

SMART Subsea Cables for Observing the Ocean and Earth: An Update

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O1.3-705



JTF SMART Cables
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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

UN Decade

Know the environment – protect the network

CAM: 3700 km, Gov't, install 2024 → SMART
Continent/Lisbon-Azores-Madeira ring

Bottom pressure, temperature,
seismic acceleration

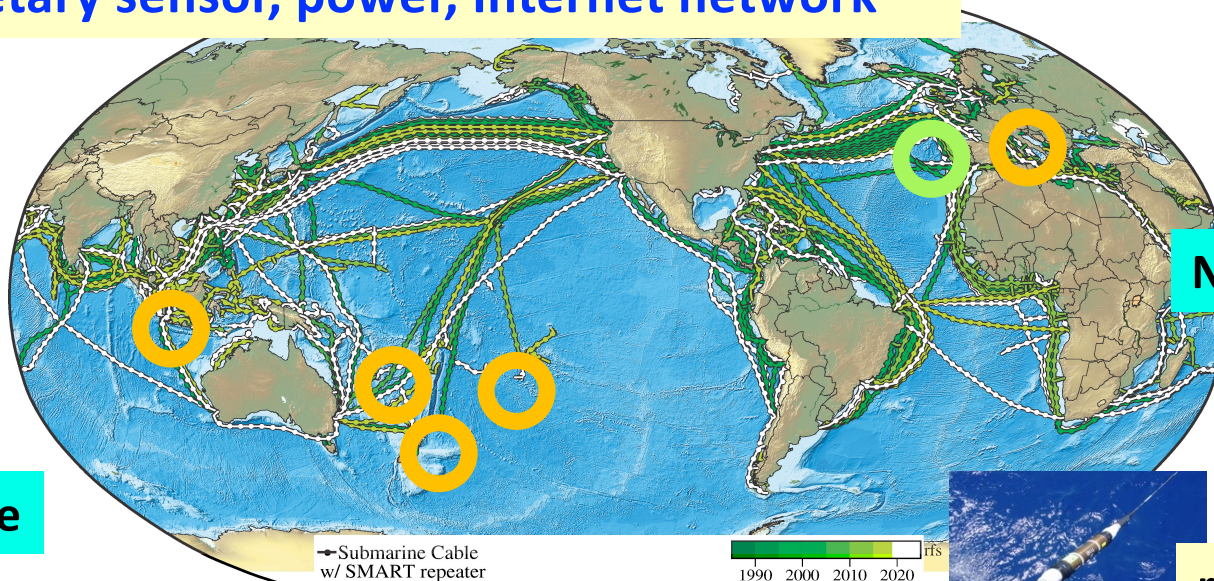
Share
submarine cable
infrastructure

Telecom + science

NO Interference ↓€\$

1.2+ Gm
~20,000 repeaters
20 year refresh

repeaters ~70 km





Societal Benefits

Climate change – humanity's greatest existential threat

Societal and environmental issues

UN Decade of Ocean Science

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



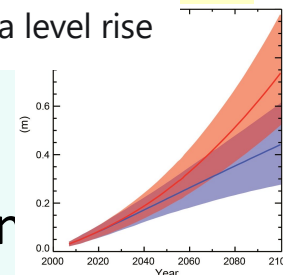
– **Disaster Risk Reduction** – tsunami
and earthquake monitoring
throughout ocean basins and coastal margins

Infrastructure
SDG 9, 11



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

Sea level rise

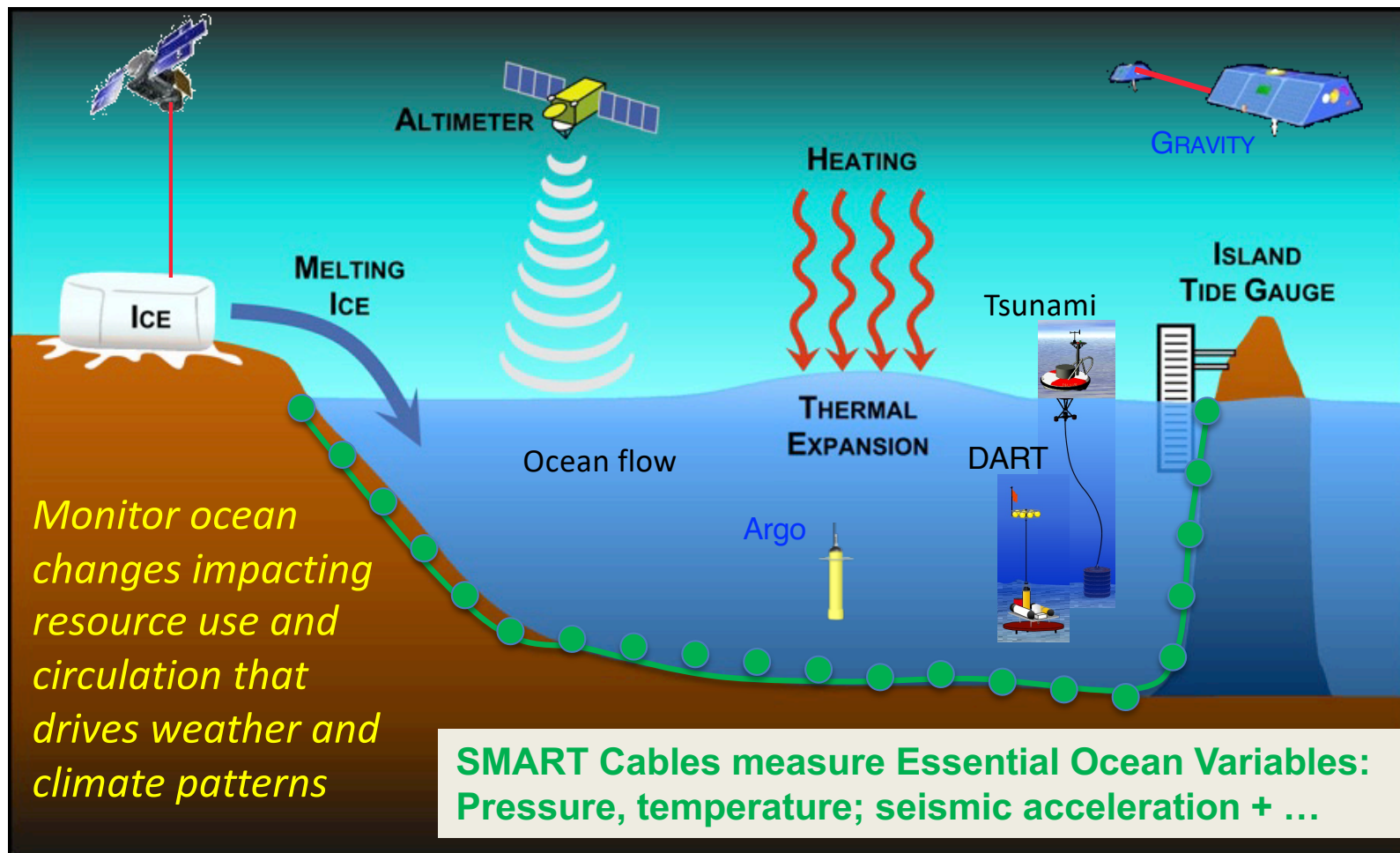


Tsunami





Ocean Observing Tools



Adapted from Nerem, 2016

Now:
**Very few
bottom obs**

Future:
**Add SMART
Cables
Augment and
complement
present**

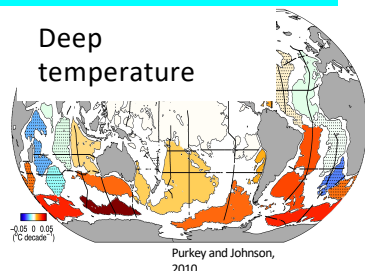




Science and Early Warning - Observables

Climate and Oceans

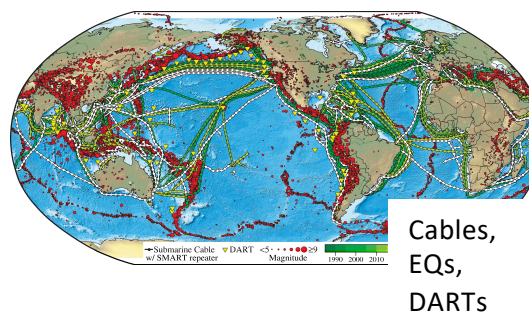
Temperature



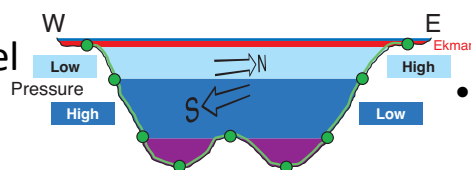
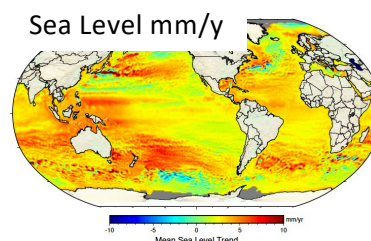
- SMART → **Subsurface temperature, EOVS**
- Deep ocean warming → sea level rise.
- Δ deep ocean temperature → Δ circulation, Δ climate.

Circulation, sea level rise, mass distribution

- SMART **Ocean bottom pressure (OBP, eEOVS)** → expansion, melting ice → sea level change (x,t).
- Δ_x between OBP → depth-averaged currents and ocean circulation.



Cables, EQs, DARTs



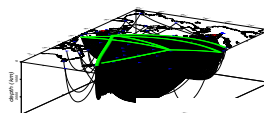
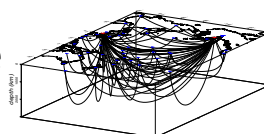
Hazards

Tsunami, Earthquake Warning

- SMART cables - vastly increase existing ocean **pressure/seismic sensors**
- Improve tsunami warning precision, Reduce unnecessary warnings/evacuations.

Seismology

- SMART **Seismic accelerometers** → advance seismology:
- Detect, locate small quakes below ocean floor
- Rupture type and dynamics, larger offshore earthquakes
- Image Earth's interior

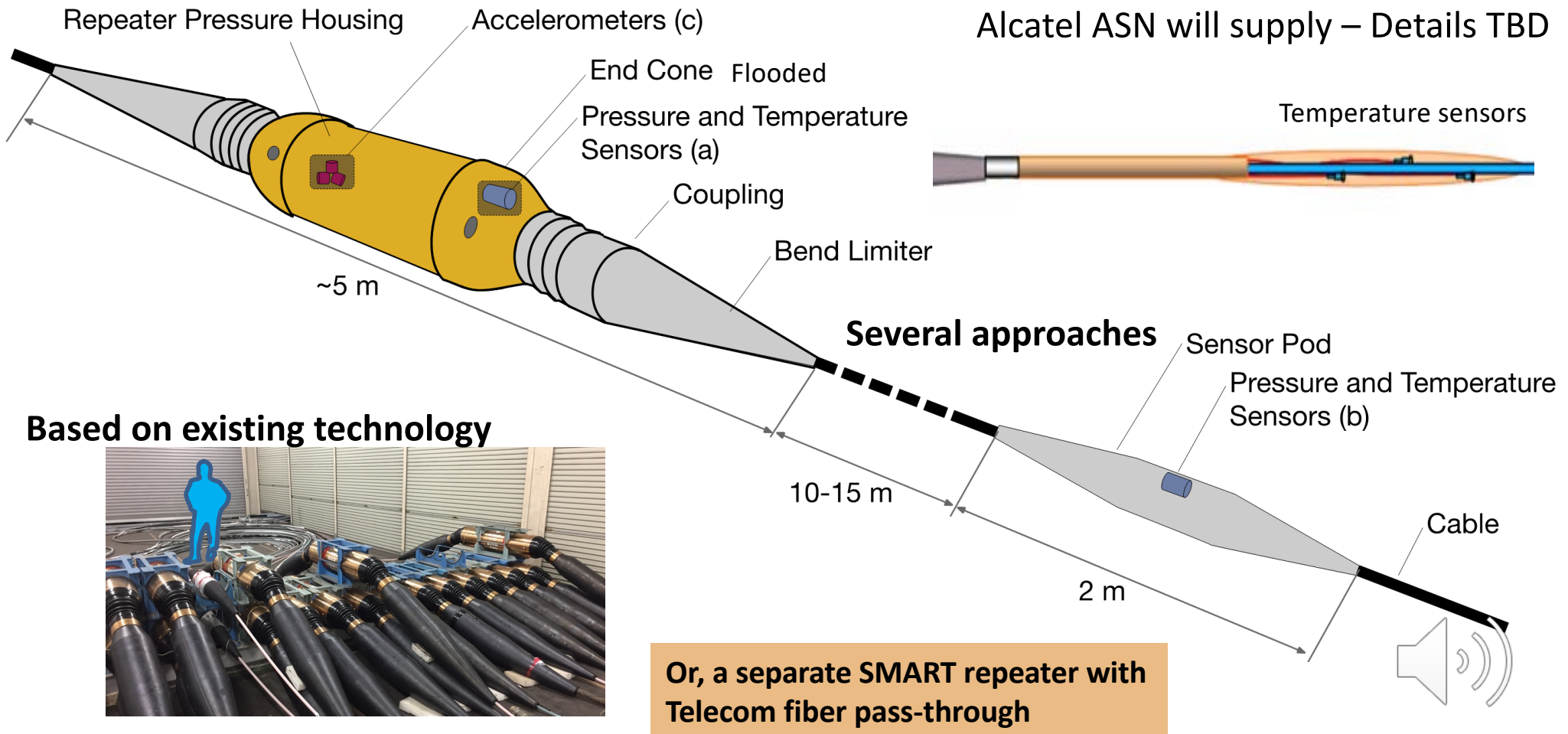


Ray sampling with and without SMART



SMART Repeaters

Alcatel ASN will supply – Details TBD

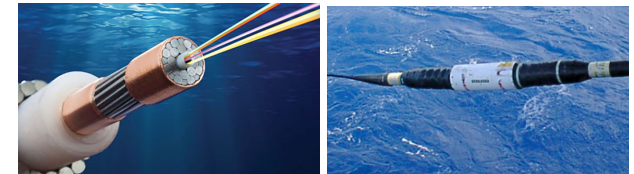




SMART Cables

Innovative + Transformative + Audacious too!

- “Joint Venture”– Science and \$5B/y cable industry, 150y
- Suppliers will provide SMART (e.g., ASN)
- Cable integrity – societal connectivity
- Working within the UN system: ITU, WMO, IOC
- Research and Education Networks, e.g., GÉANT, RedCLARA, NORDUNet
- Systems at various stages:
 - **Wet Demo/Sicily, Portugal**, Indonesia, WesternMed, New Caledonia-Vanuatu, French Polynesia, New Zealand, Australia, India-Oman, Antarctica
 - Need to be engaged from the start of a project
- Start modest and simple – KISS in all aspects
 - Technical, domestic/bilateral, regional
 - Set precedents for funding, permitting, legal, security
 - Work with all stakeholders



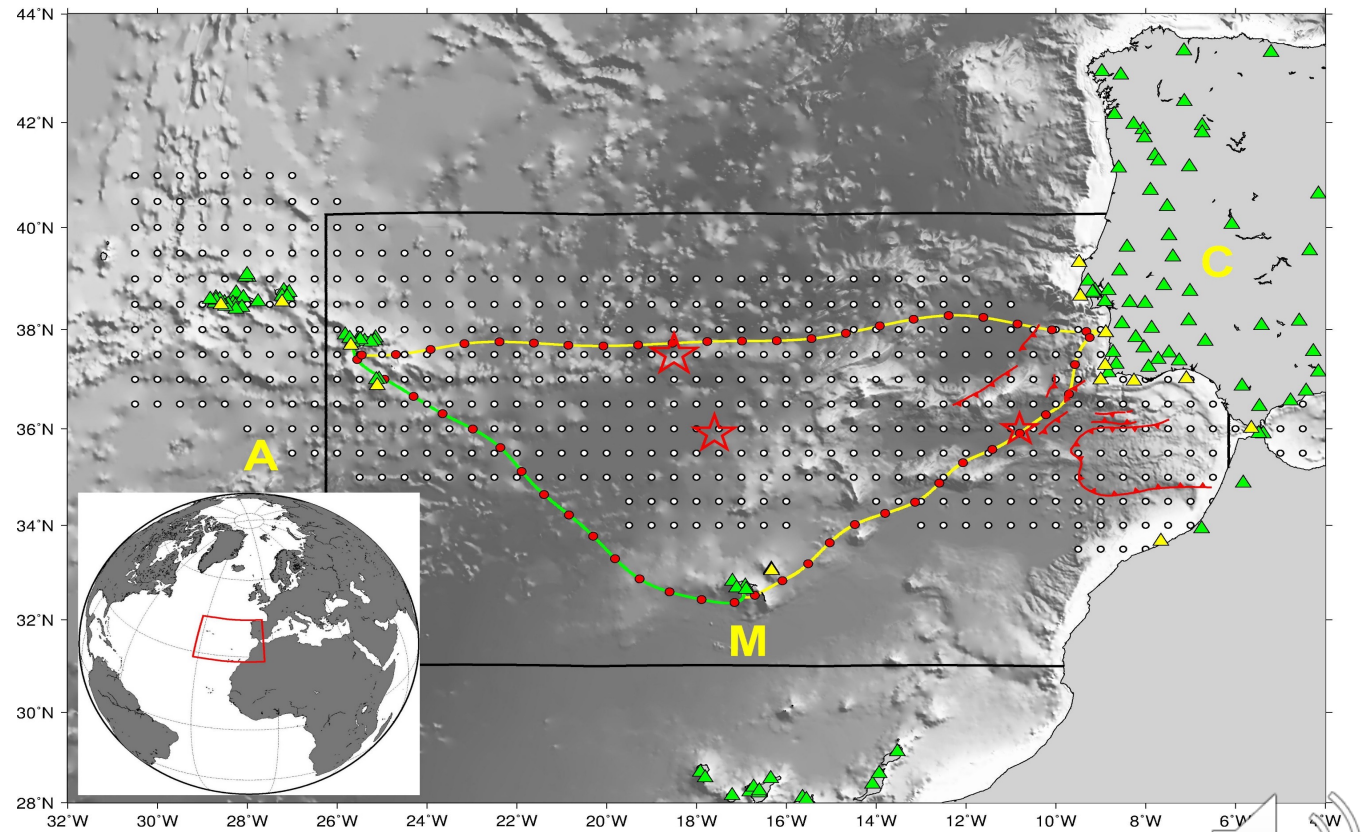
C/S Pierre De Fermat, Orange





SMART Cables – CAM2

- Domestic system with international connections
- Explicit seismic, tsunami, ocean, environment
- 3700 km, €120M
- Cost effective-lives and infrastructure
- RFP 2021
- RFS 2024



LEA – Listening to the Earth under the Atlantic



Concluding Remarks

- SMART Cables – **innovative** path outside the "oceanography box"
- **Transformative** Technology enables science and early warning
- Unique observations of major importance with societal benefit
- Unlock the global deep ocean – extend power and comms infrastructure into the ocean
- CTBTO:
 - A dense global array coverage – ocean and climate, earthquakes and tsunamis
 - Planned and future sensors
 - Will improve IMS performance (hydroacoustic, seismic) with improved media
 - Technology similar – learn from each other
 - SMART cables will contribute to and complement the CTBTO mission

