Regional Cabled Array
NE Pacific OOI Workshop

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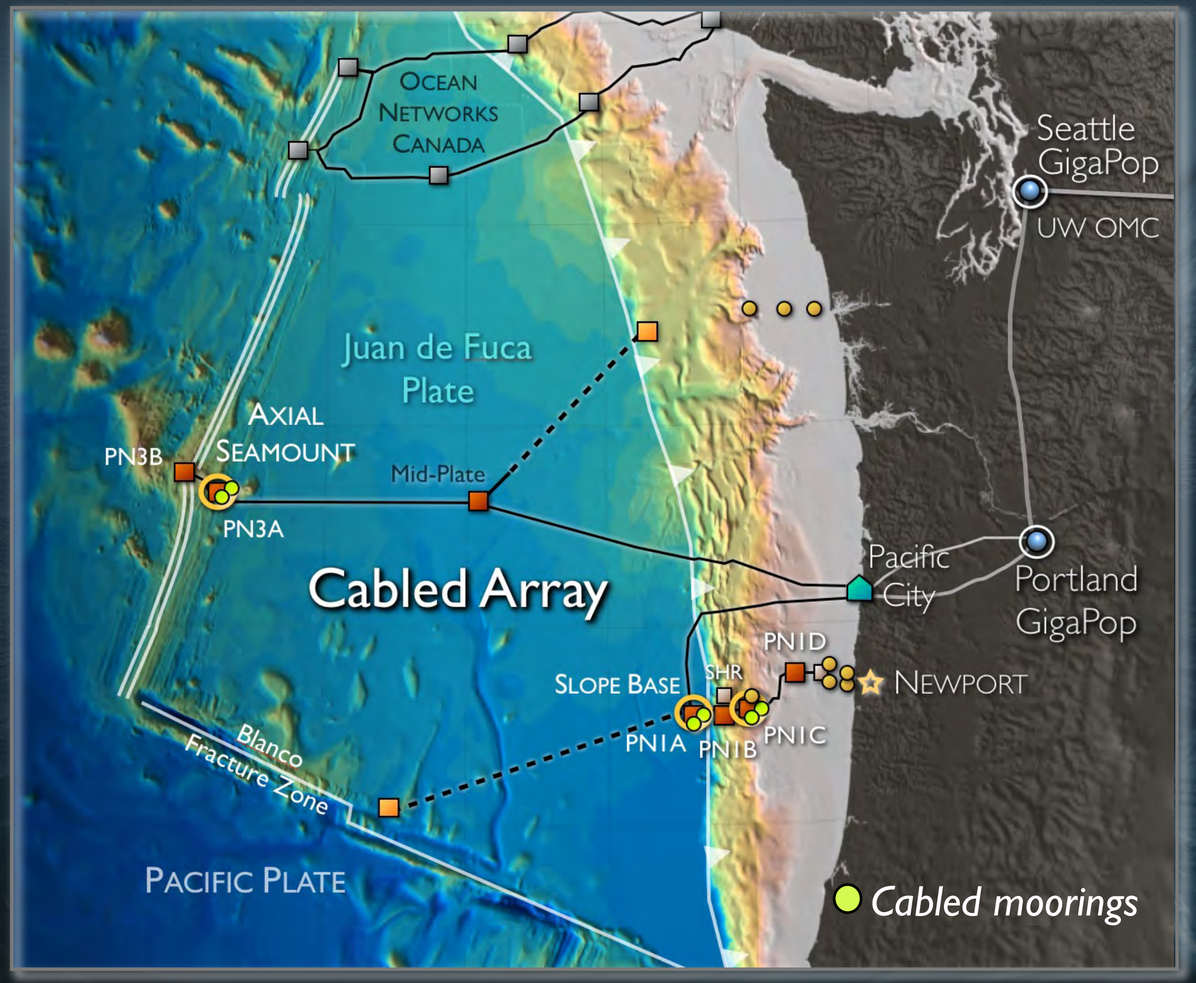
Regional Cabled Array: Why NE Pacific



275 scientists involved in 16 proposals that formed the foundation for this system

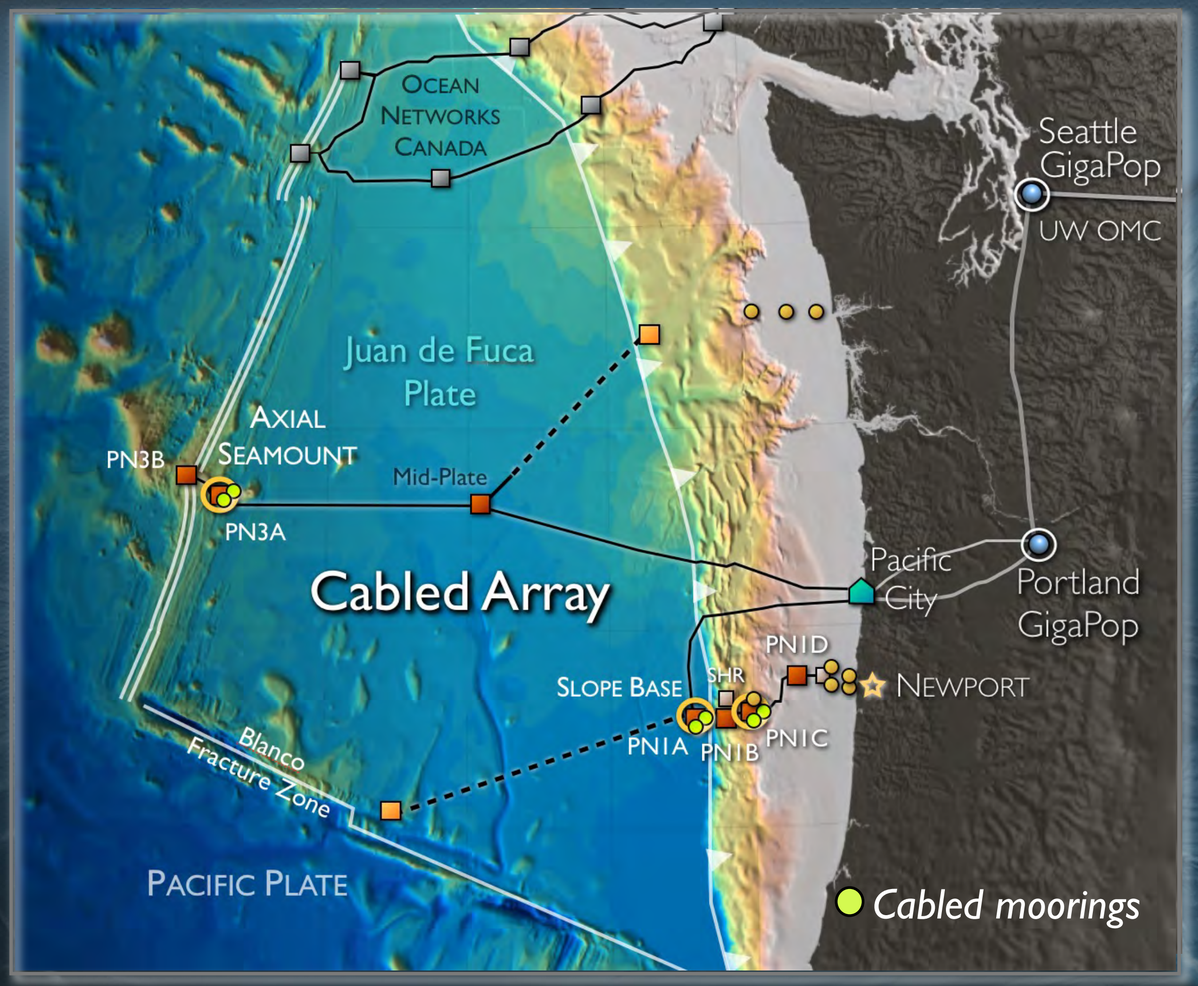
Some of most productive waters in worlds' oceans, large potential energy reserves - methane ice deposits, wave energy etc

Significant Societal Impacts: M9 earthquake, ocean acidification - climate change, low oxygen events, big storms

Real-time monitoring >150 instruments

- Offshore seismic activity, tsunami's
- Seafloor and water column organisms
- Methane seeps and novel microbial communities
- Ocean chemistry (pH, oxygen, CO_2, nitrogen etc)

NSF-OOI's Regional Cabled Array



Primary Infrastructure

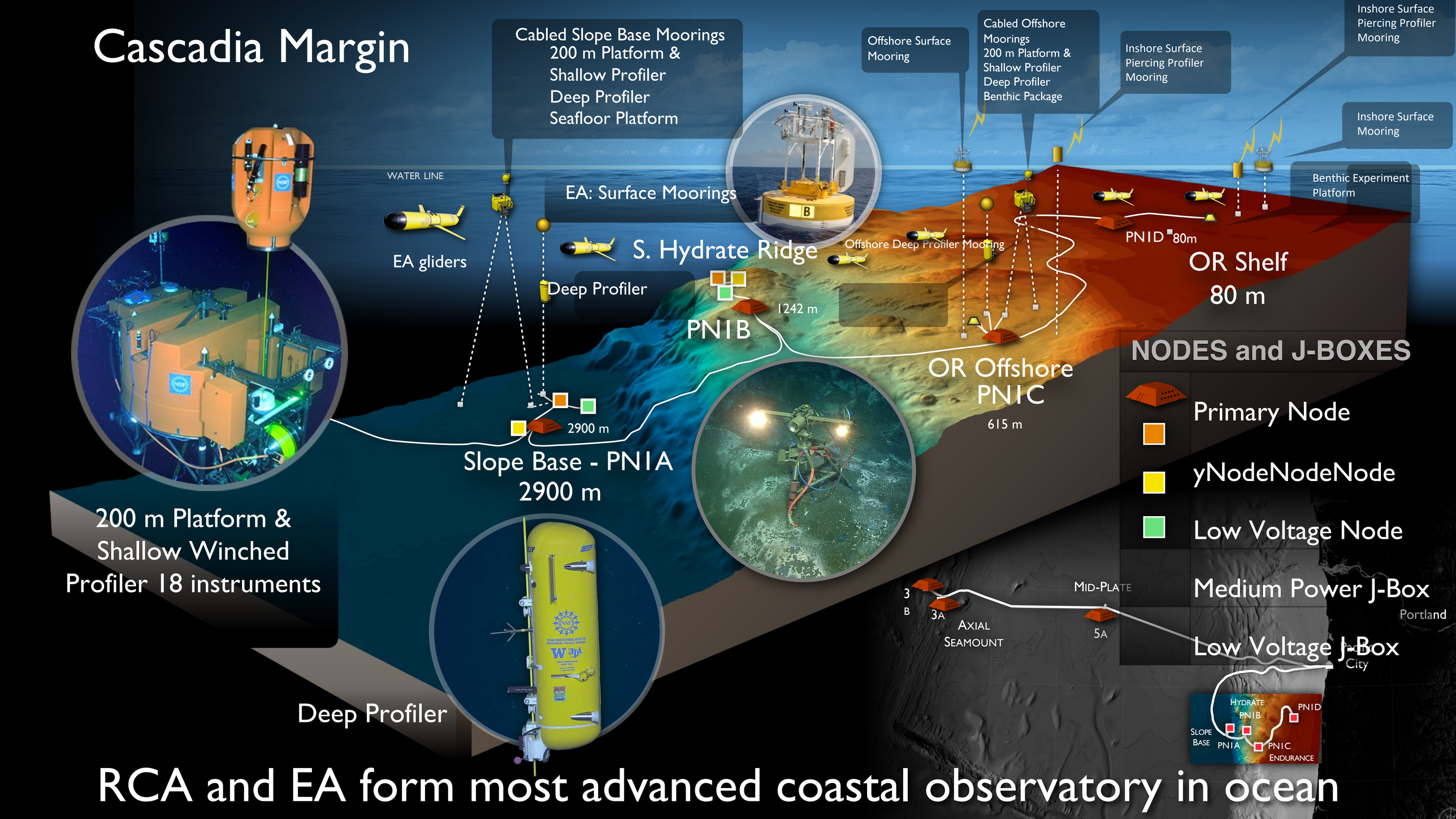
- 900 km of high bandwidth (10 Gbs) and high power (8 kW) **primary** cables & nodes

Secondary Infrastructure - APL

- 33,000 m of extension cables
- 18 junction boxes provide 375V and 1 Gbs
- 6, up to 2700 m tall instrumented moorings with wire crawlers connected to the cable
- >150 instruments provide 24/7 real-time data with two way communication - response capabilities
- highly expandable for science, industry, education

Bringing Power and the Internet Into the Ocean

Cascadia Margin



RCA and EA form most advanced coastal observatory in ocean

State-of-the-Art Shallow Profiler Moorings with winched profiler: event response capabilities (see E. McRae, Wed 1345)

- Hosts an array of 18 diverse instruments - unprecedented coregistered high resolution data in space and time
- Profiler makes 9 trips/day
- 2-way real-time communications allows adaptive sampling -.e.g. response to thin layers, storms, megaplume formation, etc

Providing unprecedented high resolution, continuous data on the ocean environment

Significant discovery opportunities - >35,000 profiles

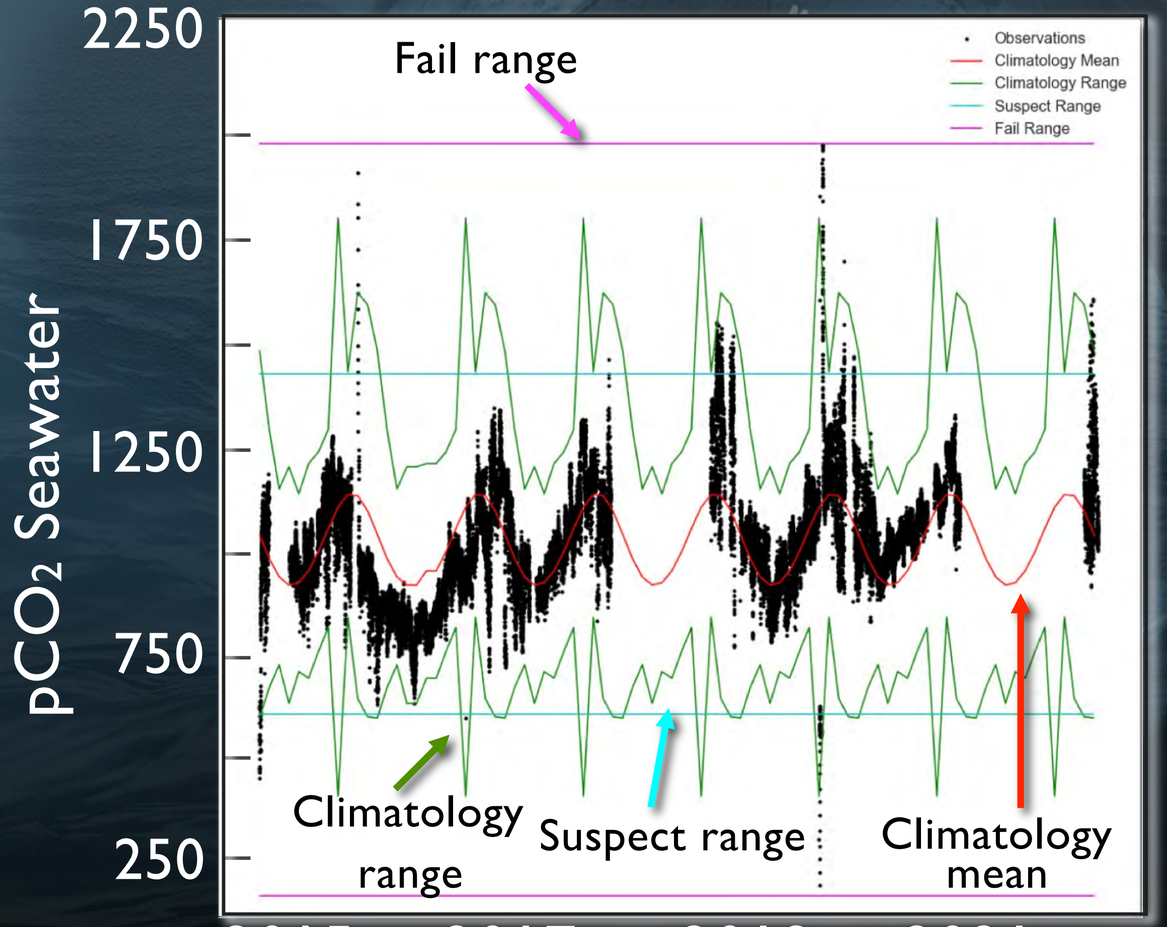
Shallow Profilers provide unparalleled "imaging" of ocean processes at Slope Base, Oregon Offshore, and Axial Seamount

Platform Interface Controller
(stationary science pod)

- pH
- broadband hydrophone
- fluormeter
- CTD-dissolved oxygen
- 5-beam ADCP
- 150 kHz ADCP
- Digital still camera

Winched Shallow Profiler

- pH
- 3W fluormeter
- CTD-dissolved oxygen
- PCO2
- nitrate
- Spectral irradiance
- PAR
- current meter+ temperature



Oregon Offshore, 200 m Platform

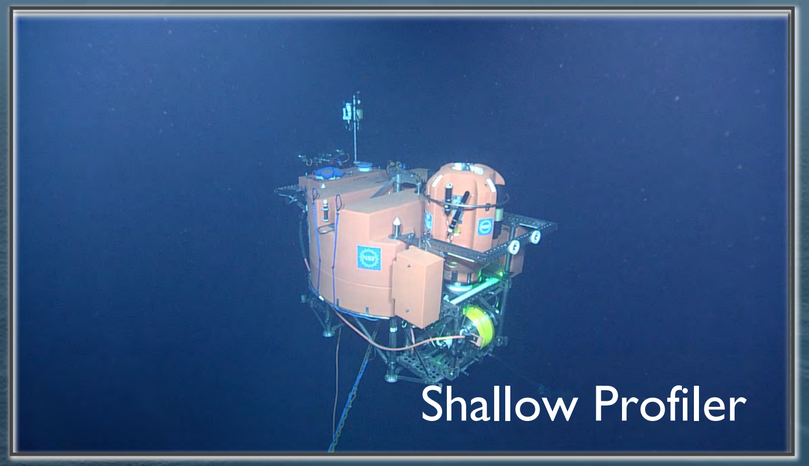
pCO_2 measurements coregistered with 17 instruments in space and time

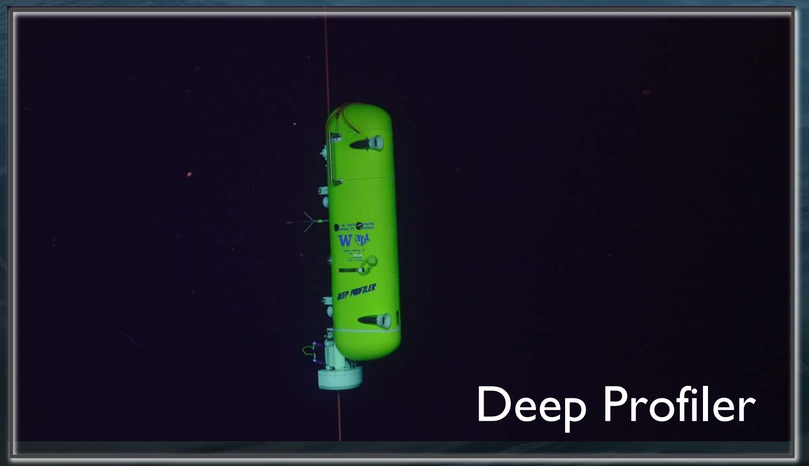
pCO_2 significant data QA/QC effort (see 1320 QA/QC presentation)

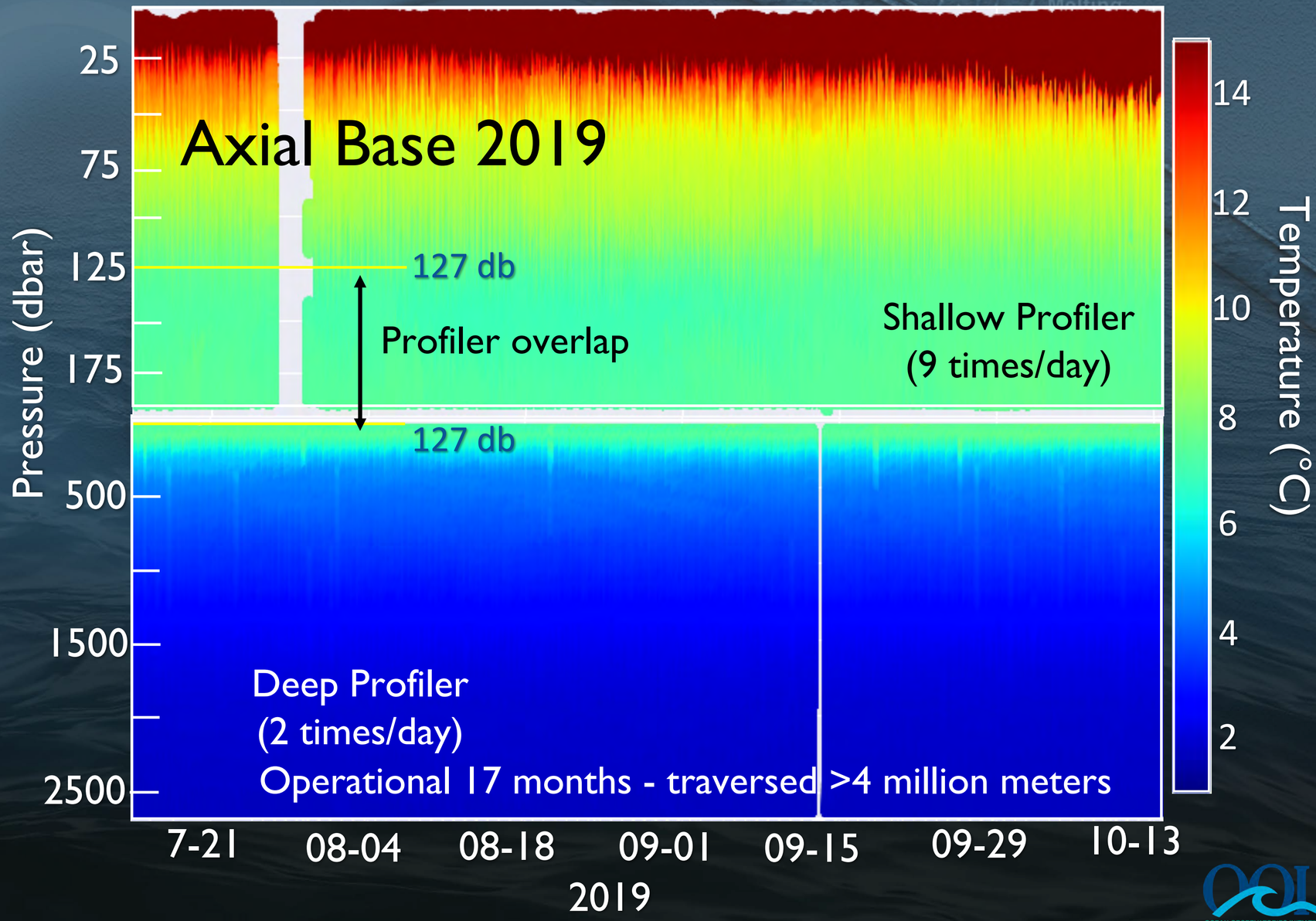
Wendi Reuf: RCA

Real-time monitoring of ocean environments across full ocean depths

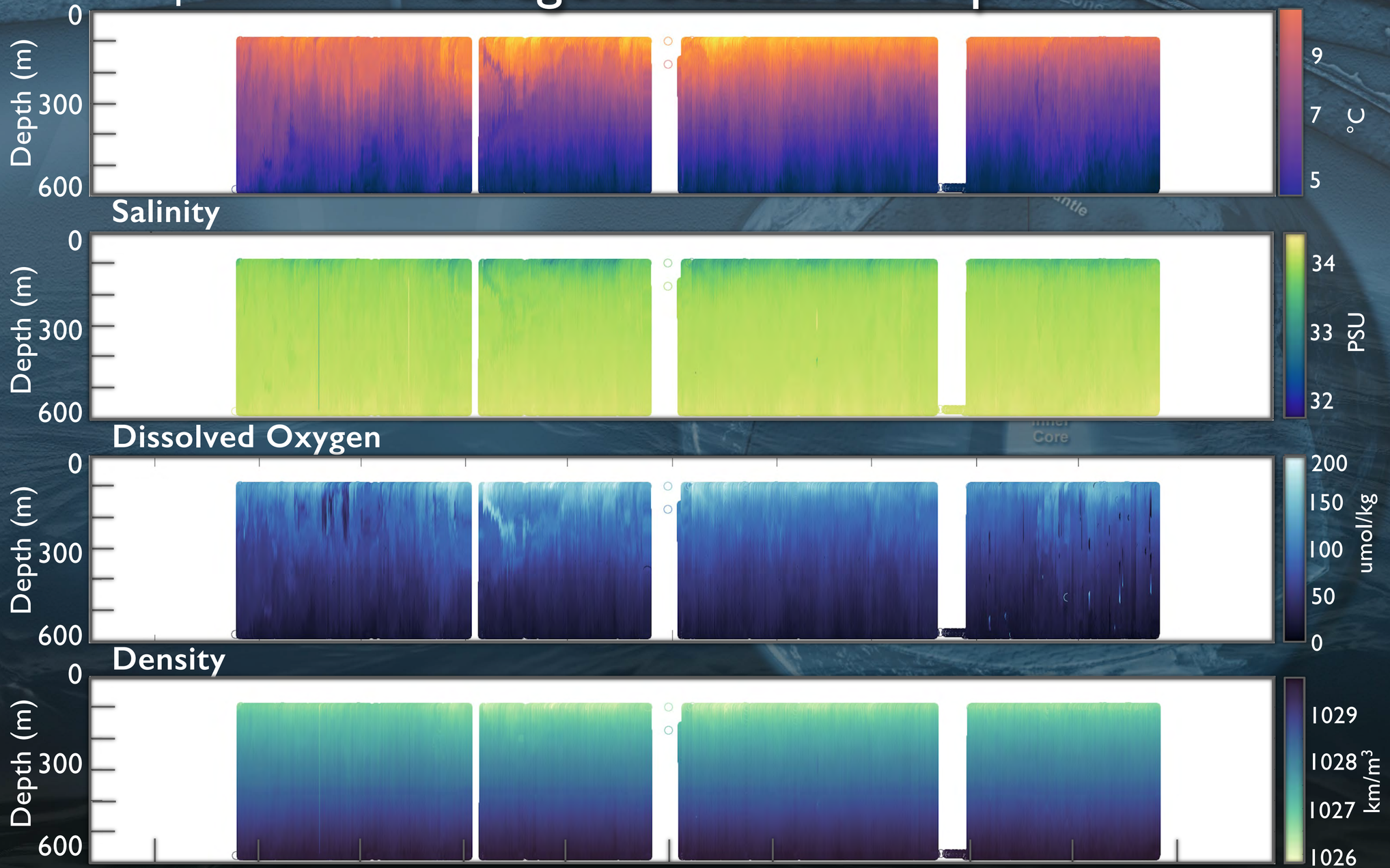
Shallow Profilers are paired with Deep Profiler moorings Slope Base, Oregon Offshore, Axial Base







Oregon Offshore Deep Profiler

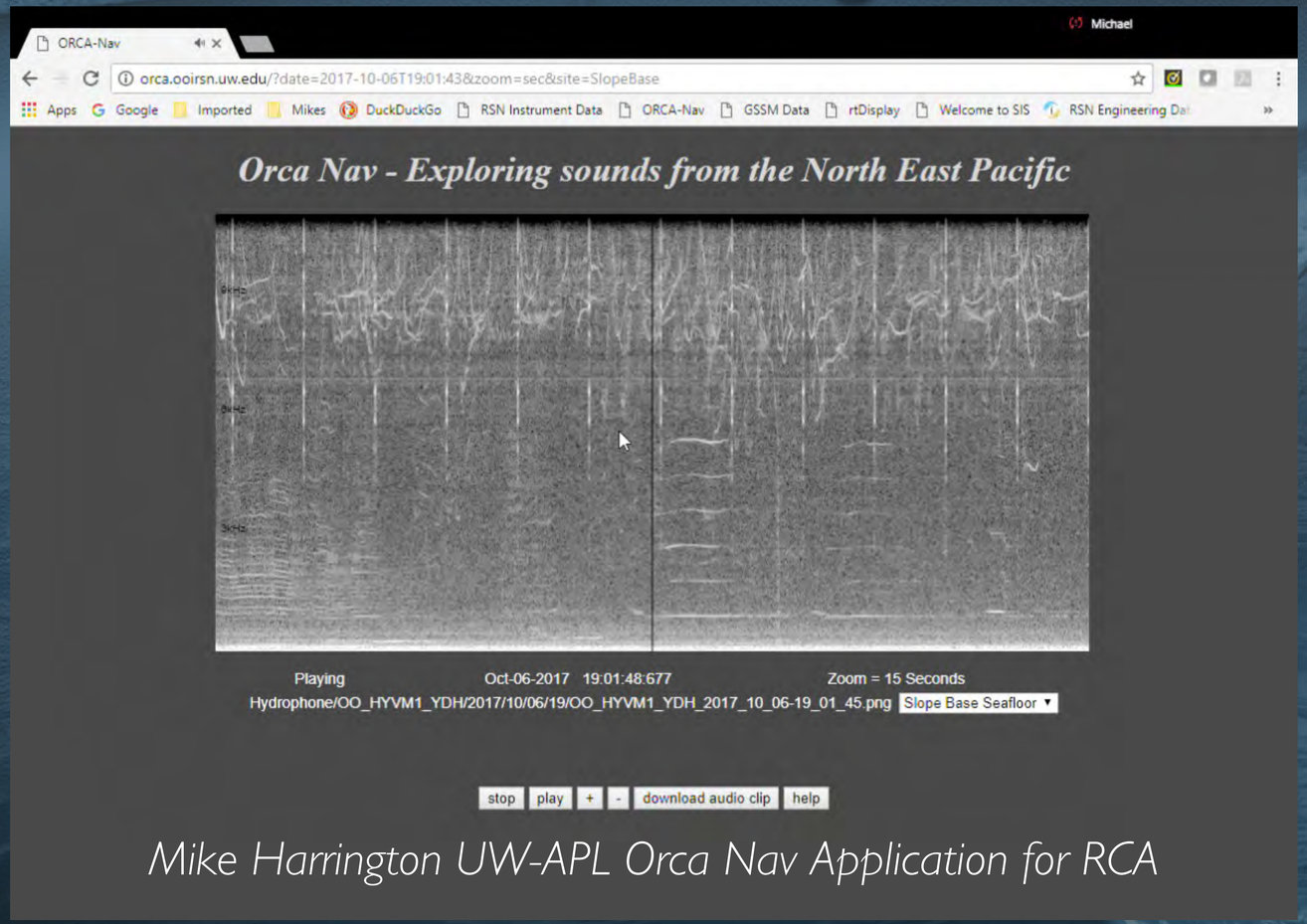


Fully operational since vehicle turned August 2021

>2.6 million meters traversed!

OR Margin 600 m

Listening to the Ocean: RCA Hydrophones

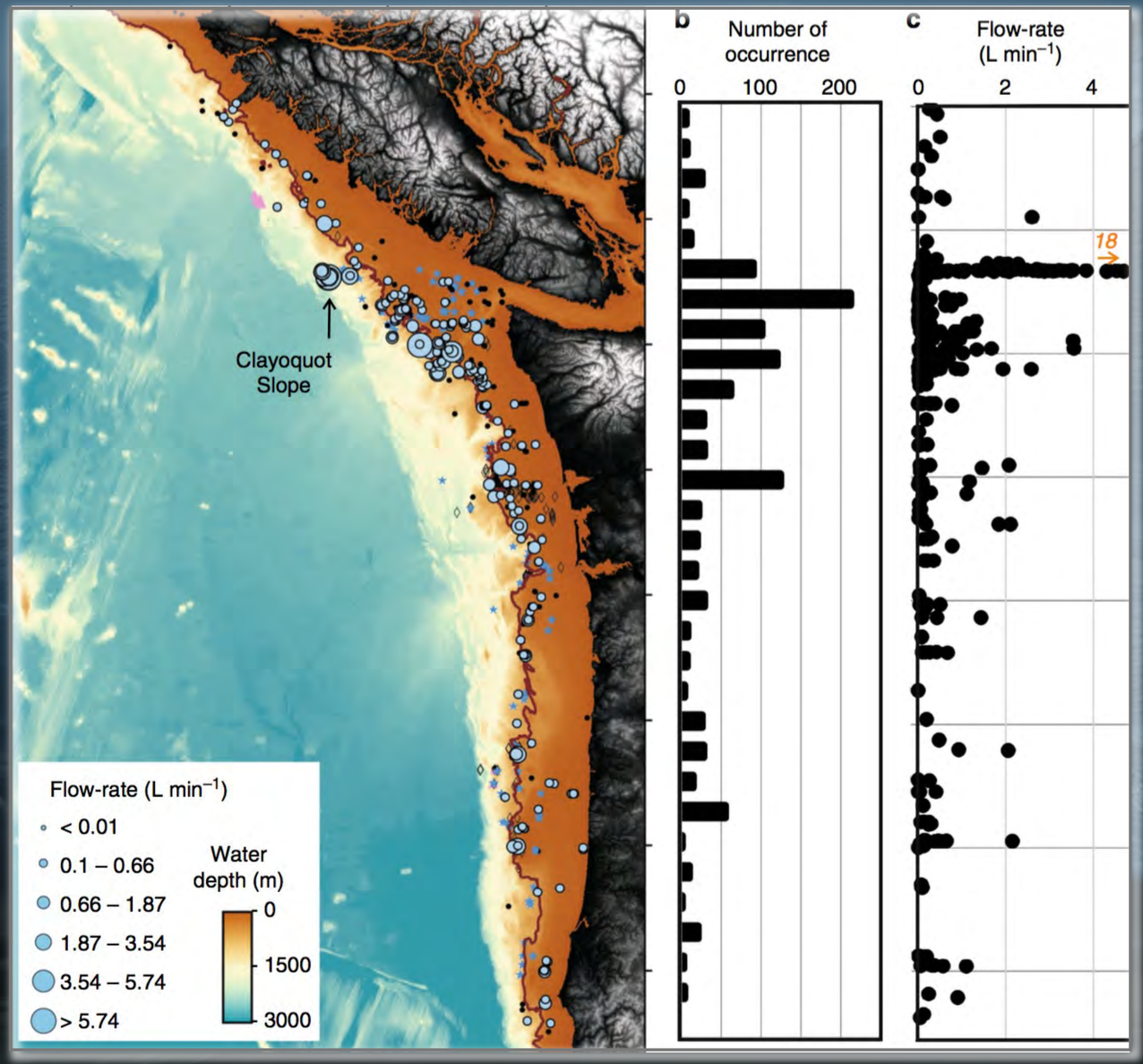


Mike Harrington UW-APL Orca Nav Application for RCA

Hydrophone data streaming from the Regional Cabled Array

- Hydrophone data over past decade show Fin whale songs are changing off our coast over time - becoming quieter (***Weirathmuller et al.,*** 2017).
- UW undergrad K Gonzales Senior Thesis analyzed 143,102 Fin whale calls at Axial and Slope Base over 5 years. Prior data lacking on Fin migration patterns offshore Cascadia.
- Showed that fin whales arrive at Slope Base 2-3 months earlier than at Axial, and that Axial calls end 2-3 mo later. Following availability of prey?
- Forms important foundation for follow-on studies

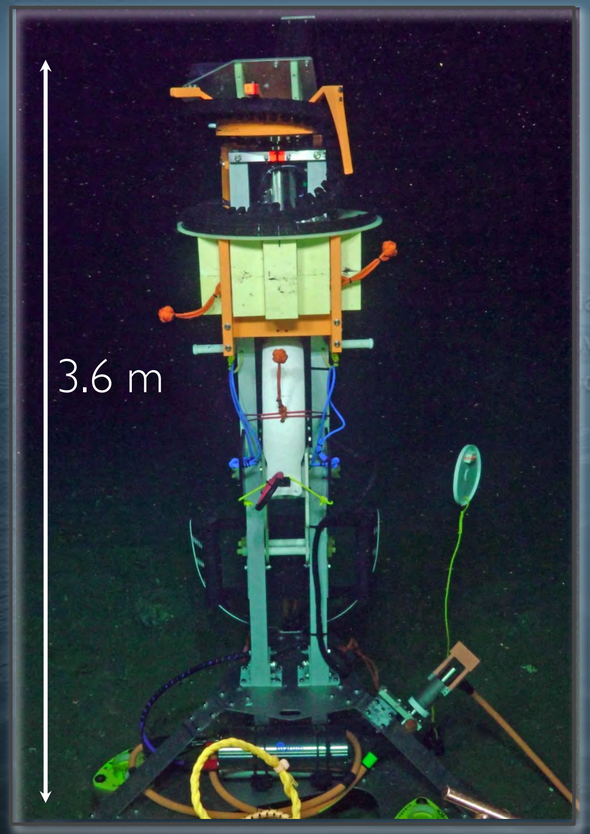
Methane Seeps Are a Significant Environment Along the Cascade Margin, Geohazard - landslides, release of methane - climate change



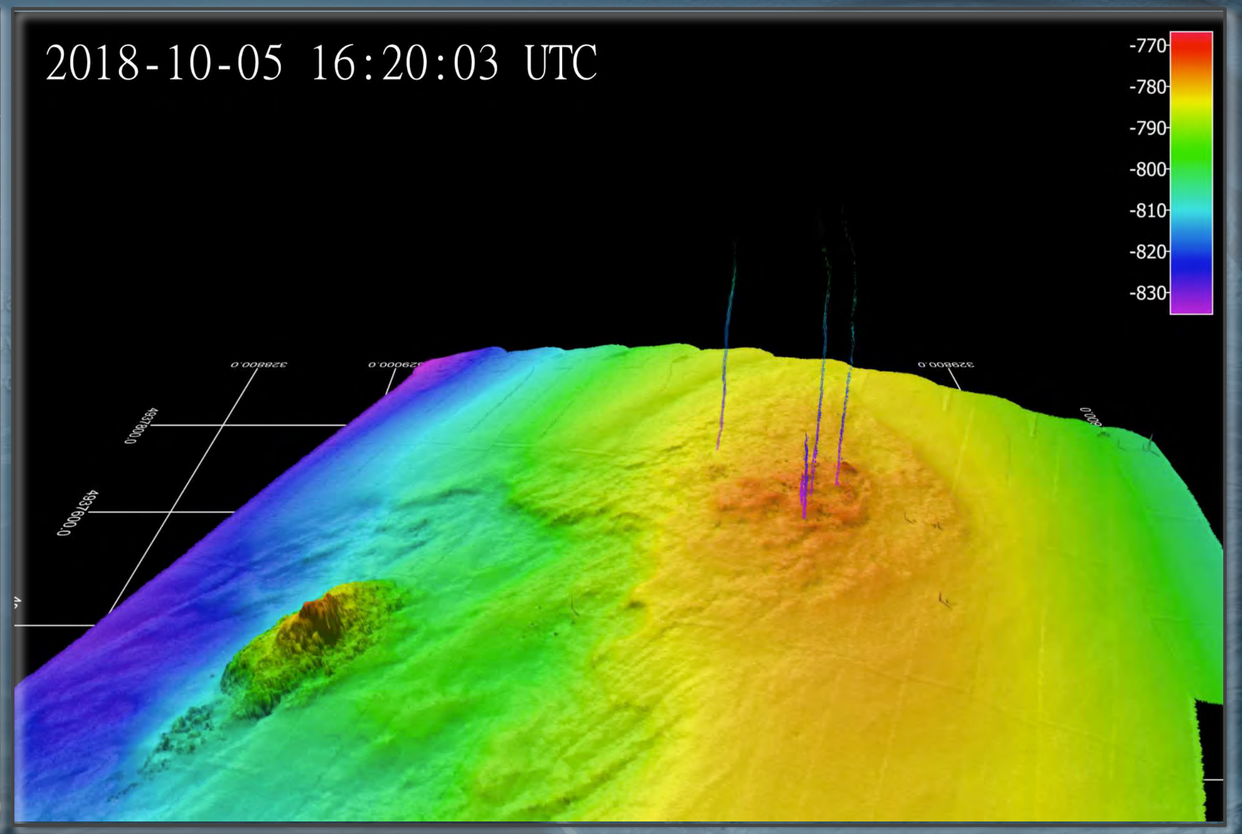
- Over 1100 Acoustic Flares (bubble plumes) mapped along the Cascade Margin (Reidel et al., 2018 Nature)
- Potential energy reserve, green house gas, slope instability, designated essential fish habitats
- Yet only 3 studied in any detail: Regional Cabled Array & ONC

OOI
OCEAN OBSERVATORIES INITIATIVE

MARUM AWARD: Unprecedented 360° imaging of all methane plumes issuing from SHR! First time flux measurements co-registered with seismicity



Multibeam sonar, ~ 700 m range, every 2 hrs for ~ 12 minutes



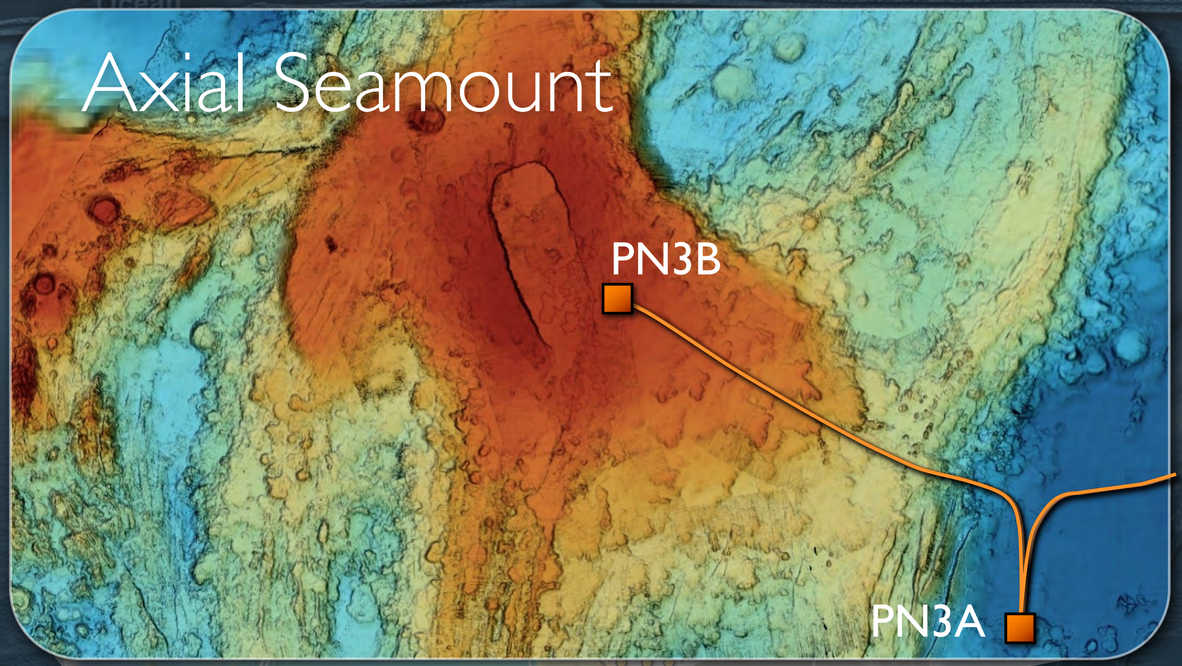
Overview sonar: one 360° scan every 2 hours - large files so buffered

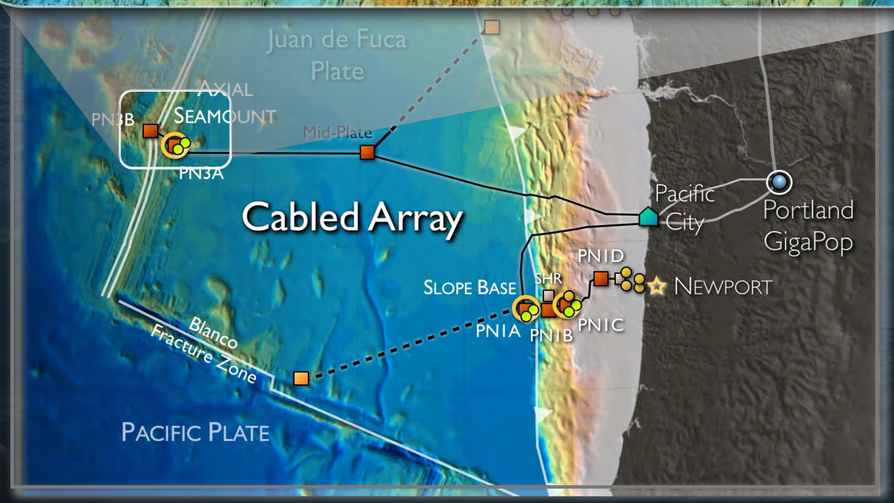
- Overview Sonar images all plumes issuing from SHR every 2 hrs,
- High resolution quantification sonar focused on Einsteins Grotto provides allows flux calculations and cm scale bathymetric quantification

Added 4K camera & CTD

NSF

OOI OCEAN OBSERVATORIES INITIATIVE





Axial erupted in 1998, 2011, and April 24, 2015 - Poised to Erupt again

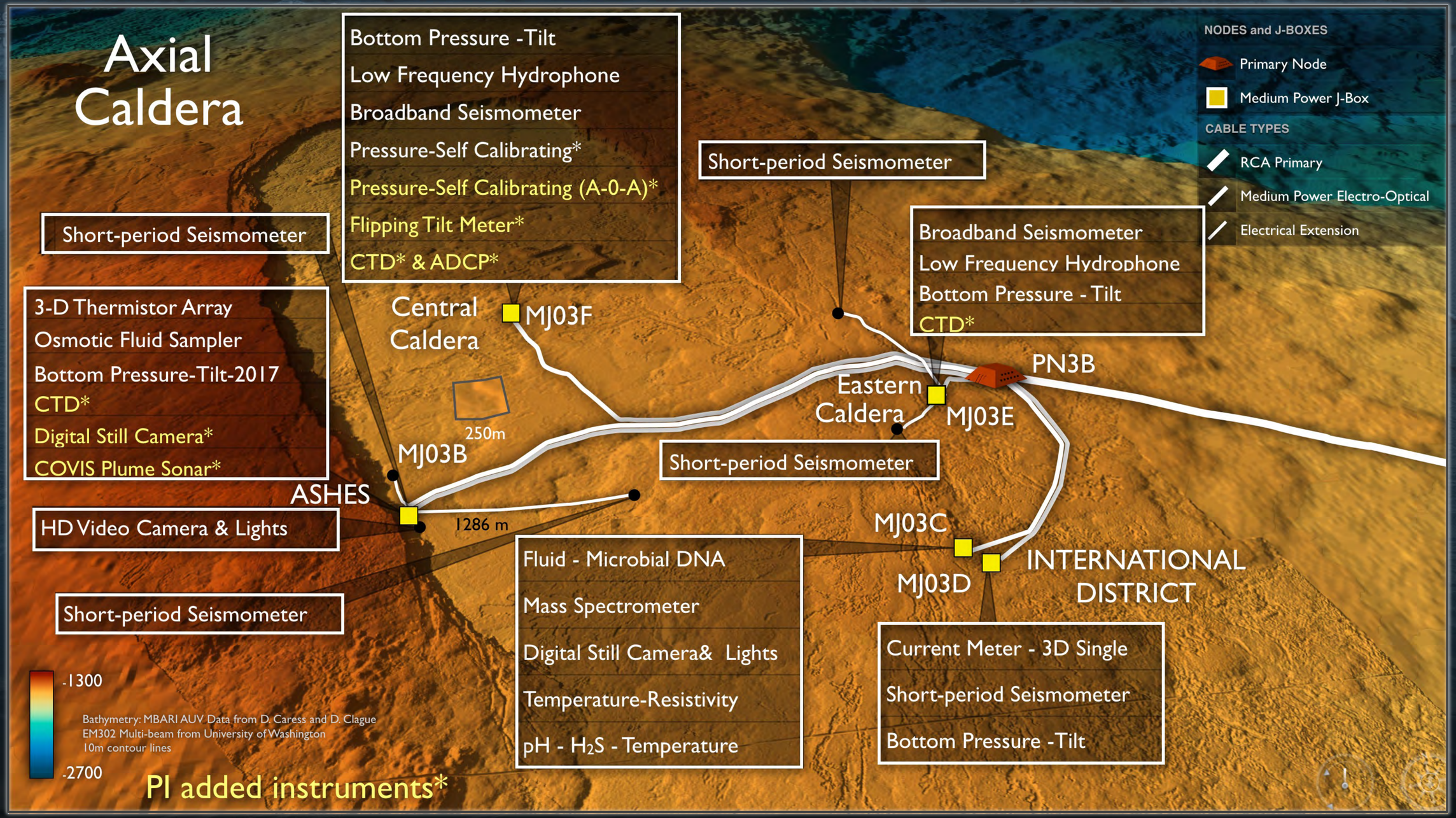
Axial Seamount
An advanced submarine volcanic observatory

- >70% of the volcanism on Earth occurs under water in systems like the one off our coast - largest mountain chain on Earth
- Emit huge amounts of heat, chemicals and biological material from the seafloor into the overlying ocean, but poorly studied temporally
- One of most extreme environments on Earth

Axial is the largest and most magmatically robust volcano off the WA-OR coast

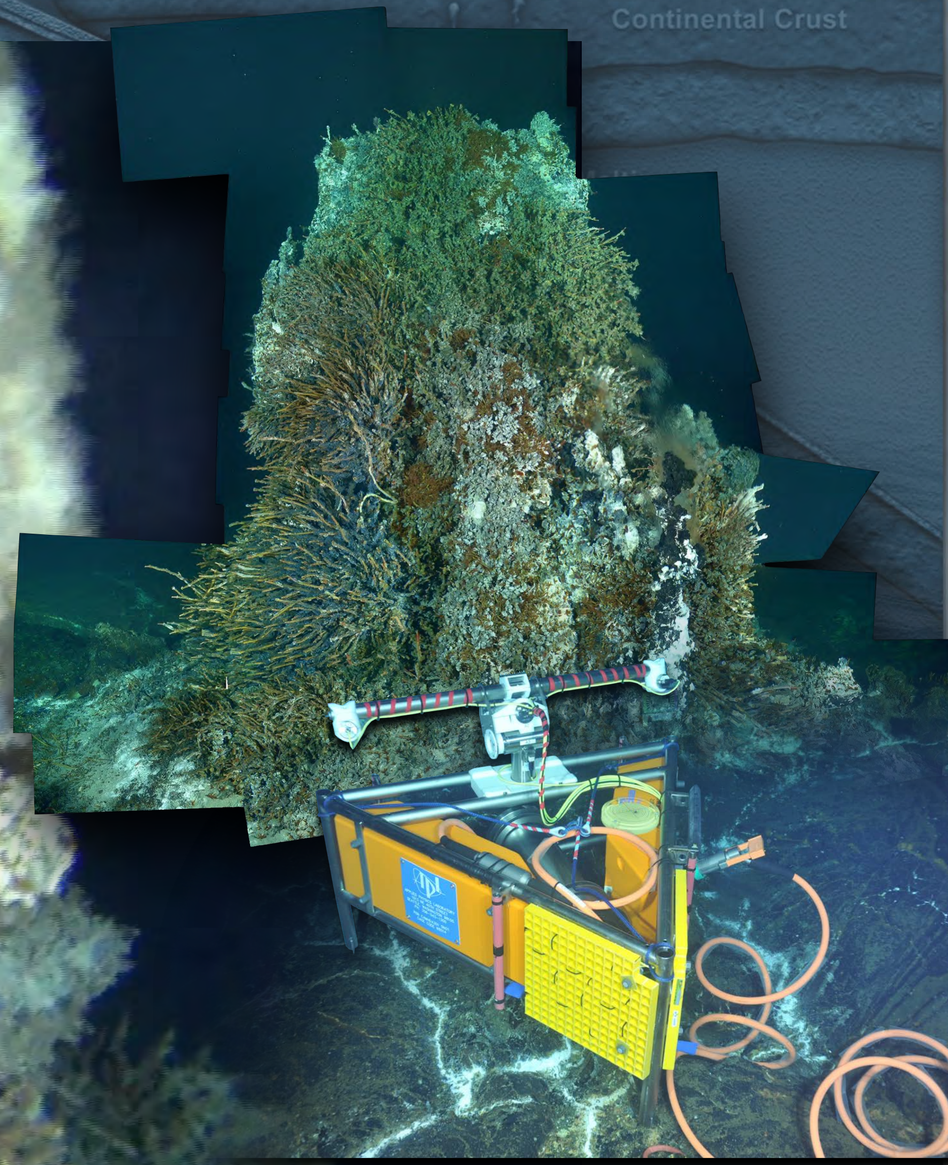
NSF

OOI OCEAN OBSERVATORIES INITIATIVE



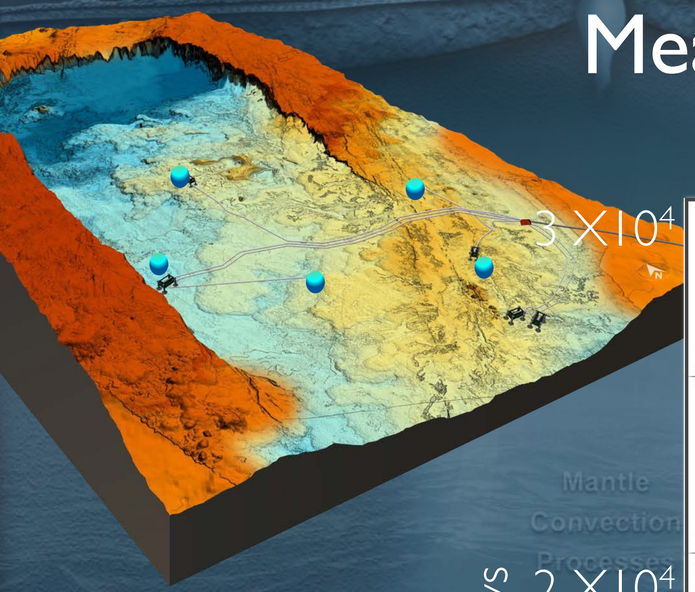
Cabled instruments allow co-measurement of earthquakes, changes in vent fluid temperature-chemistry, seafloor inflation and deflation, and microbial and macrofauna communities

High definition video streaming live every 3 hrs from 300 miles offshore, 1500 m deep



UW-APL HD Camera at the Mushroom hydrothermal vent

Measuring the heart-beat of a submarine volcano



Full Catalog (10 day bin)

Earthquakes detected
Earthquakes located

http://axial.ocean.washington.edu

2015 eruption

>8,000 earthquakes

in 24 hrs

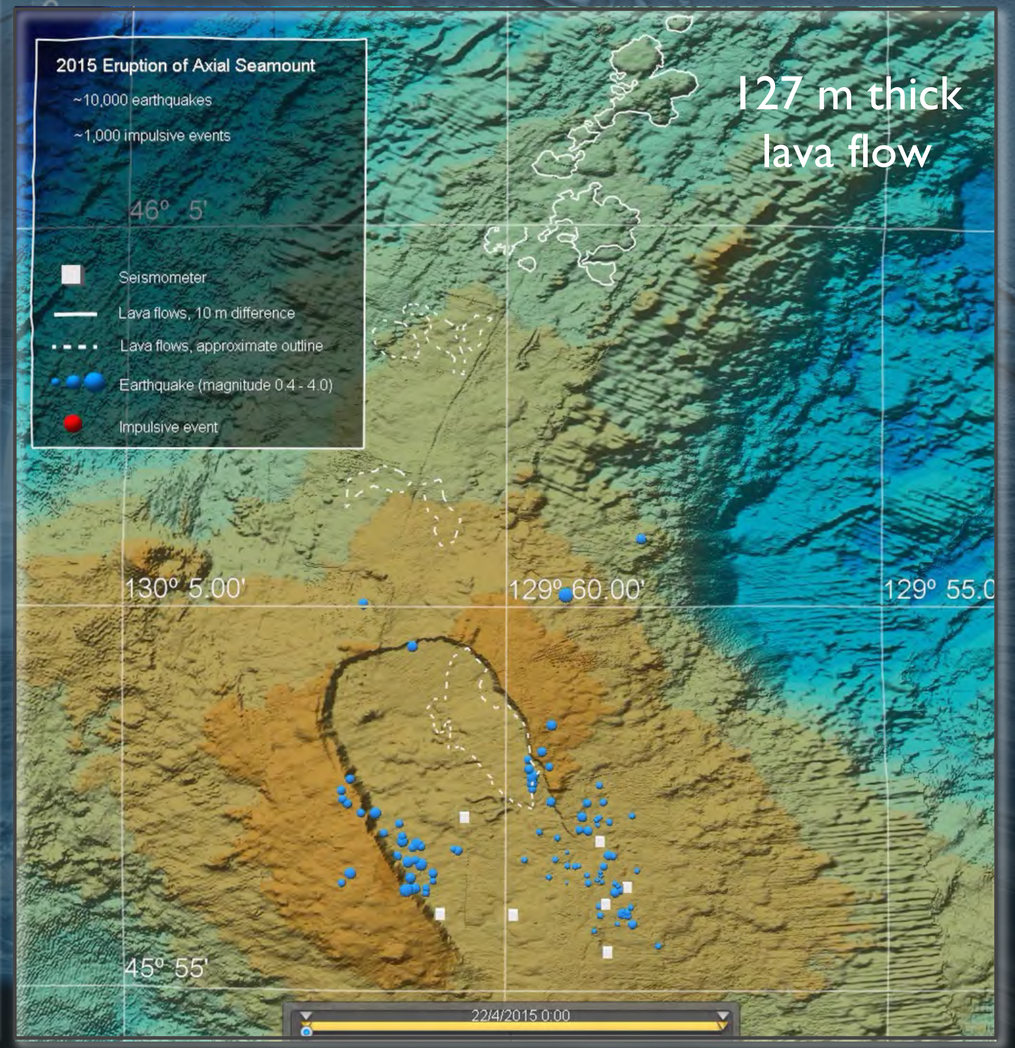
Earthquakes per 10 days

3×10^4
2×10^4
1×10^4
0

2014 2016 2018 2020 2022

2019

Wilcock et al., Science *2016*

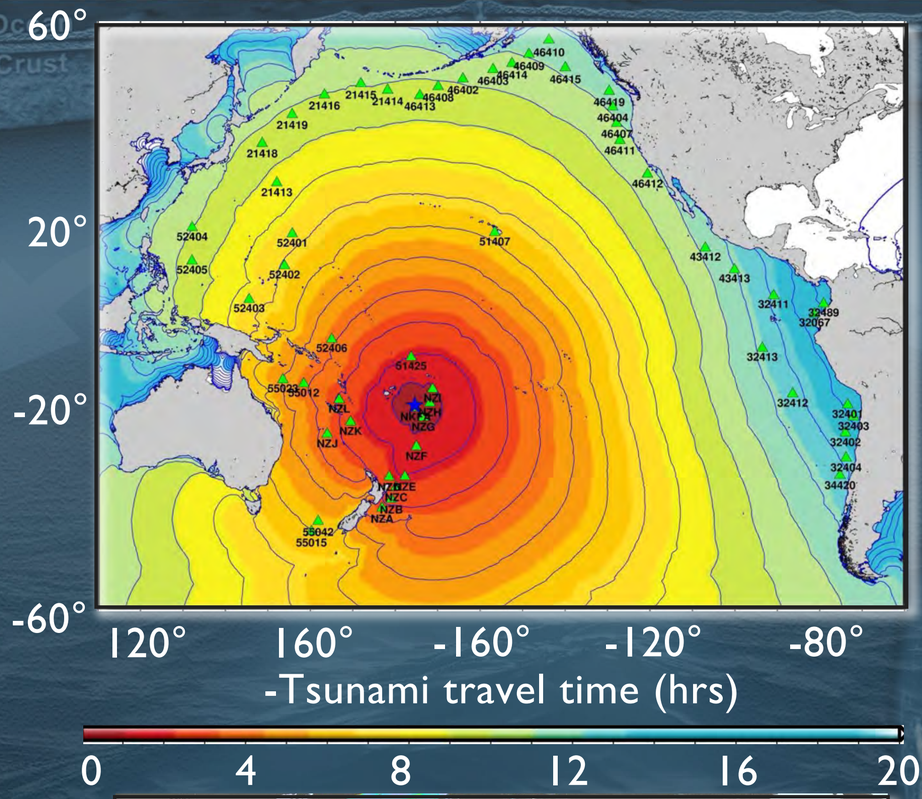


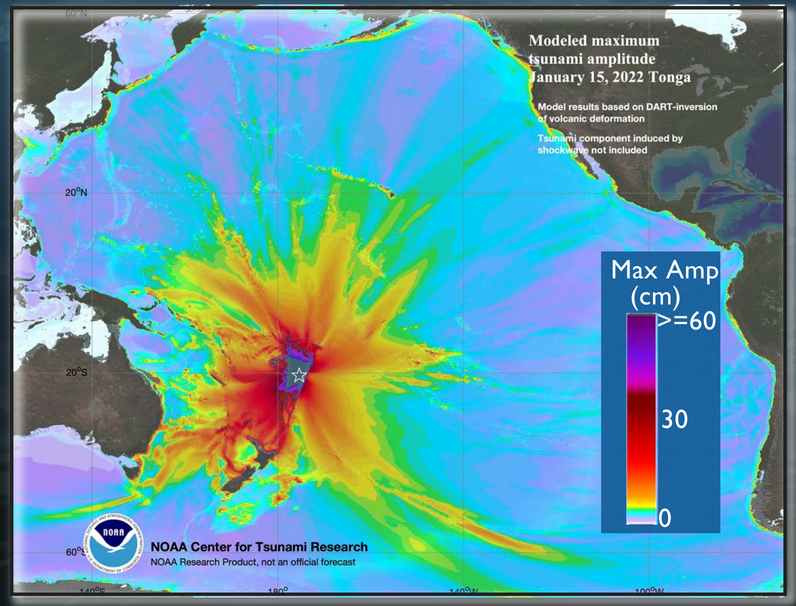
Earthquakes

Hydroacoustic events (explosions)

See William Wilcocks Science Plenary "Preparing for the next eruption of Axial Seamount"

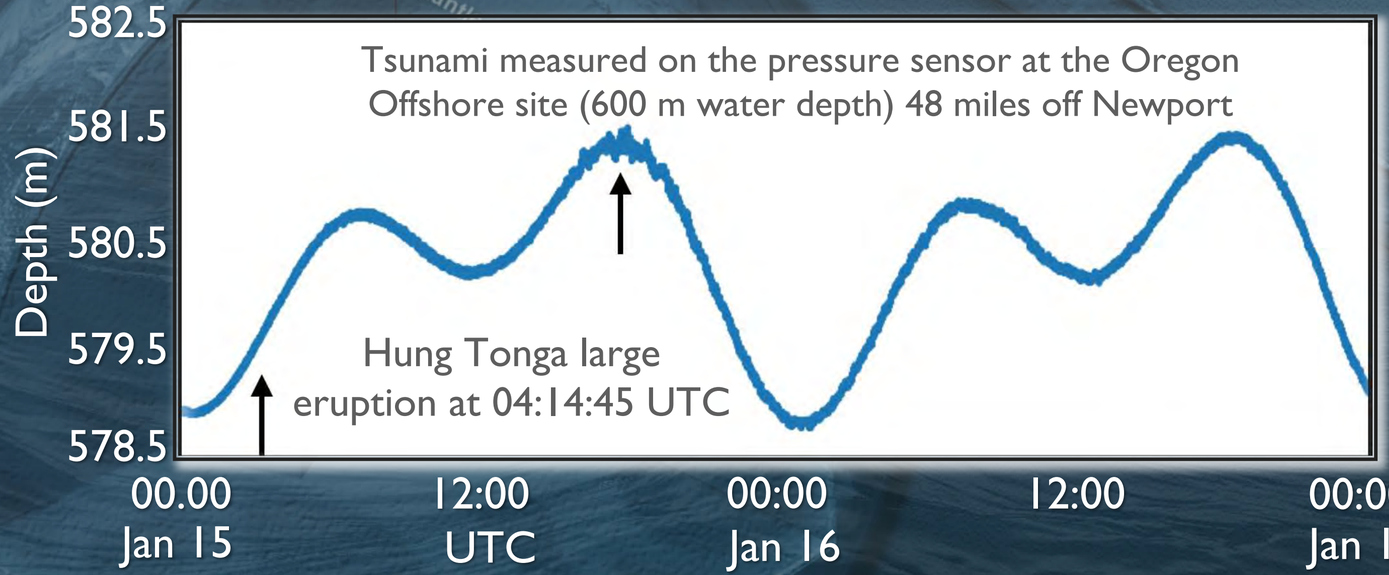
RCA Geohazard Applications





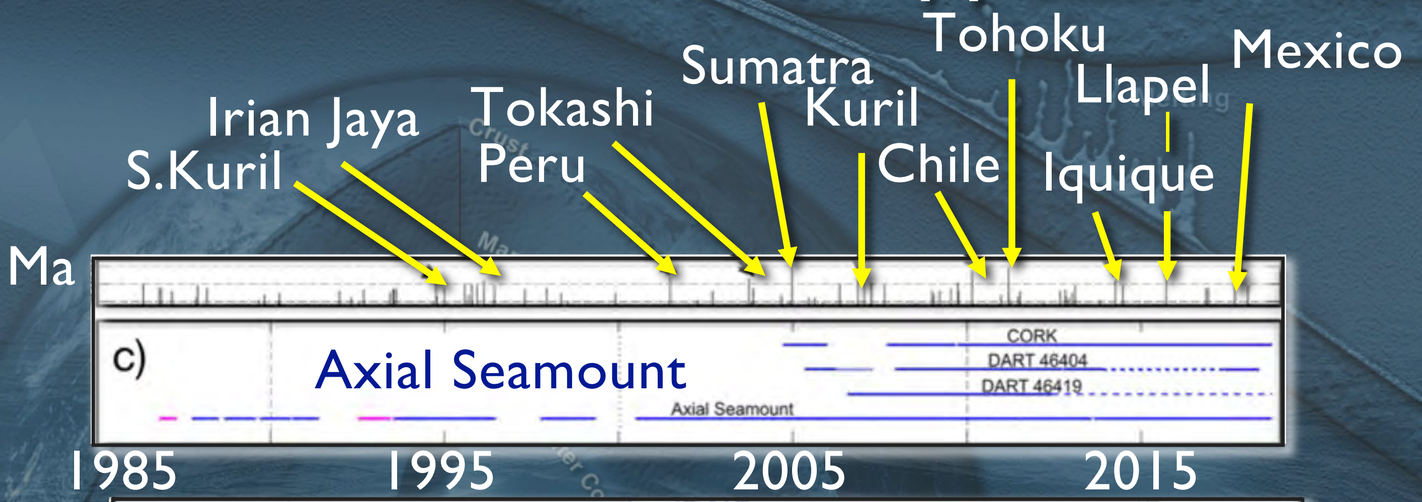
Modeled maximum tsunami amplitude

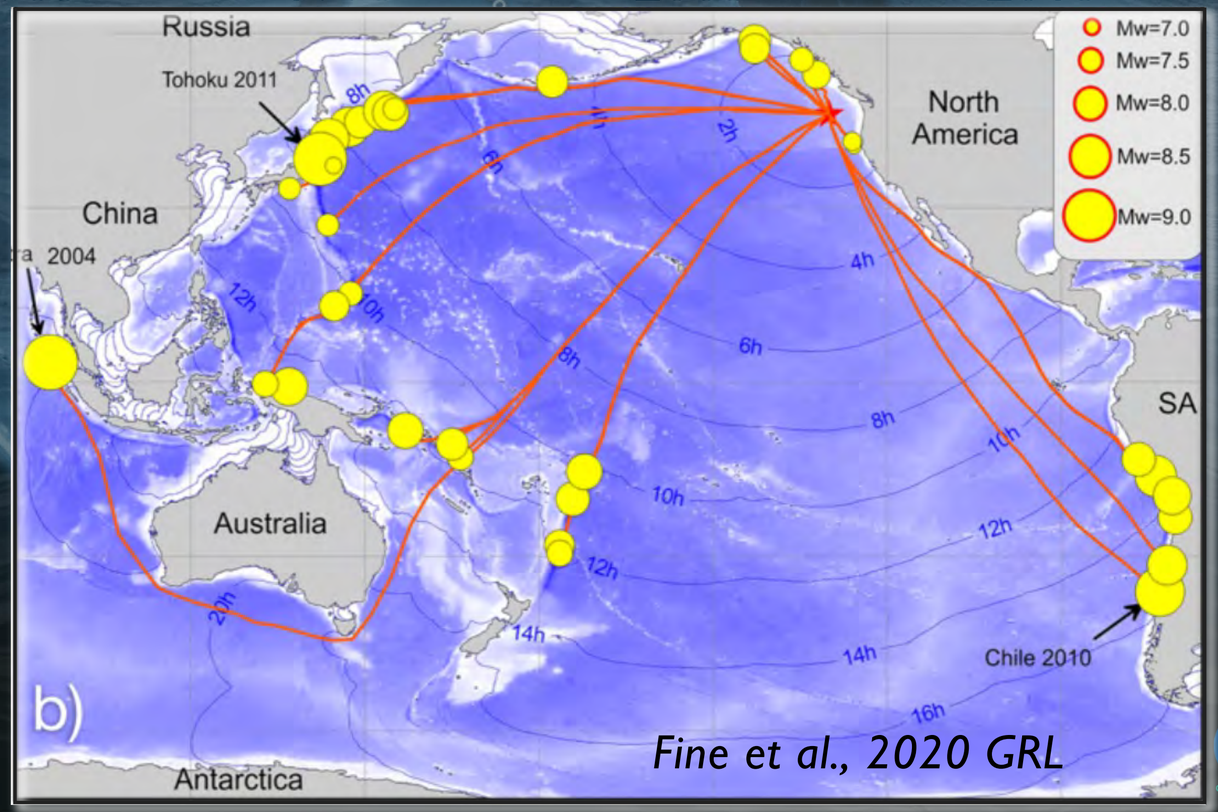
Tonga Tsunami: Oregon Offshore BEP Detection



- Late in the afternoon Hung Tonga volcano explosions produced 5 km-wide ash column between 17:00 -18:30 local time. A much larger eruption started the following day (15 January 2022) at 17:14 local time (04:14:45 UTC).
- RCA data incorporated into NOAA Tsunami Warning Database

RCA Geohazard Applications

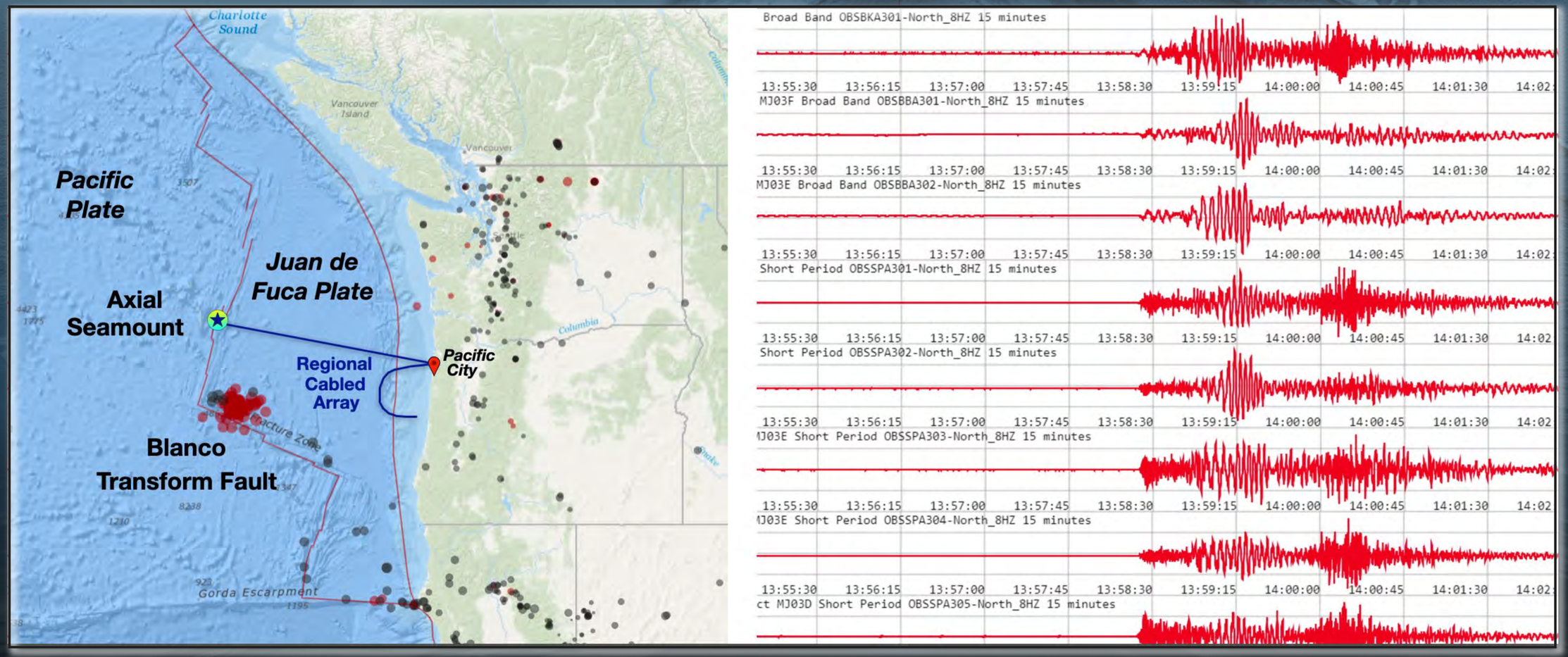




- Fine et al. (2020) examined 32-year record of uncalled and cabled bottom pressure recorders (BPR) at Axial Seamount and NE Pacific
- BPR's have better detection than tide observations
- 41 tsunamis documented 1986-2018 from 7.0 Ma or greater earthquakes: several new detections
- Allows forecasting in NE Pacific & size frequency model world wide. 20 Hz sampling rates with 2 mm seawater depth provide especially high resolution measurements

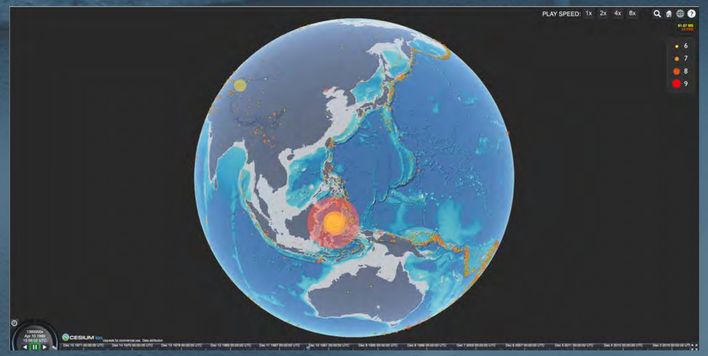
RCA Geohazard Applications

OOI Regional Cabled Array Real-Time Seismic Data Display: Axial Seamount, Juan de Fuca Ridge

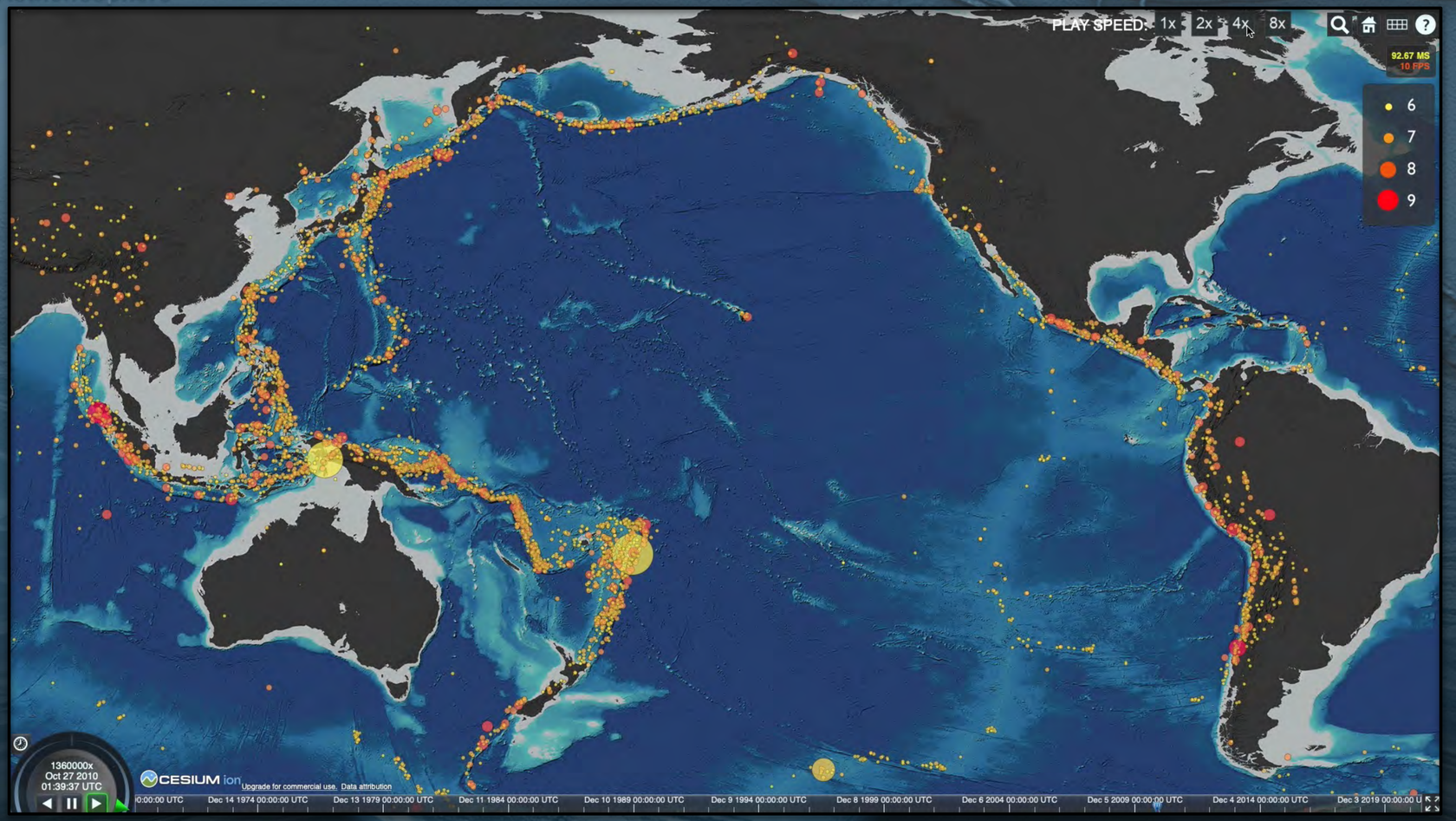


- Blanco Transform Fault seismic swarm Dec. 2021 produced nearly 100 earthquakes in 48 hrs
- Discussions underway to get RCA seismic data into ShakeAlert®

K. Borders - NSF OCE K12 Ocean Observatories Initiative (OOI) Workshop Series

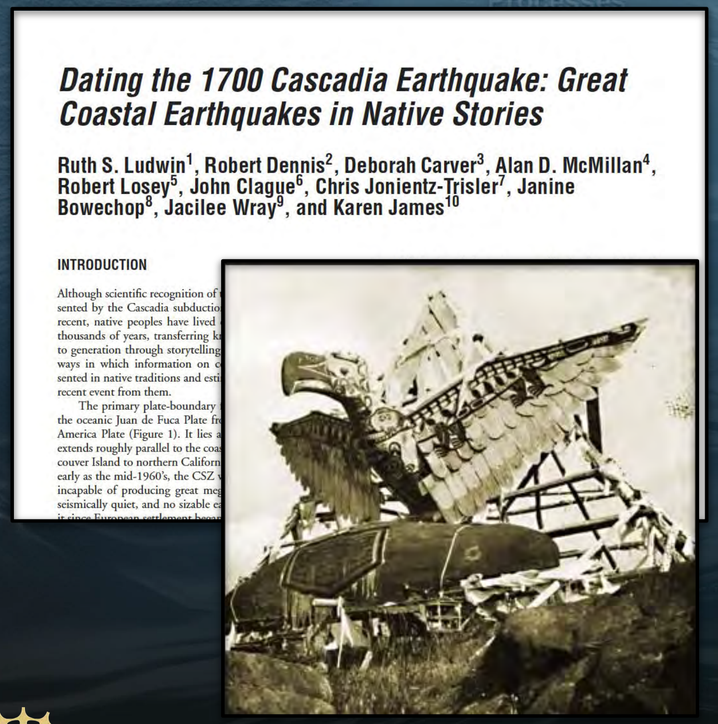


Interactive globe
Data from 1974 to present



K12 Earthquake Visualization

K12 Module examining earthquakes and tsunamis along Cascadia Margin incorporating indigenous storytelling



Dating the 1700 Cascadia Earthquake: Great Coastal Earthquakes in Native Stories

Ruth S. Ludwin[1], Robert Dennis[2], Deborah Carver[3], Alan D. McMillan[4], Robert Losey[5], John Clague[6], Chris Jonientz-Trisler[7], Janine Bowechop[8], Jacilee Wray[9], and Karen James[10]

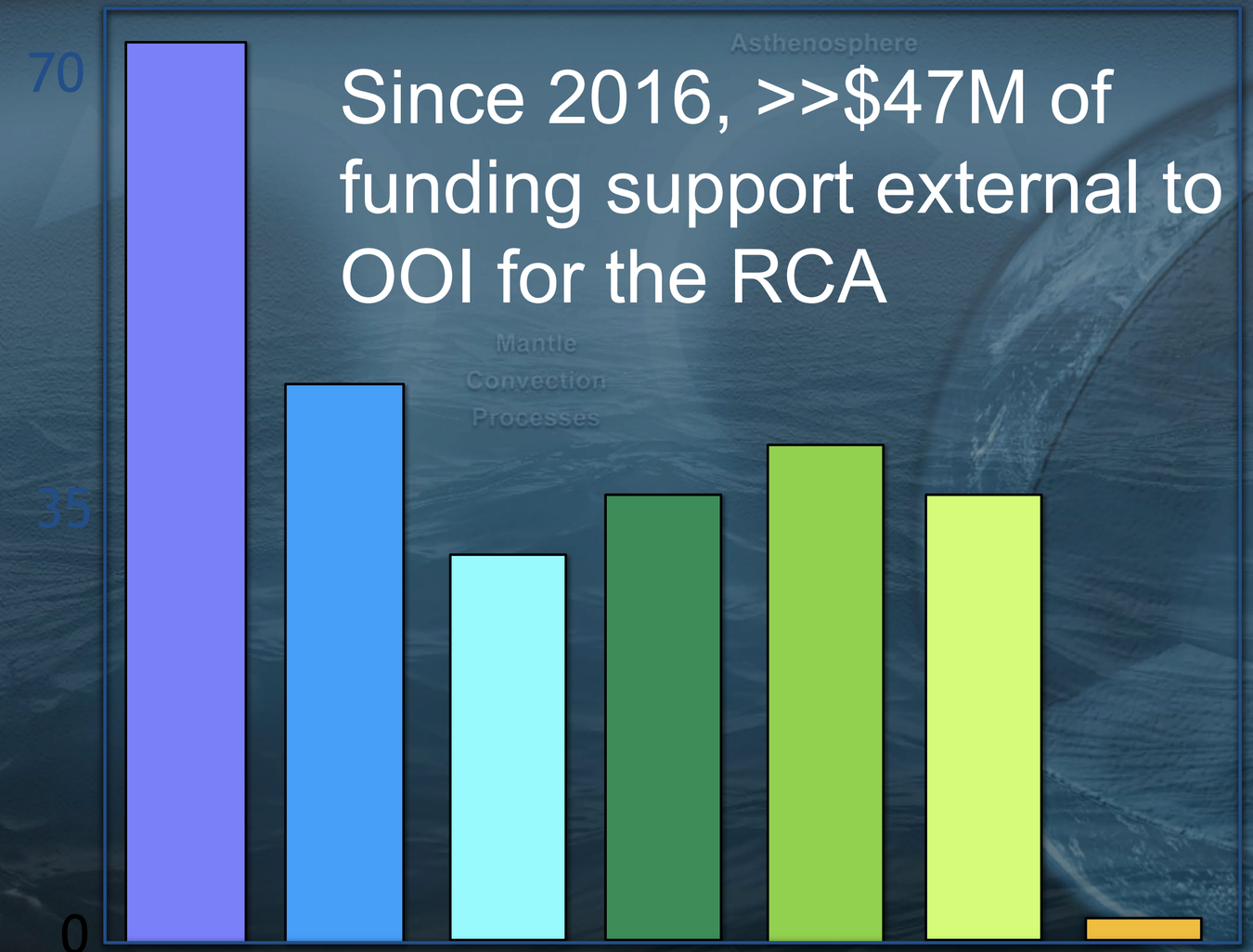
INTRODUCTION

Although scientific recognition of
sented by the Cascadia subductio
recent, native peoples have lived
thousands of years, transferring k
to generation through storytelling.
ways in which information on e
sented in native traditions and esti
recent event from them.

The primary plate-boundary
the oceanic Juan de Fuca Plate fr
America Plate (Figure 1). It lies
extends roughly parallel to the coa
couver Island to northern Californ
early as the mid-1960's, the CSZ
incapable of producing great me
seismically quiet, and no sizable e
it since European settlement began

Thunderbird and Whale
Quileute, Hoh, Kwakiutl

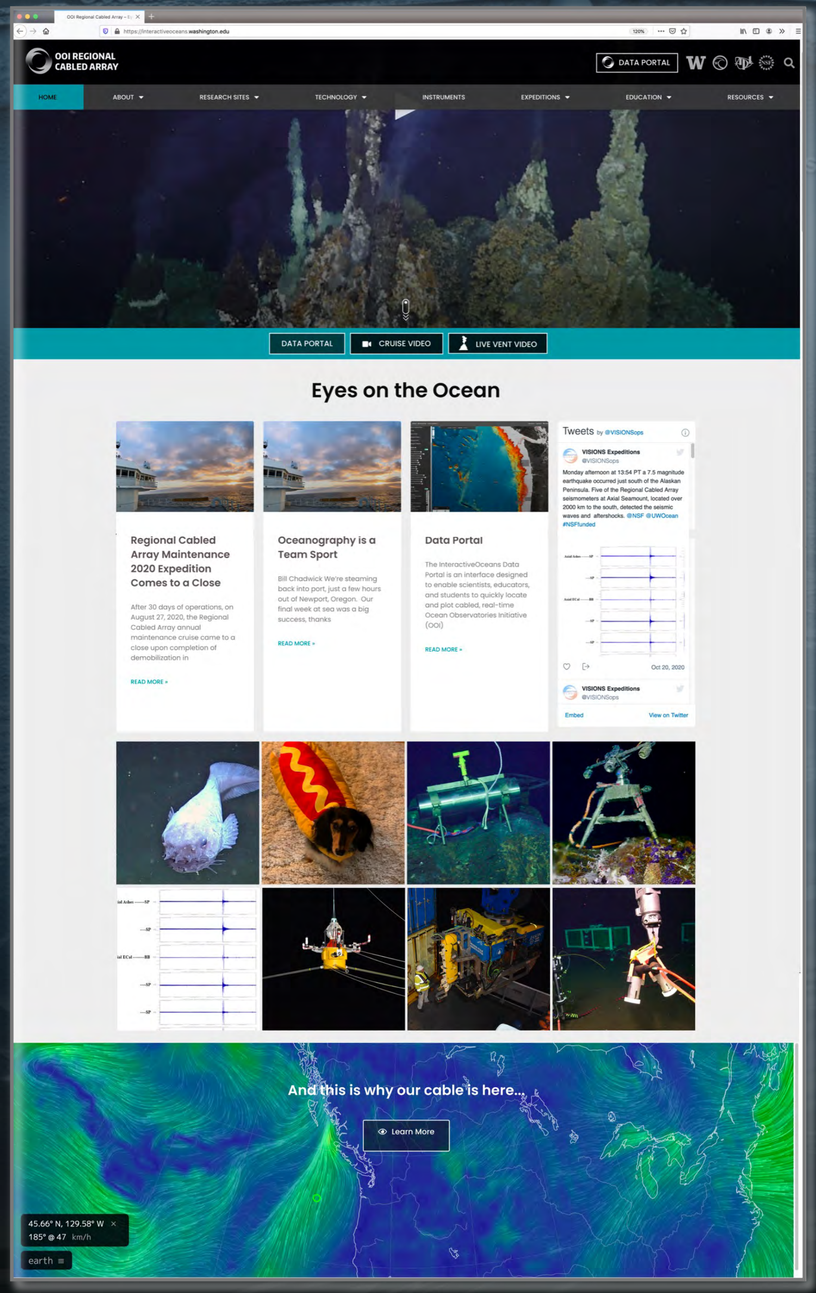
Significant Opportunities for Funding External To OOI

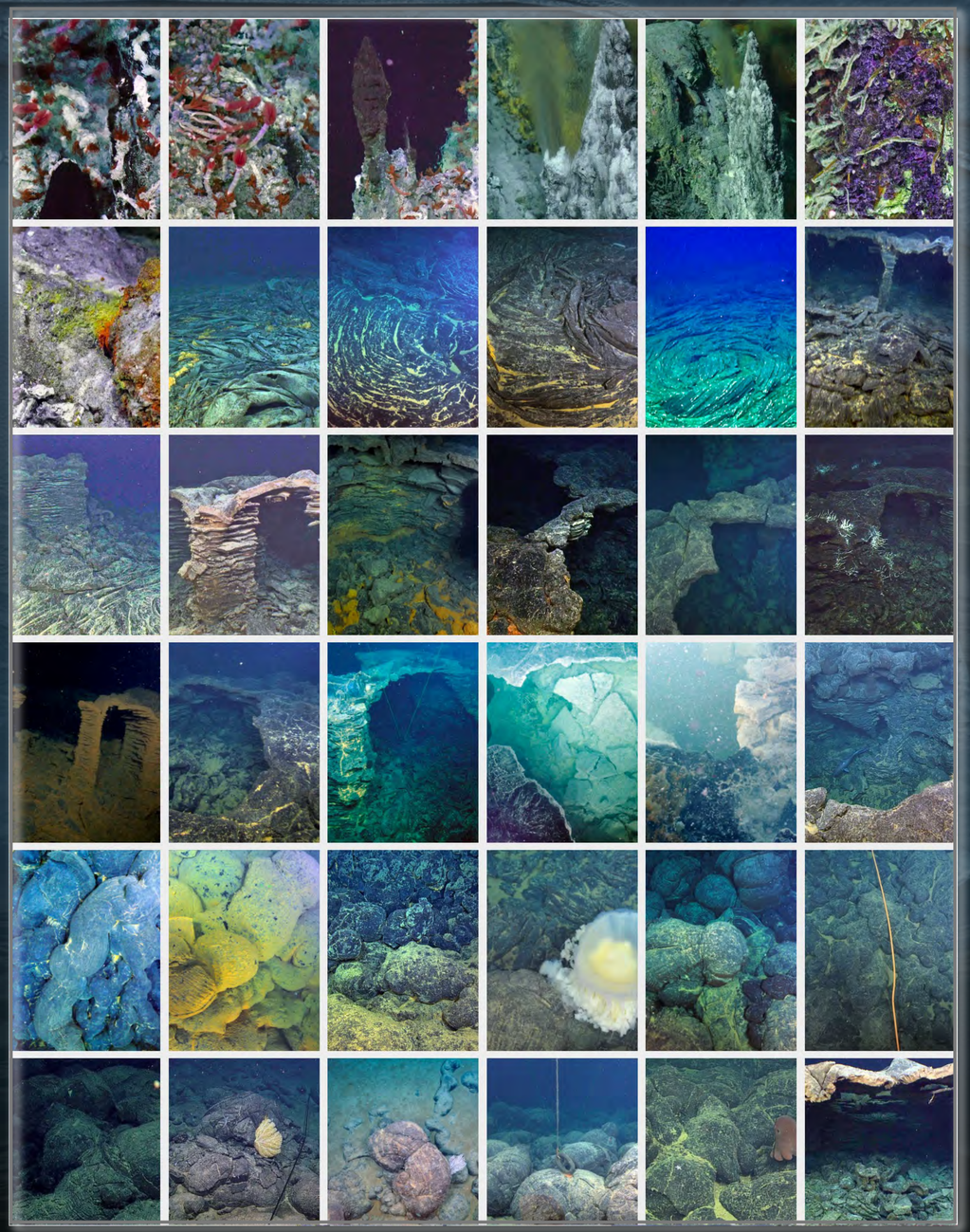


Since 2016, >>$47M of funding support external to OOI for the RCA

- 73 Total Funded awards (PI and Subawards)
- 43 PI Awards
- 30 Co-PI awards
- 35 PI's
- 40 Co-PIs
- 35 Institutions (including JPL and MARUM - Germany)
- 2 Industry

Diverse Portfolio = NSF, Office of Navy Research, NASA, Bureau of Ocean Energy Management, MARUM Germany





Resources

RCA science and technology

All research sites

Extensive video library

Over 3,000 images (perfec for outreach)

Biological catalog for Axial and the Cascadia Margin/Slope Base

Data portal hosts >600 data stream

UW Cloud-Hosted Educational Site interactiveoceans.washington.edu & Data Portal









Thank You!

>160 Undergrads have participated on the UW-RCA VISIONS At-Sea Experiential Program