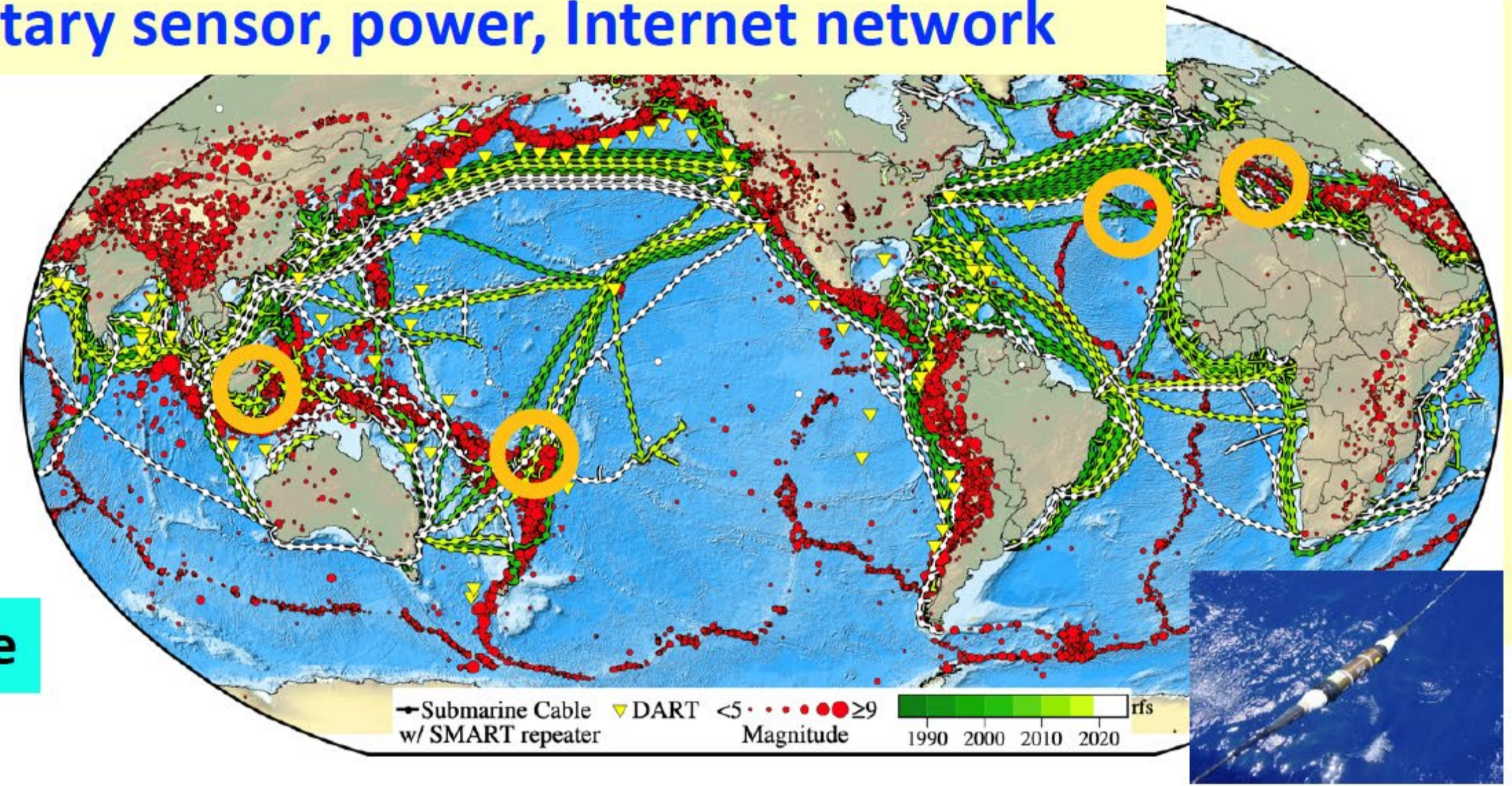
UN Decade
Challenges

Concluding
Remarks

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
↓ \$

1+ Gm
~10,000+repeaters
20 year refresh

UN Decade

1st
SMART CAM: Portugal-Azores-Madeira
3700 km, Gov't, €120M, install 2024

Bottom pressure, temperature,
acceleration → Power/Internet nodes

SMART Cables Mission:
To implement telecom+sensing
SMART subsea cable systems
on a global scale, to support
climate, ocean circulation, sea
level monitoring, and tsunami
and earthquake early warning
and disaster risk reduction
(OObs19).

Innovative !

Transformative !

- Planetary scale sensor array - 1st order addition. Climate, oceans, sea level, earthquakes and tsunamis.
- Global submarine telecommunications network connecting society, countries and continents. \$5B/y.
- Leverage network, power, communications, host sensors. Repeaters every ~100 km. Consider as power/Internet nodes.
- First major SMART project underway in Portugal; orange circles - first systems; still others in planning/funding.



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Climate and Oceans

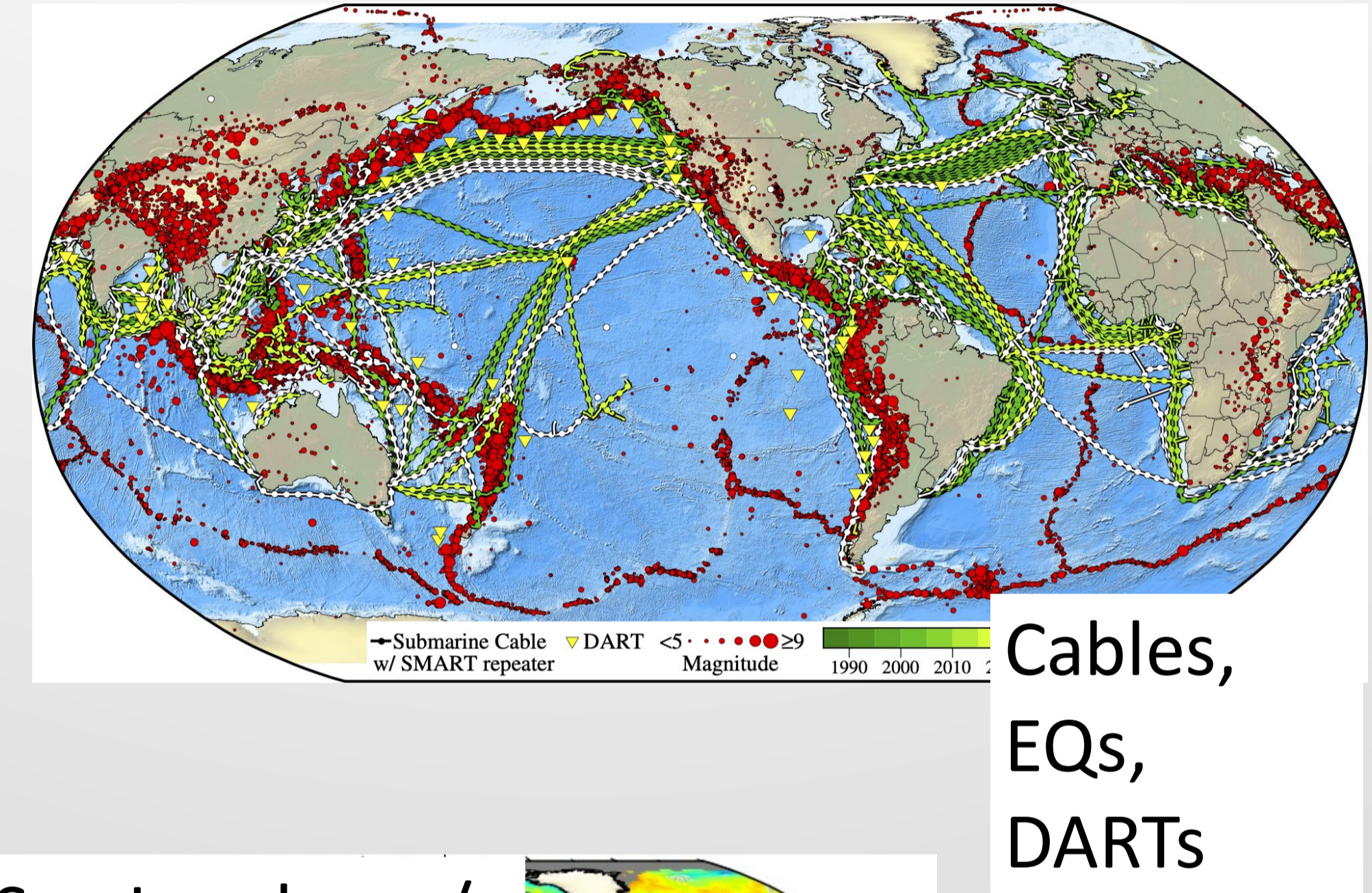
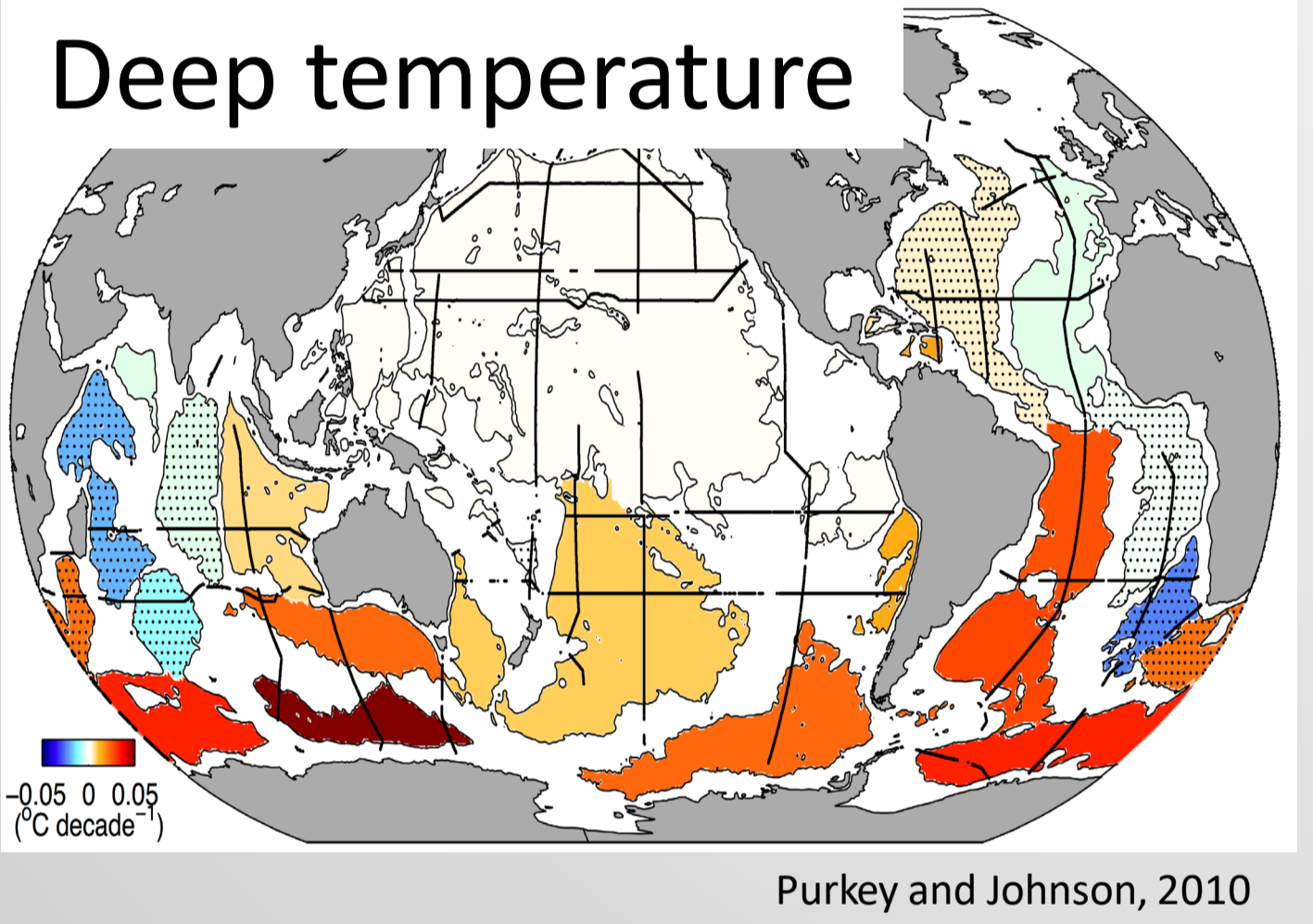
Hazards

UN Decade
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Temperature

- Deep oceans warming → sea level rise.
- Δ **deep ocean temperature** → Δ circulation, Δ climate.
- SMART → real-time temperature at the ocean bottom.

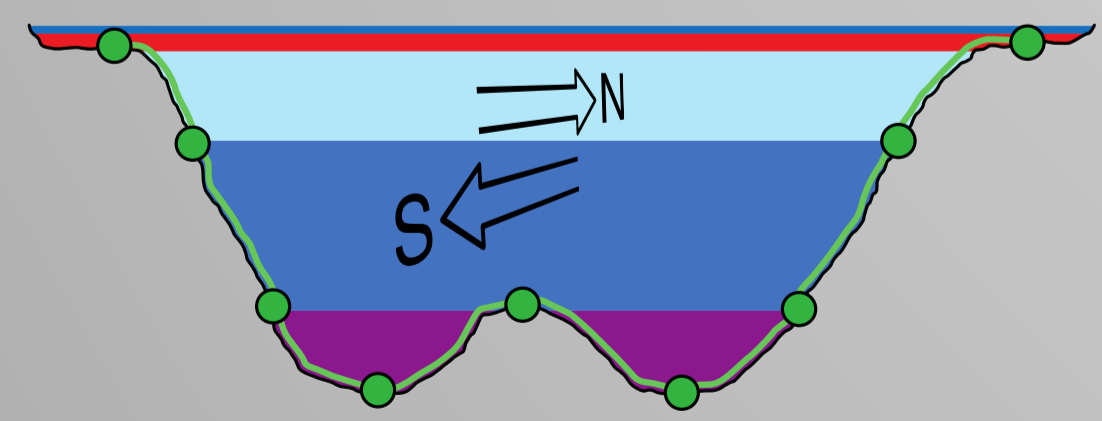


Cables,
EQs,
DARTs

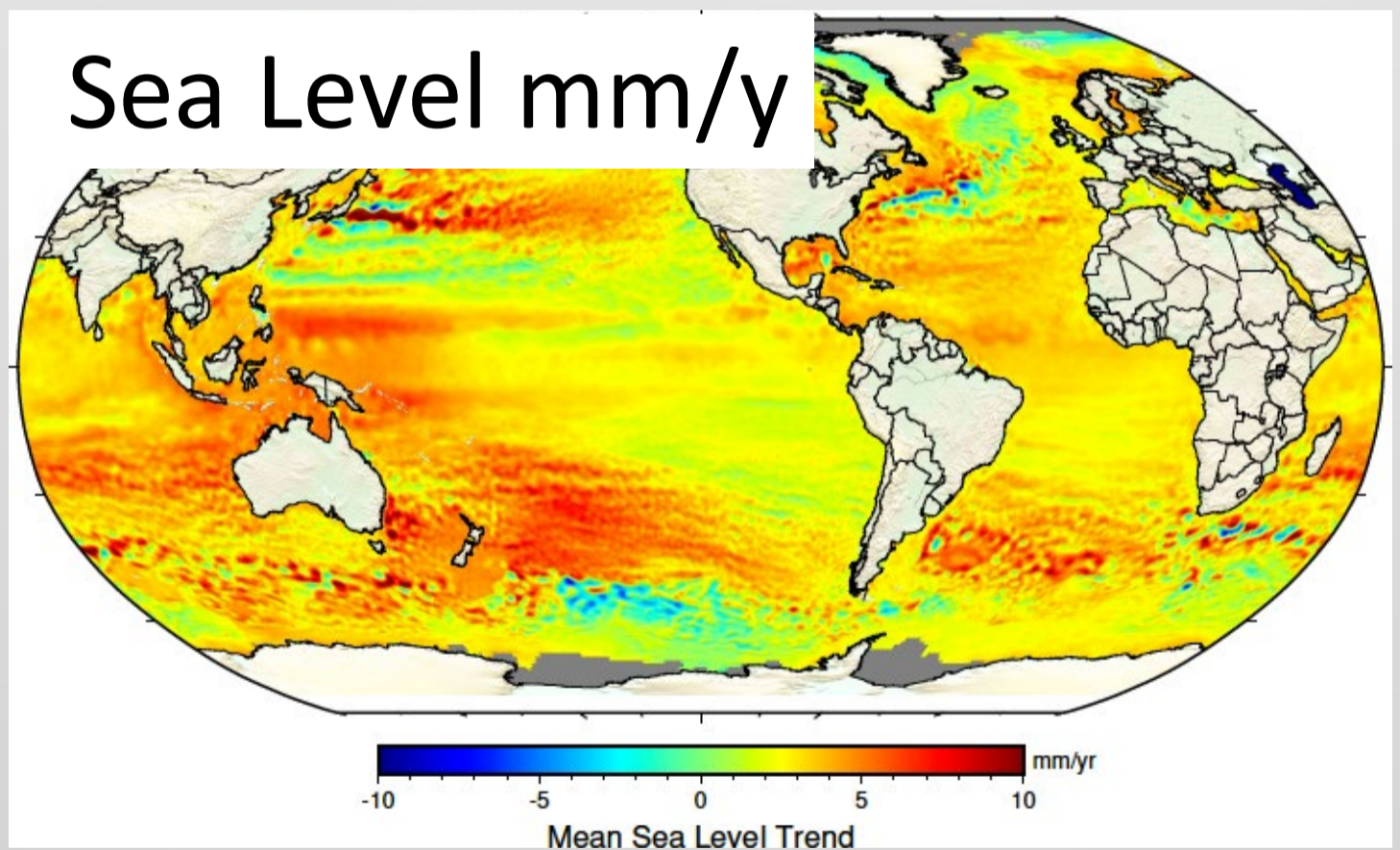
Tsunami Warning

- SMART cables - vastly increase existing small number of deep ocean **pressure and seismic sensors**
- Improve precision of tsunami warnings, greatly reduce unnecessary warnings and evacuations.

Circulation, sea level rise, mass distribution

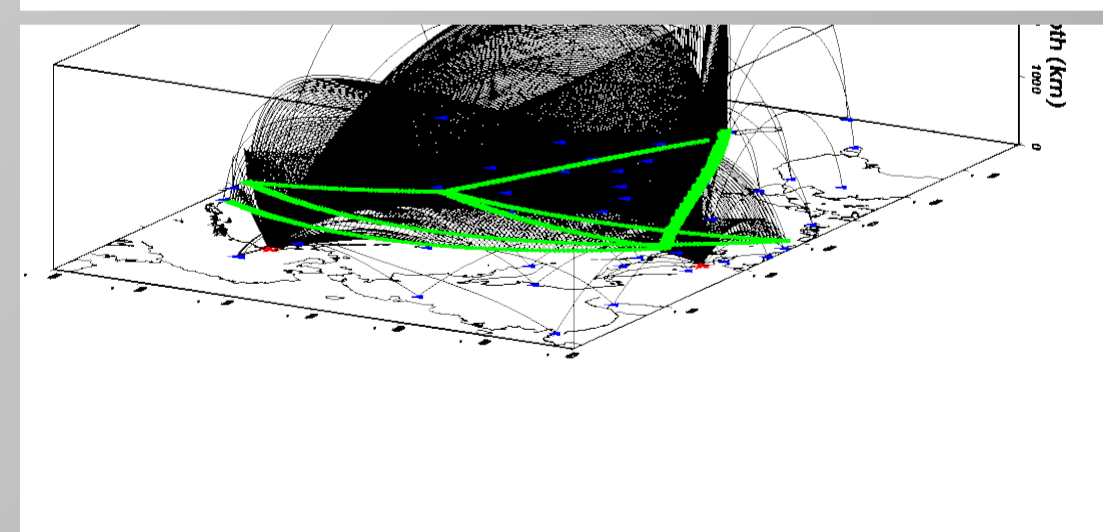
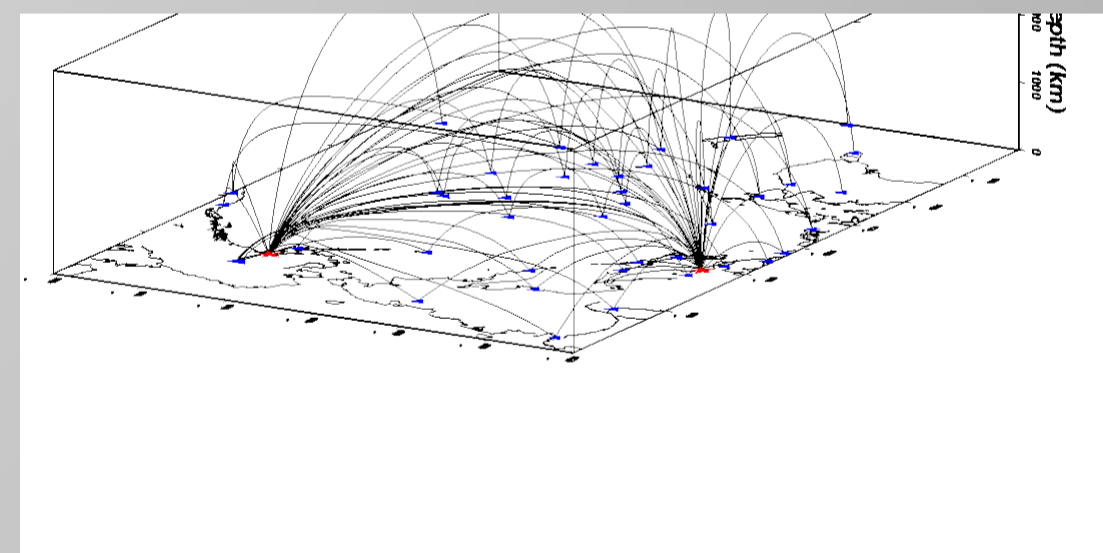


- **SMART Ocean bottom pressure (OBP)** → separate warming expansion, mass change melting land ice → better sea level change (x,t).
- Δ_x between OBP → directly related to depth-averaged currents and ocean circulation.



Seismology

- **SMART Seismic accelerometers** → significant advances in seismology:
- Detect and locate small earthquakes below the ocean floor
- Determine rupture type and dynamics for larger offshore earthquakes
- Image Earth's interior



Ray
sampling
with and
without
SMART



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UN Decade Challenges



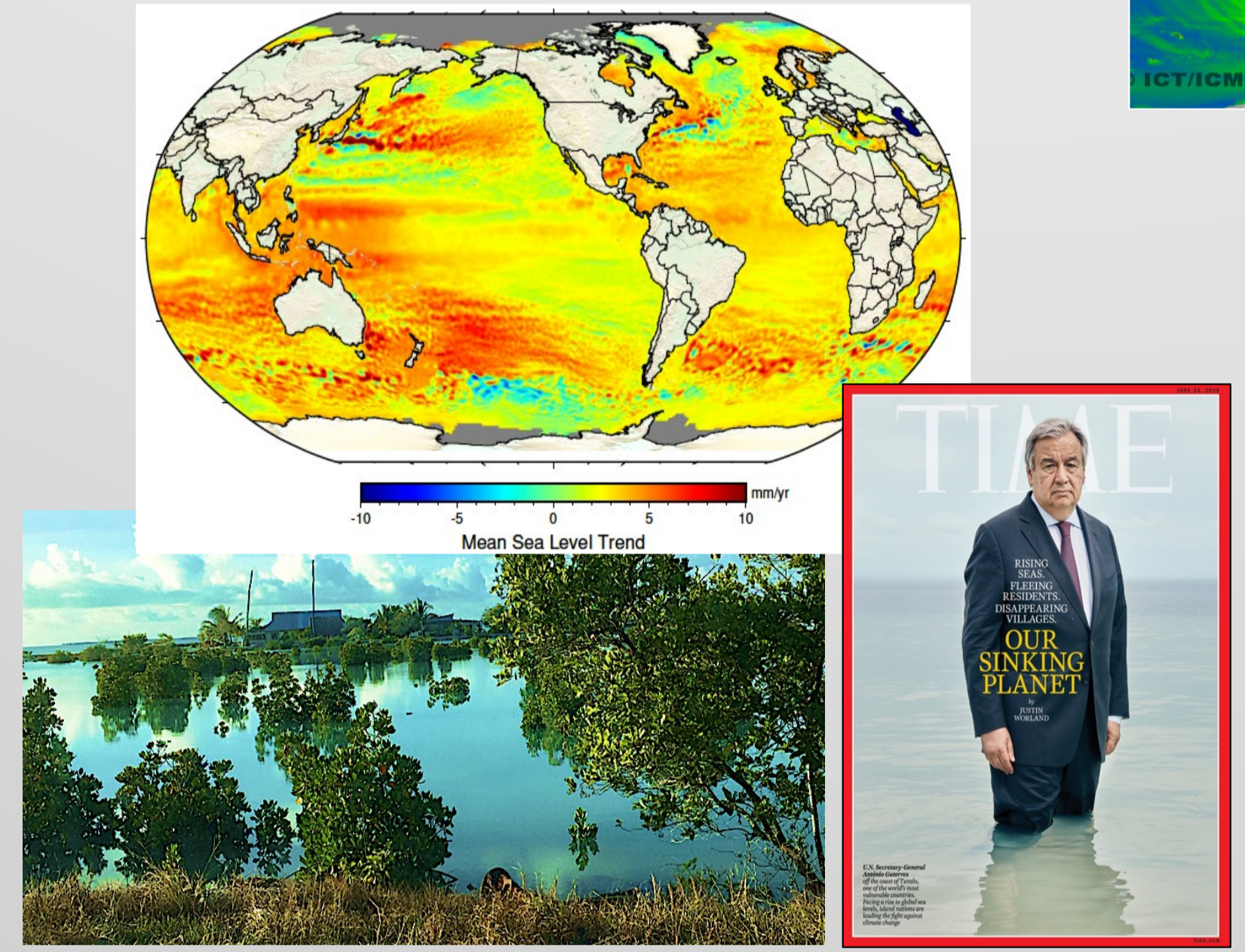
UN Decade
Challenges

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Remarks

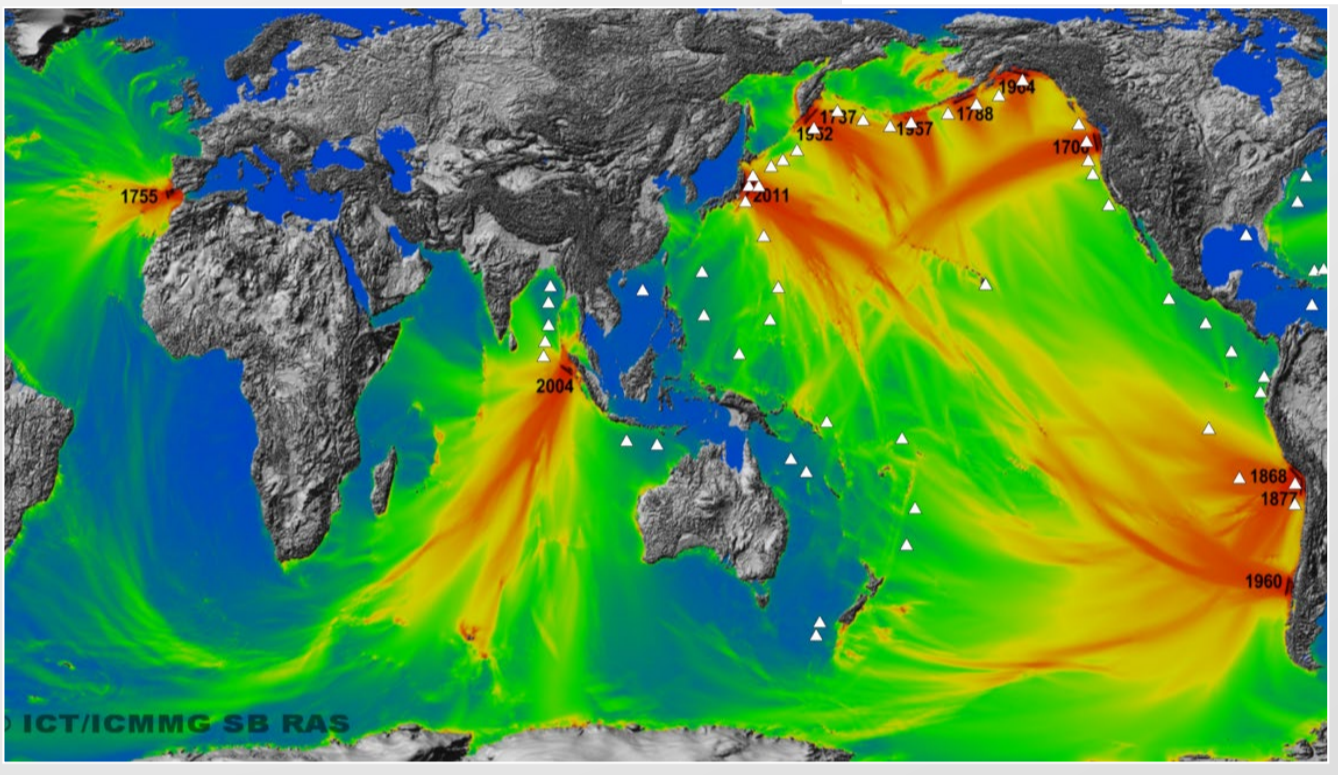
Challenge 5: Ocean-Climate nexus

- SMART observations → monitoring ocean portion of the atmosphere-ocean-climate-Earth system
- SMART temperature, ocean flow →
- Ocean circulation, time/space variability of sea level
- Secular changes of tidal coefficients → satellite altimetric and gravity observations (and sea level) and ocean mixing (via tides, circulation, and stratification).

Challenge 6: Early warning services



- SMART observations →
- Early warning of earthquakes and tsunamis (seismic, landslide induced, and meteorological)
- Sea level rise → informed mitigation coastal flooding and erosion, plus tidal/storm flooding exacerbated by sea level rise.

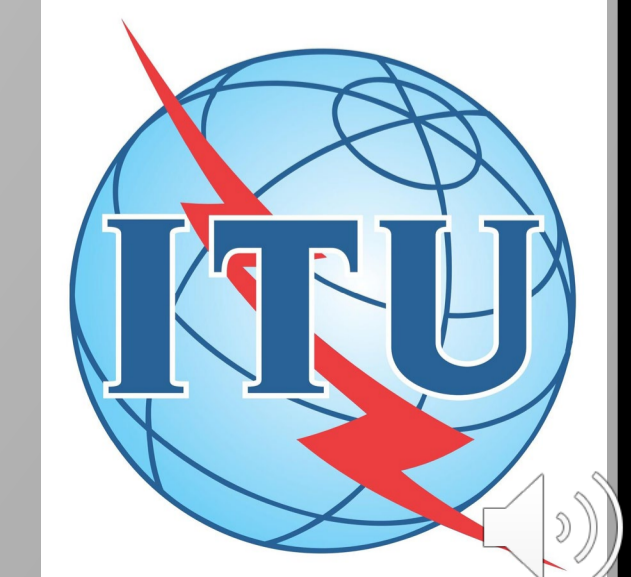


Challenge 7: Sustainable ocean observing system

- SMART Cables emphatically address this Challenge: A growing and sustained observing system.
- Two scenarios:
- End of Decade, ~650 SMART repeaters, 45 Mm cable in service, 15 systems.
- Another Decade, 2000 repeaters, 140 Mm cable, 30 systems (3.5 x around Earth)

Innovative !

Transformative !



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Next Steps

UN Decade
Challenges

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Innovative + Transformative

SMART Cable Attributes

Request for Endorsement to UN Decade – Programme Office
Engaging Stakeholders and Funders

Societal, science, environment, cable benefits

- Climate, ocean circulation, sea level rise
- Earthquake and tsunami early warning, geophysics
- Improved cable integrity – societal connectivity

A new element of the Global Ocean Observing System

- Needed observations, global, fixed, high rate, real time
- Distributed power and comm nodes - future
- Turn-key, reliable, long-lived, sustainable, maintained

Blue Economy

- Leverage the \$5B/y submarine cable industry
 - Alcatel Submarine Networks: Climate Change strategy, SMART capability
 - Turn-key, highly reliable, long-life, maintained

- Leverage the unconventional
- Blue Economy
- Regulators:
 - ITU – SMART Resolution for World Tech Stds Assembly
 - ITU – Global Symposium for Regulators
 - European Digital Strategy
- Research and Education Networks
- Multi-lateral Development Banks
- Philanthropy
- Horizon 2021
- Engage new US Admin, NOAA, OSTP, ...
- Pursue current and new possibilities:
 - Wet demo, Indonesia, Western Med, Vanuatu-New Caledonia, French Polynesia, India-Oman, Australia-Darwin-Singapore, Arctic, Antarctica, ...
 - Entrain OTT providers (e.g., Facebook)



[SMART Cables for Observing the Global Ocean: Science and Implementation](#)

