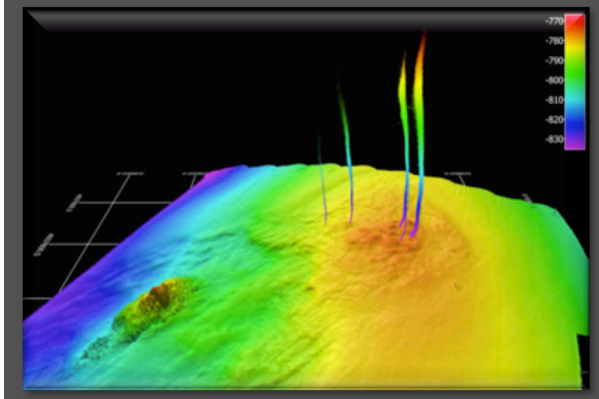
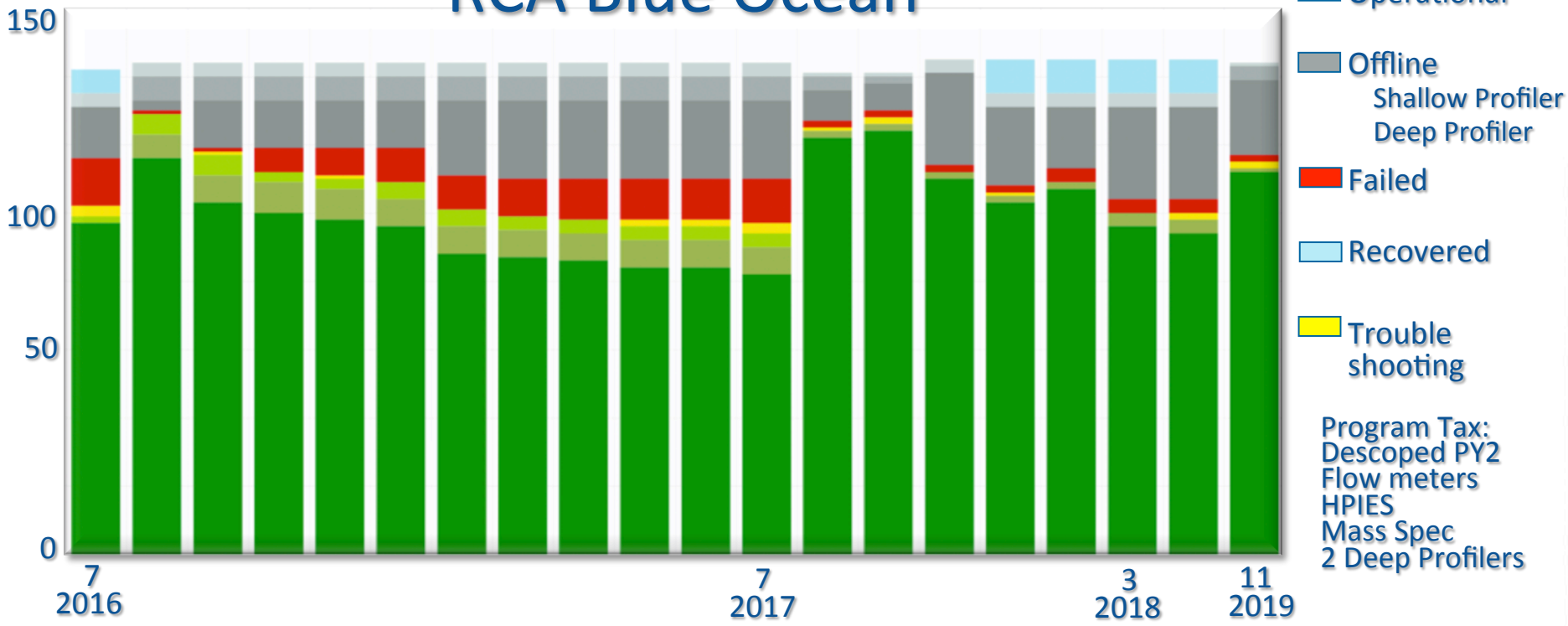
Ocean Observatories Initiative
Regional Cabled Array

November 12, 2019



Debbie Kelley & RCA Team
University of Washington

Instrument/Infrastructure Status
RCA Blue Ocean

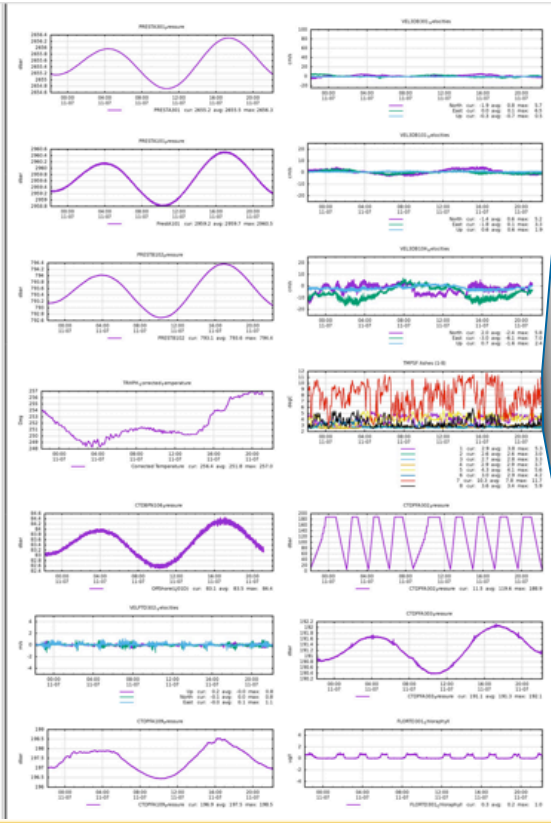


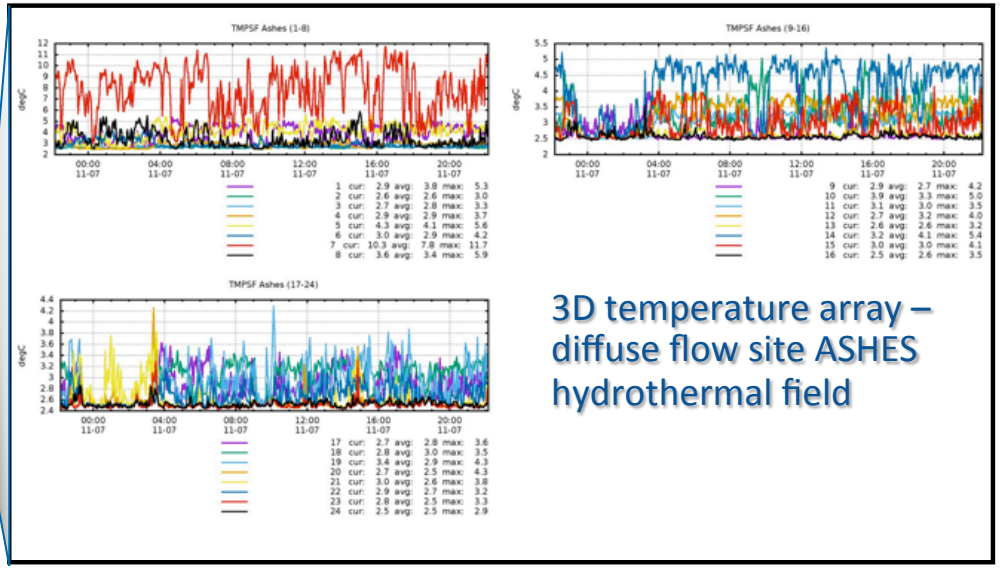
Deployed M2M Real-Time Monitoring

- Top Links
  - RSN Instrument Data Page
  - RSN Process Logs Page
  - OOI Process Logs Page
  - Seismic Data Page
  - Hydrophone Test Page
  - M2M Instrument Data
  - M2M Engineering Data (Beta)
  - M2M Response Status
  - M2M Inst. Status
  - CAMDS Stills

OOI Instrument Data Page

- Summary
  - Summary (w) (m) (y)
- MJ01A
  - PRESTA101 (w) (m) (y)
  - VEL3DB101 (w) (m) (y)
- LJ01A
  - CTDPFB101 (w) (m) (y)
  - HYDBBA102
- PC01A
  - CTDPFA103 (w) (m) (y)
  - HYDBBA103
- SF01A
  - CTDPFA102 (w) (m) (y)
  - PARADA101 (w) (m) (y)
  - VELPTD102 (w) (m) (y)
  - FLORTD101 (w) (m) (y)
  - SPKIRA101 (w) (m) (y)
  - NUTNRA101 (w) (m) (y)
  - PHSENA101 (w) (m) (y)
  - PCO2WA101 (w) (m) (y)
- PD01A
  - CTDPFL104 (w) (m) (y)
  - VEL3DA103 (w) (m) (y)
  - CDOMAA101 (w) (m) (y)
  - FLORTA102 (w) (m) (y)
  - DOSTAD104 (w) (m) (y)
- LJ01B
  - PRESTB102 (w) (m) (y)
  - VEL3DB104 (w) (m) (y)
- PC01B
  - CTDPFA109 (w) (m) (y)
- SF01B
  - CTDPFA107 (w) (m) (y)
  - PARADA102 (w) (m) (y)
  - VELPTD106 (w) (m) (y)
  - FLORTD104 (w) (m) (y)
  - SPKIRA102 (w) (m) (y)
  - NUTNRA102 (w) (m) (y)
  - PHSENA108 (w) (m) (y)
  - PCO2WA102 (w) (m) (y)
- PD01B
  - CTDPFV105 (w) (m) (y)





3D temperature array – diffuse flow site ASHES hydrothermal field

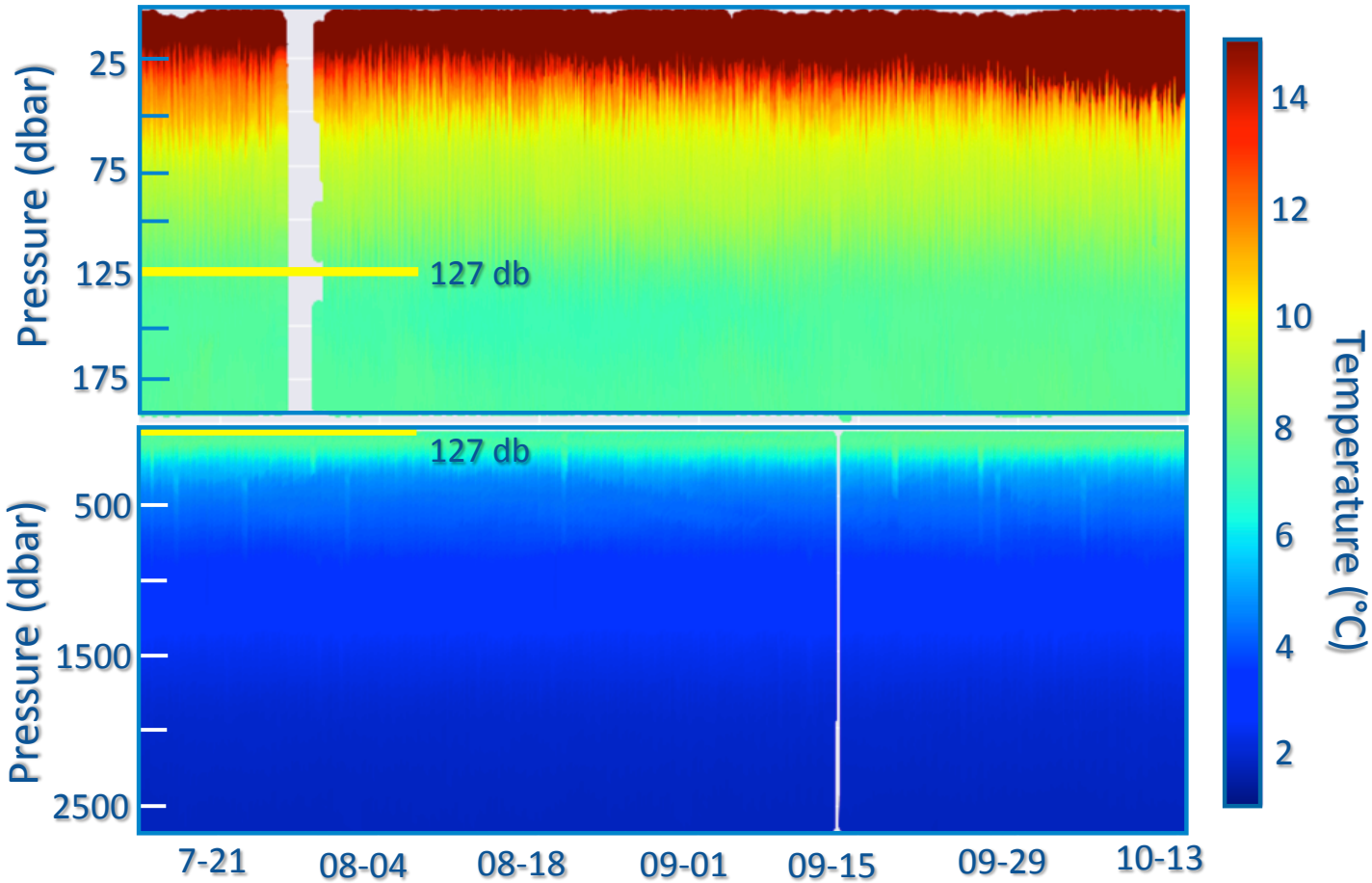
Profiling Mooring Status

Shallow Profiler Moorings (>40,000 profiles since 2015)

- Axial Base: Turned EOM >2700 m cable, 12 ft platform, instrumented science pods; fully operational with significant overlap with Deep Profiler - yahoooooo
- Turned stationary platforms and winched science pods at Slope Base and Oregon Offshore; investigating oil pressure drop that impacts science pod, stationary platform fully operational

Deep Profiler Moorings

- Axial Base: Turned vehicle; fully operational for **~17 months** transiting 2 times/day
- Slope Base: Vehicle transiting 2 x day full depth range, but not communicating; Oregon Offshore powered down to use port for Shallow Profiler Mooring

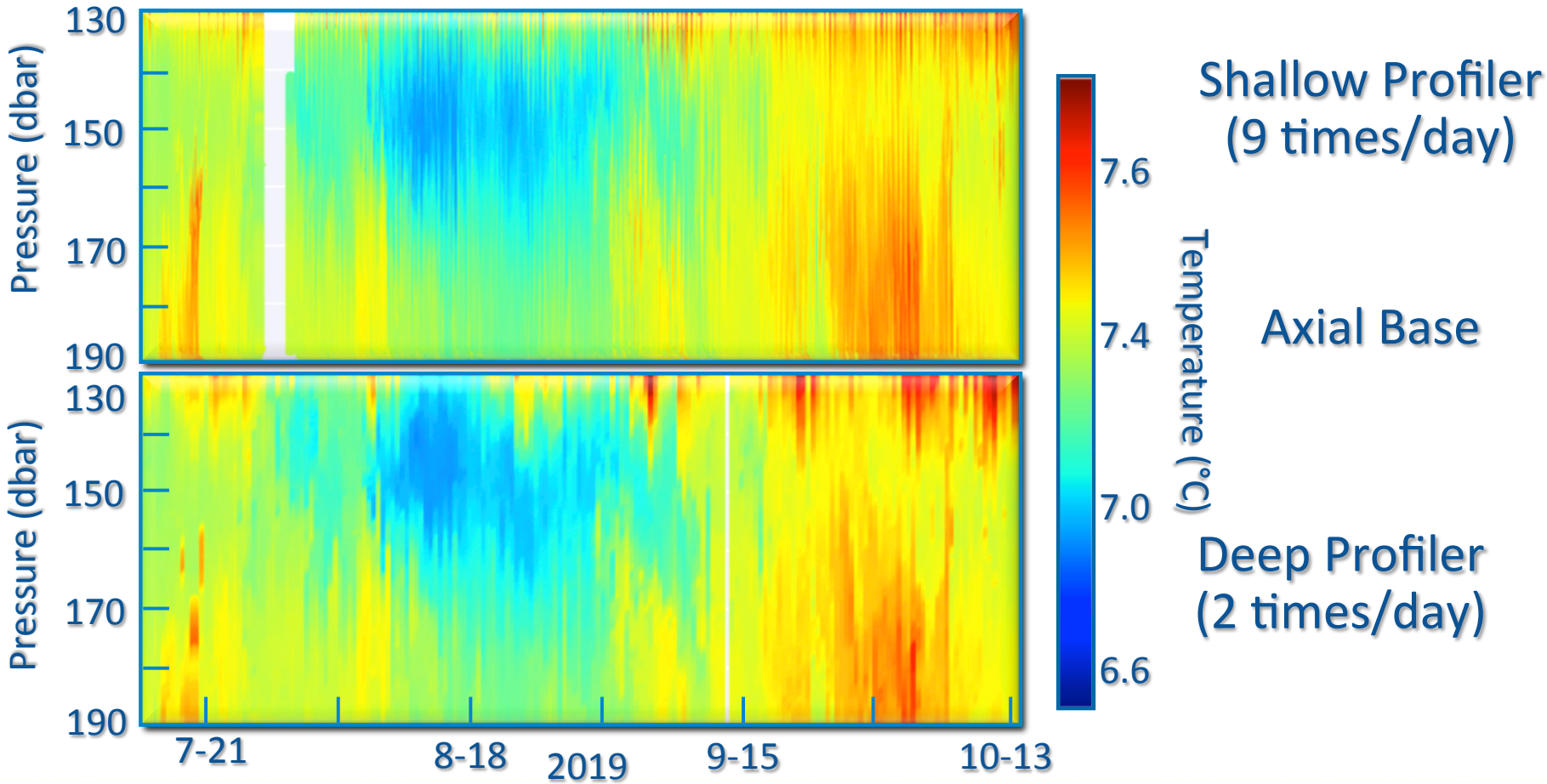


Shallow Profiler
(9 times/day)

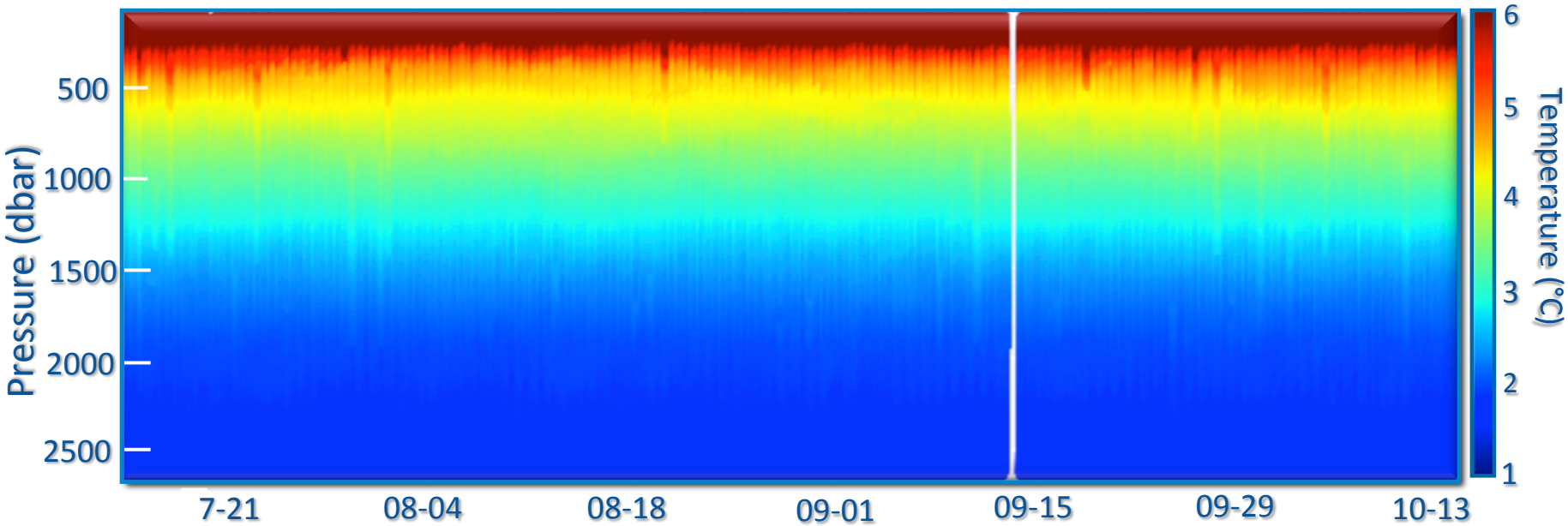
Axial Base
2019

Deep Profiler
(2 times/day)

2) Axial_SP_DP_full_anot:

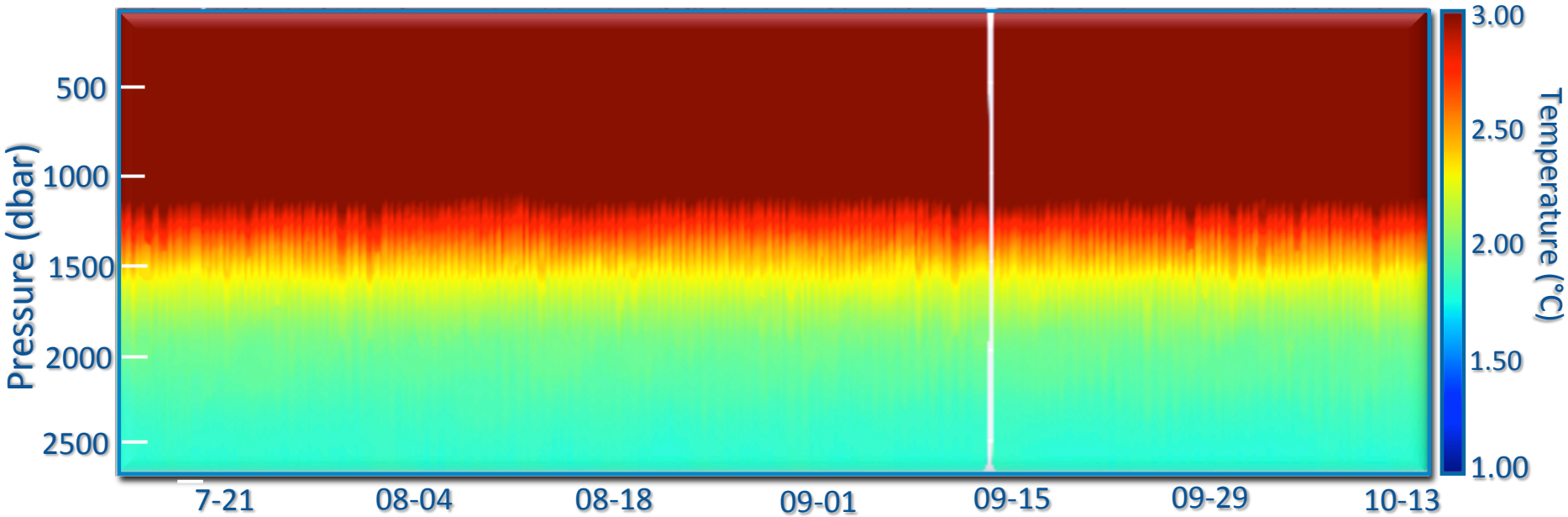

Pressure (dbar)
130
150
170
190
Pressure (dbar)
130
150
170
190
7-21
8-18
2019
9-15
10-13
7.6
7.4
7.0
6.6
Temperature (°C)
Shallow Profiler
(9 times/day)
Axial Base
Deep Profiler
(2 times/day)

Axial Base
Deep Profiler August-October 2019



Graphs by R. Scott, recent UW B.Sc. Oceanography & VISIONS18 & 19 student: Developed Jupyter notebook for Deep and Shallow Profiler Data

Axial Base – delineating fine scale structure at depth
Deep Profiler August-October 2019



Graphs by R. Scott, recent UW B.Sc. Oceanography & VISIONS18 & 19 student: Developed Jupyter notebook for Deep and Shallow Profiler Data

UW Regional Cabled Array Engagement

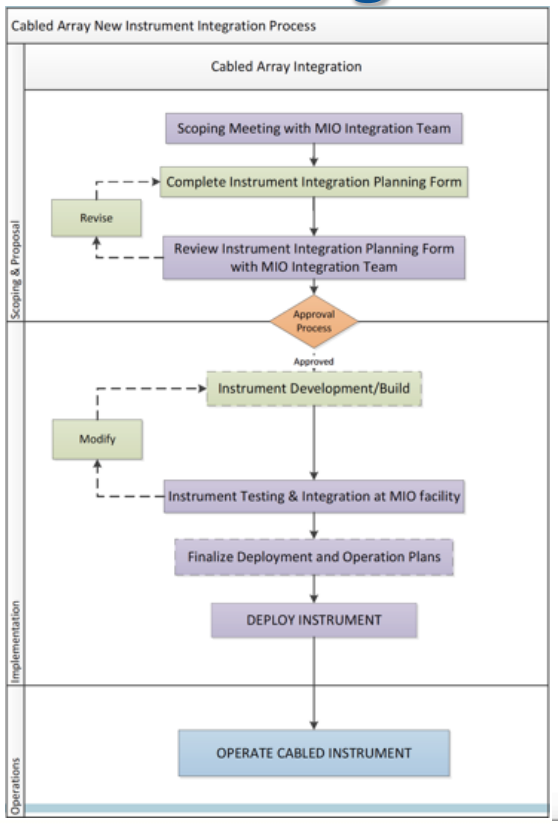
- Community Webinar
  - Interaction with PI's for Proposals and follow-on awards
- Conferences/Workshops Talks
- 2019 O&M Cruise: Externally Funded Instruments
- Educational Efforts
- PY2 Engagement Activities

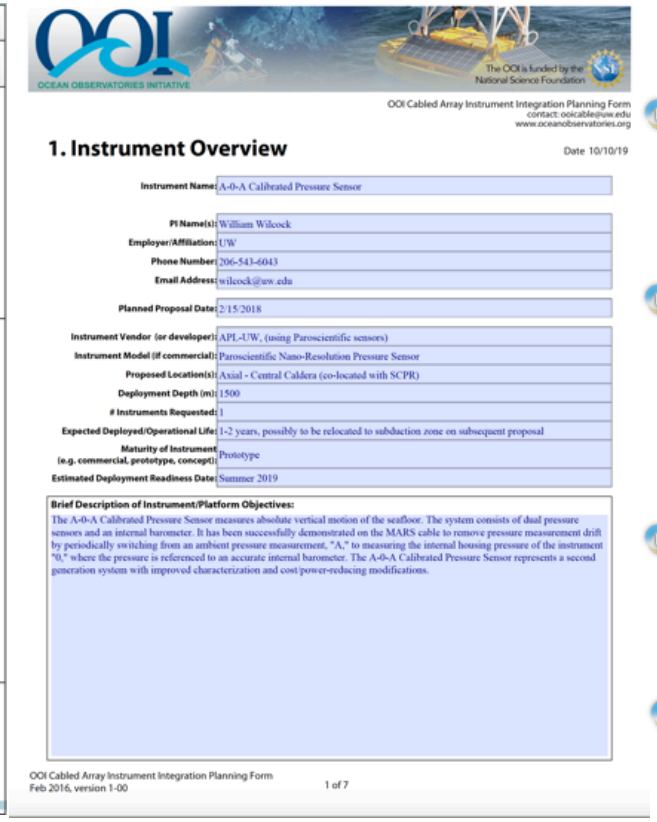
UW Regional Cabled Array Engagement

- Community Webinar (Will reschedule for early January): Paired Science and Engineer lead for each PI inquiry
- Significant interactions (2018-2019) by the UW RCA team for NSF, ONR, International and NASA proposals and awards

- Review of infrastructure and architecture overview
- Secondary Node Overview
- Interface summary and details (e.g power and communications, cables, connectors)
- Instrument Integration and testing
- Lessons learned
- UW Facilities and Support

Regional Cabled Array PI Proposal Process





OCEAN OBSERVATORIES INITIATIVE

The OOI is funded by the National Science Foundation

OOI Cabled Array Instrument Integration Planning Form
contact: ooicable@uw.edu
www.oceanobservatories.org

1. Instrument Overview

Date 10/10/19

Instrument Name:	A-0-A Calibrated Pressure Sensor
PI Name(s):	William Wilcock
Employer/Affiliation:	UW
Phone Number:	206-543-6043
Email Address:	wilcock@uw.edu
Planned Proposal Date:	2/15/2018
Instrument Vendor (or developer):	APL-UW, (using Paroscientific sensors)
Instrument Model (if commercial):	Paroscientific Nano-Resolution Pressure Sensor
Proposed Location(s):	Axial - Central Caldera (co-located with SCPR)
Deployment Depth (m):	1500
# Instruments Requested:	1
Expected Deployed/Operational Life:	1-2 years, possibly to be relocated to subduction zone on subsequent proposal
Maturity of Instrument (e.g. commercial, prototype, concept):	Prototype
Estimated Deployment Readiness Date:	Summer 2019

Brief Description of Instrument/Platform Objectives:

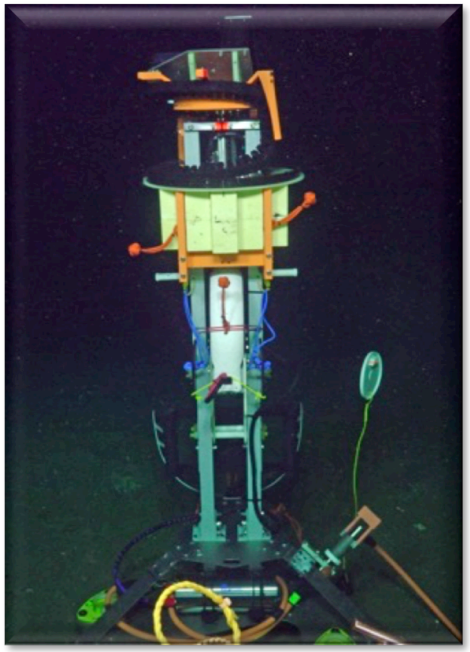
The A-0-A Calibrated Pressure Sensor measures absolute vertical motion of the seafloor. The system consists of dual pressure sensors and an internal barometer. It has been successfully demonstrated on the MARS cable to remove pressure measurement drift by periodically switching from an ambient pressure measurement, "A," to measuring the internal housing pressure of the instrument "0," where the pressure is referenced to an accurate internal barometer. The A-0-A Calibrated Pressure Sensor represents a second generation system with improved characterization and cost/power-reducing modifications.

OOI Cabled Array Instrument Integration Planning Form
Feb 2016, version 1-00

1 of 7

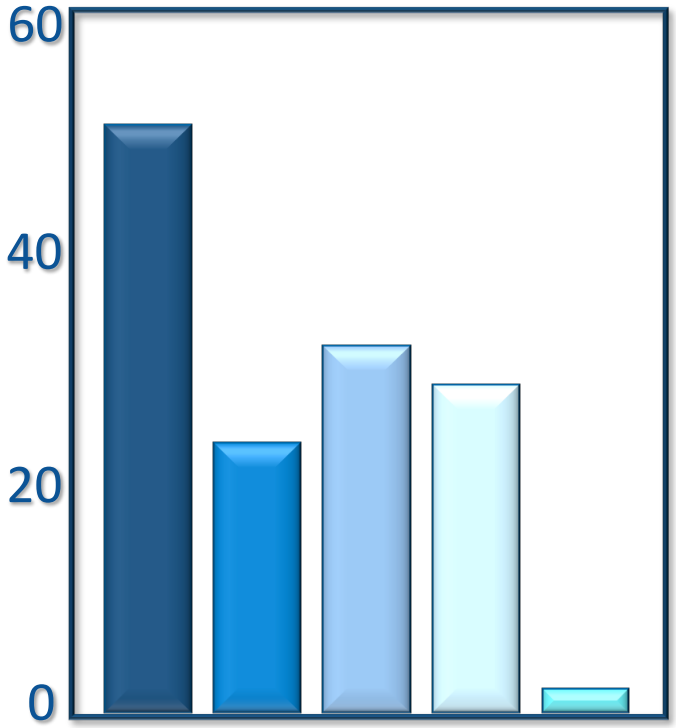
- Typically significant follow-on engagement with PI's & their engineers
- Subcontract for all proposals with scope of work, deliverables, budget, justification etc
- RCA Technical Feasibility/ Cost Letter
- Intense testing, integration, cruise planning

Regional Cabled Array External PI Proposals PY1 OOI2.0



- Dealt with 16 proposals/awards
- Four included existing awards (NASA, ONR, Germany, NSF) – testing, integration, field programs
- Four new awards were funded (1 EAGER)
- Three not funded
- Three pending (1 Early Career) – 2 on ship schedule
- Two preproposals (IODP) with cabled corked observatories – Axial, Cascadia Margin-Slope VBase, two in progress, one add on small field program

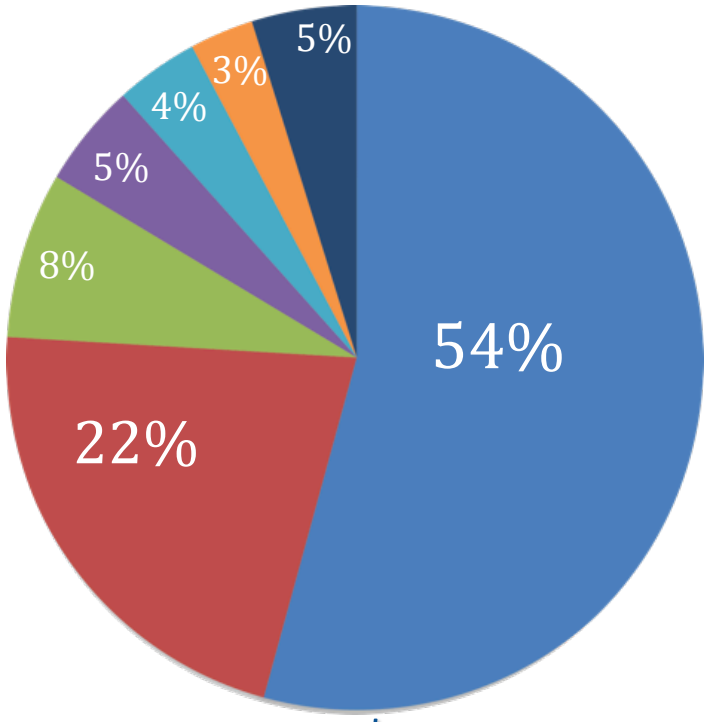
Regional Cabled Array Funded Community
2016-2019



- 50 Awards-Subawards since 2016
- 23 PI's
- 31 Co PI's
- 28 Institutions (including JPL and UNAVCO)
- 2 Industry Awards

Regional Cabled Array External Awards

2016-2019

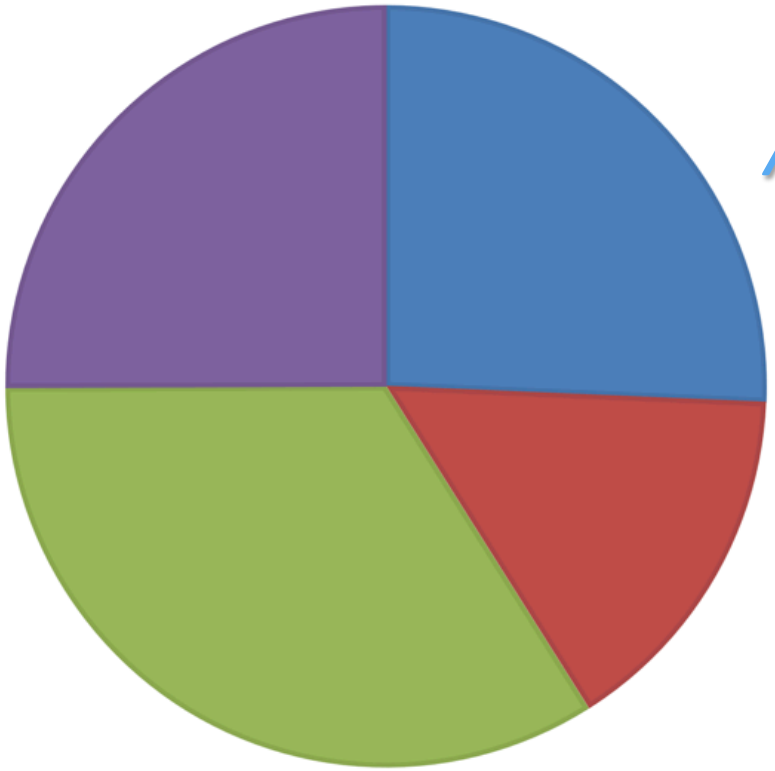


>$26M
(not including ship-ROV funding)

"If you build it they will come"
M. Leinen 2006 OOI CDR

- PI Instruments added to the RCA
- RCA data focused
- Education using RCA data
- Adjacent uncabled instruments
- Development (Moore-Sloan Foundation)
- Associated Field Programs (NSF)
- Other (e.g. workshops)

Regional Cabled Array Instrument Awards By Source



A diverse funding portfolio

- National Science Foundation
- International
- NASA
- Office of Navy Research

RCA Conferences/Workshops/Talks

- Kelley gave 10 presentations (e.g. Rutgers Ocean Data Lab, Ocean Hackweek, Universities-Colleges, Local Communities, West Sound STEM, NASA workshop)
- 10 other presentations by team (e.g. iMove workshop Norway; OceanObs19; Earthcube etc); Oceans19 Plenary

Kelley Fall AGU 2019 PY2

- DESSC Early Career Workshop Keynote Speaker
- Invited Speaker "Advances in Seafloor Instrumentation"
- Invited Speaker Union Session "100 Years of Technological Advances in Earth and Space" Sciences [The Changing Ocean: 100 Years of Oceanographic Sensing]
- Kelley-Chadwick Chair/Co-Chair "Advancements in understanding Seafloor Volcanism and Life: Axial Seamount a Wired Submarine Volcano Observatory

2019 O&M: Cruise Externally-funded Instruments

Bemis (Rutgers) Flow imaging Sonar (COVIS) & 2 thermistor arrays

Wilcock (UW) A-O-A self calibrating pressure sensor

Chadwick (NOAA-OSU) 1 CTD - 2 additional in 2020

Zumberg & Sasagawa (SIO-UCSD) Self calibrating pressure sensor

Wilcock (UW) Flipping tilt meter

NSF

Already on the cable

Breedlove (Creare) Digital Still Camera

Reimers (OSU) & Girguis (Harvard) Benthic Observer Platform

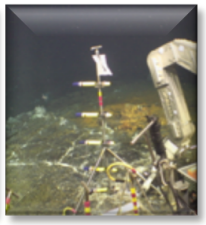
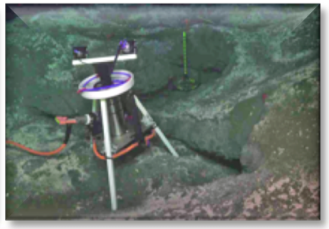
ONR

Borhmann & Marcon (MARUM-Germany) Overview sonar, quantification sonar, 4K camera, and CTD

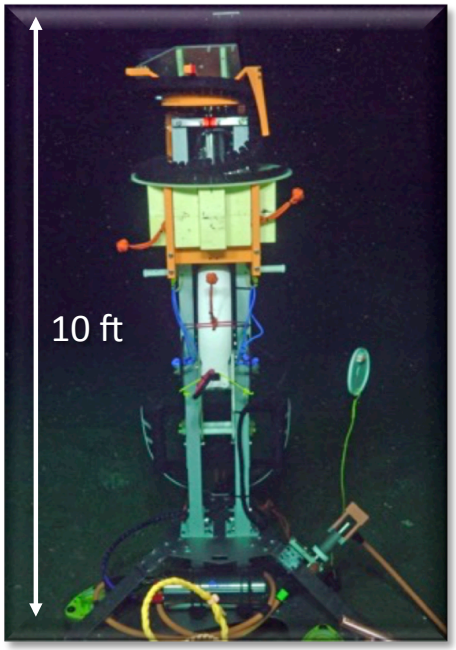
Germany



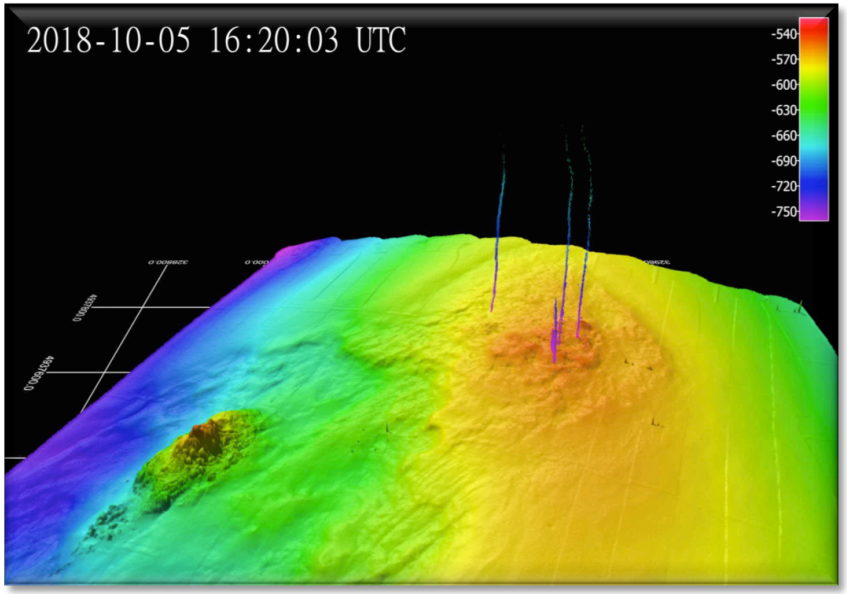


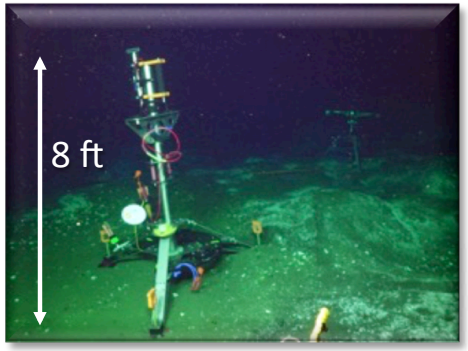
MARUM: Quantifying Gas Emissions At Southern Hydrate Ridge



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



Provides unprecedented 360° imaging of all methane plumes issuing from SHR. First flux measurements.



2020 O&M: Cruise Externally-funded Instruments

Chadwick (NOAA-OSU) 1 CTD - 2 CTDs to be added – subseafloor emission of brines into the Caldera following eruptions (1 day ship-ROV time)

Zumberg & Sasagawa (SIO-UCSD) Self calibrating pressure sensor – will request an extension

Two others pending; on 2020 ship schedule

NSF

Breedlove (Creare) Vent Energy Extraction Platform (1)

Reimers (OSU) & Girguis (Harvard) Benthic Observer Platform – recovery (1)

ONR

Borhmann & Marcon (MARUM-Germany) Overview sonar turn, quantification sonar turn, 4K camera leave in place and CTD recover (1)

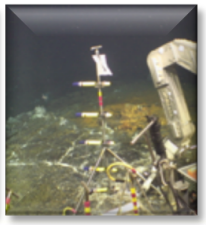
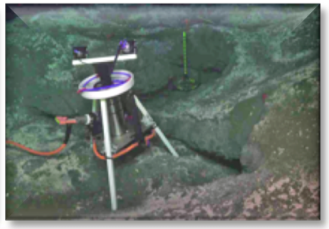
Germany

Sobron (SETI) and 9 others PI's – INVADER (2)

NASA





NASA Exobiology: P. Sobron (SETI Institute) InVADER

In Situ Analyses Divebot for Exobiology Research (4-5 year award); 9 Co-PI's

- Design, build and implement ~ 4.6 m tall platform with three raman laser systems, laser line scanner, and imaging cameras for real-time visualization to:

InVADER Target
2020,2021, 2022

- Validate strategies and adaptive missions, and signatures for life in extreme environments (on other watery planets)
- Hydrothermal fluid and rock sampling (development of ROV rock drill), fluid gas and chemical analyses, microbial genomic characterization, extensive site characterization, machine learning and creation of "virtual" world
- Significant outreach component in collaboration with Citrus College, JPL and UW – exploring significant telepresence option, kick off community & JPL event in LA January (Kelley keynote speaker); hired an engagement team member.

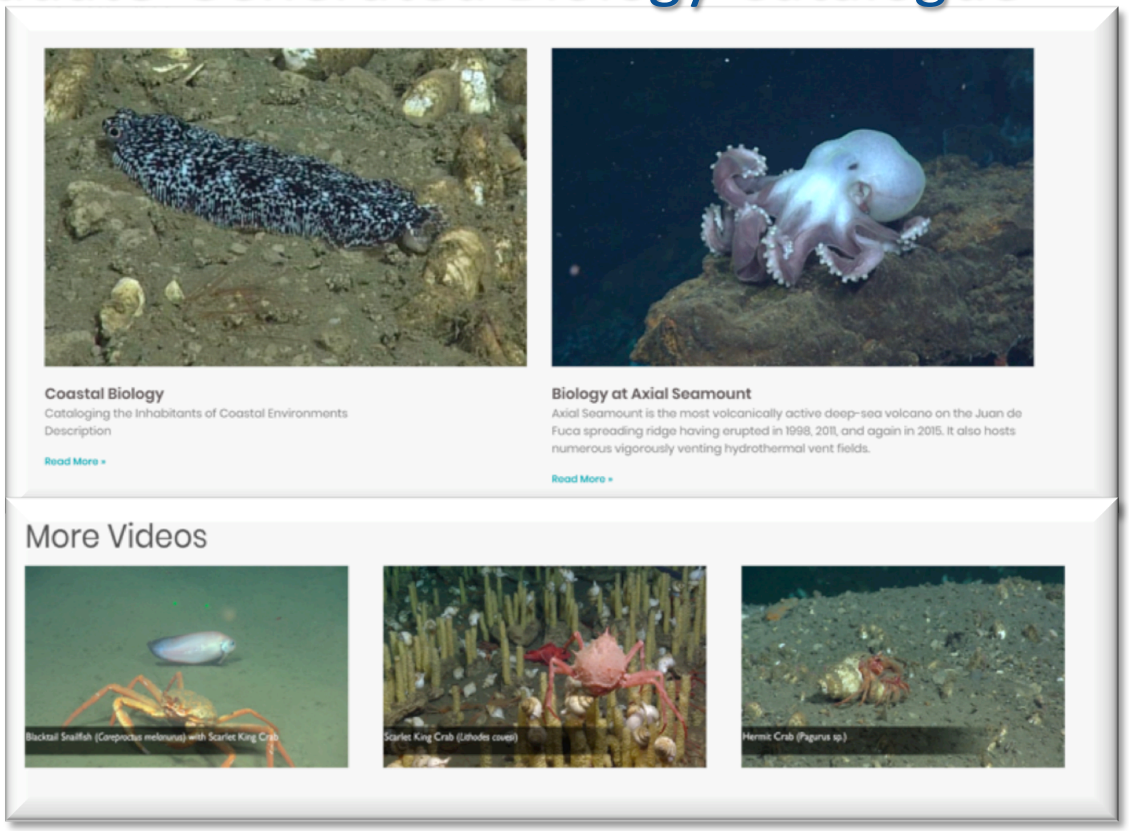
RCA-OOI-UW Educational Efforts

VISIONS at-sea experiential learning program:

>160 undergraduate and graduate students have participated; 13 on VISIONS'19; diverse population – socioeconomic, ethnic, and educational (i.e. numerous first generation; K12 schools of 130 students) backgrounds.

- This years projects include
  - Computer Science Student - Creating Python code for 5 years of temperature for climatology investigations (code will be used for other measurements)
  - Oceanography student: Processing EM122 bathymetry and bubble plume data for major new discovery of > 1 km long seep site associated with major strike-slip fault on Cascadia Margin - several new gas emission sites
  - Ocean & Geology Students – Engagement video re work, cable and extreme environments
- PY1: 4 VISIONS students working with RCA team all year, participated on the cruise

Undergraduate-Generated Biology Catalogue



Led by K. Bigham – now Ph.D program - New Zealand, Wellington

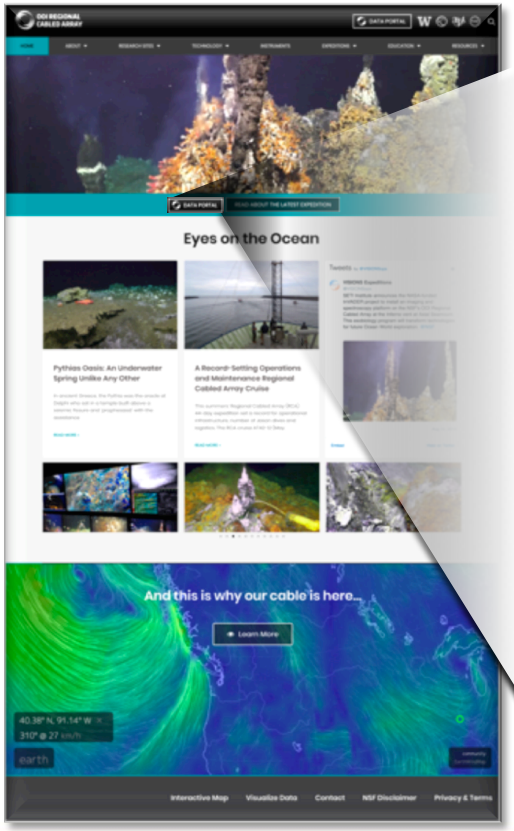
Regional Cabled Array PY2 Engagement

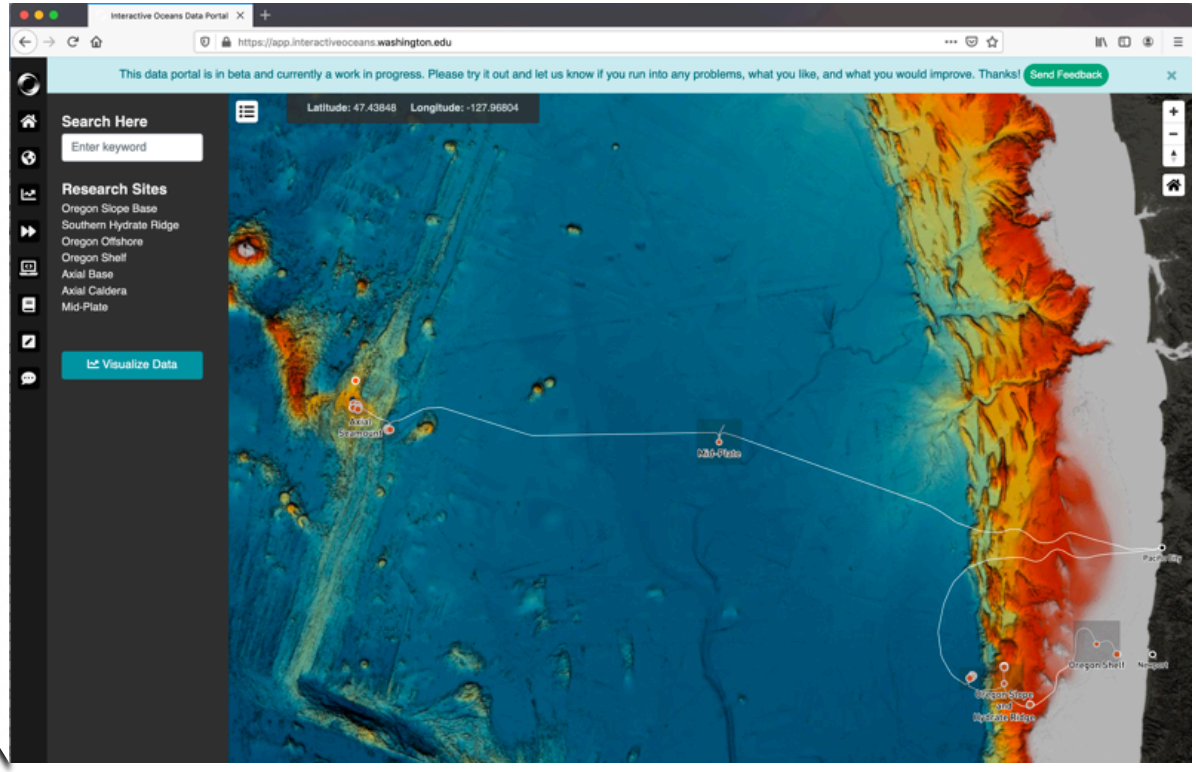
- Extensive planning with PI's regarding 5 externally-funded field programs next summer on RCA cruise – 2 others on ship schedule pending
- Community RCA Webinar January 2020, Fall AGU and Ocean Sciences
- NASA significant engagement effort re InVADER exobiology program including Citrus College; Kelley keynote at kickoff event in January LA 2020; exploring high end telepresence option
- RCA data continue to be incorporated in UW Tacoma and Seattle Ocean 100 classrooms reaching >>100 students: NSF education proposal in process
- Several local talks scheduled – community college, (ORCA - Ocean Research College Academy, Walla Walla College, AGU 2019)
- West Sound STEM Network – Executive Committee; >14 School Districts in Washington, beginning partnership with Bremerton Navy Shipyard – in situ sensors in Puget Sound

Regional Cabled Array PY2 Engagement

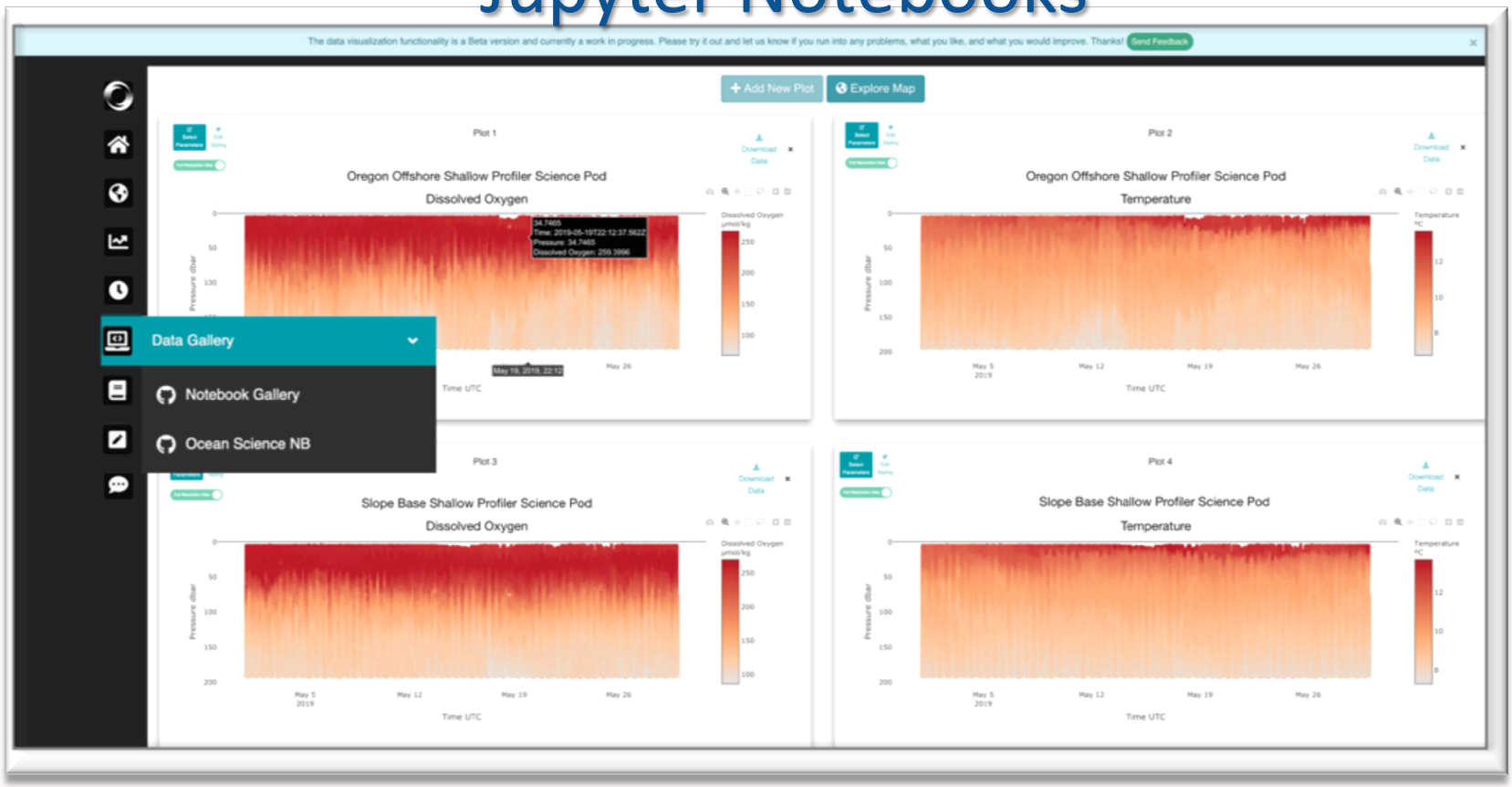
- Formalize collaboration with UW-RCA, Grays Harbor College, and Quinault Indian school (Taholah)
- Continue mentoring of VISIONS19 students – symposium December 2019 and senior thesis projects Spring 2020
- VISIONS'20 Applications Feb 2020 - anticipate ~25 students (Queens College NY and Citrus College included)
- Continue planning of NE Pacific OOIFB-RCA-Endurance Community Workshop
- Continue expansion of Interactive Oceans and data portal – educational tools and extensive image/content gallery and community Python tools
- Continue/expand collaboration with P. McCready and LiveOceans re RCA data

Interactiveoceans Website and Data Portal





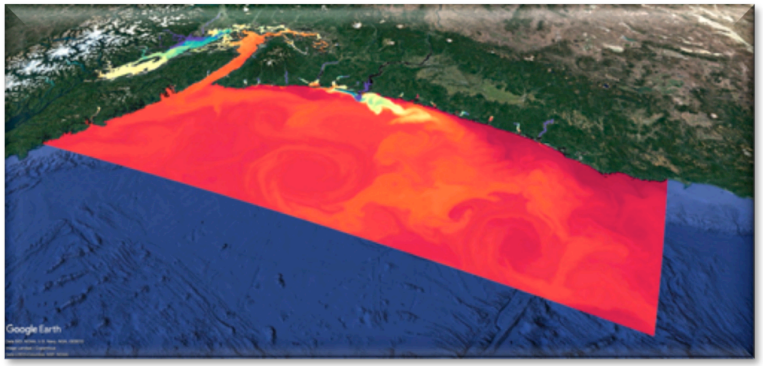
Jupyter Notebooks



Interactive Oceans Website and Data Portal

- Jupyter notebooks [satellite, shallow and deep profiler comparison e.g chlrophyll, citizen science – Megaptera game [humpback whale] calls etc

PY2 Emerging LiveOcean and RCA Collaboration



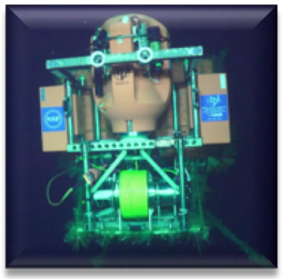
PY2 will work with Parker to get OOI data for testing of model output

McCready excited especially to bring in data from full ocean depth deep water moorings off Cascadia Margin as few measurements exist past the margin toe

May help inform OOI observations

Parker McCready, UW School of Oceanography

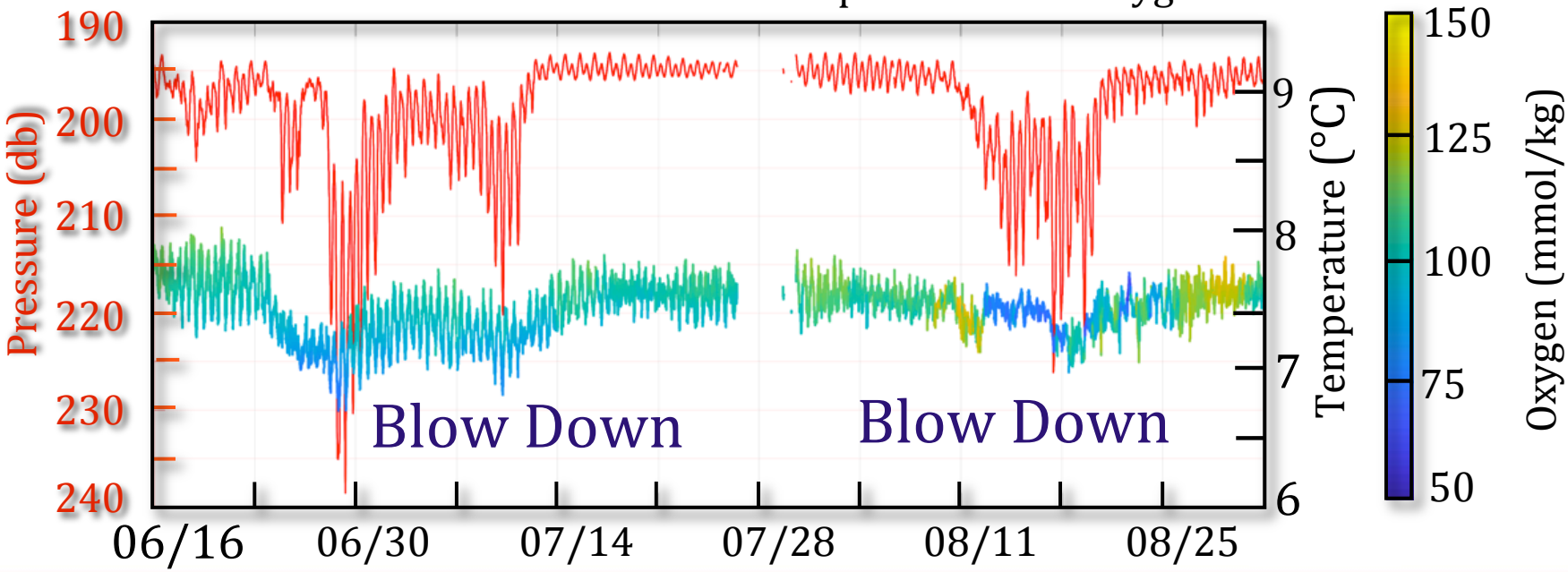
- Provides three dimensional output with 72 hour forecasts every day; Regional Ocean Modeling System with horizontal resolution of 500 m in Salish Sea, 1500 m offshore.
- Open boundaries in pacific come from HYCOM Navy run global ocean model
- Data from NOAA, NANOOS, 45 rivers, Washington Department of Ecology etc
- Multiple stake holders – e.g. predictions for oil spills, harmful algal blooms, hypoxia forecasts, WA ocean acidification Center, NANOOS

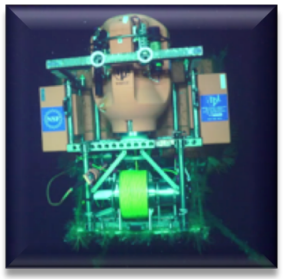


Origin of Blow Down Events

200 m platform blown down nearly 50 m in depth and 150 m to the west

Platform Pressure versus Temperature and Oxygen





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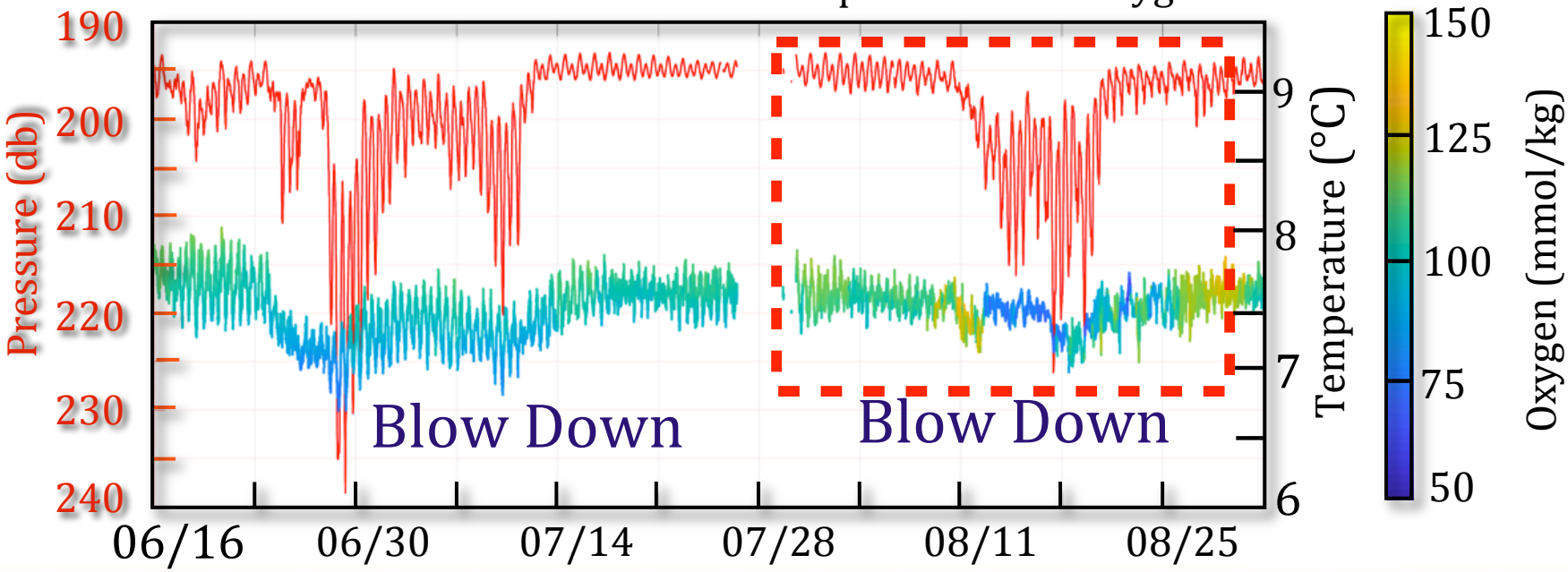
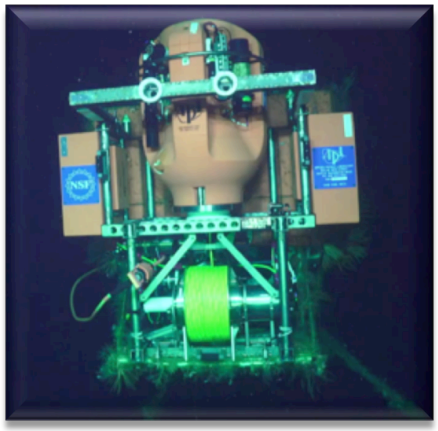
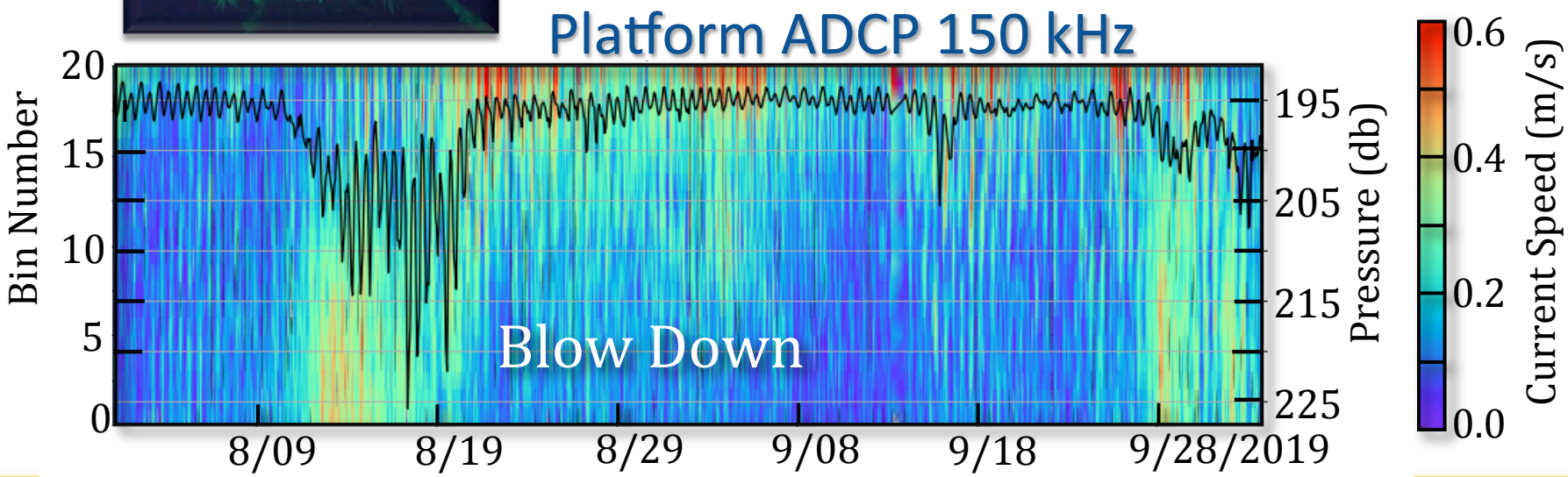




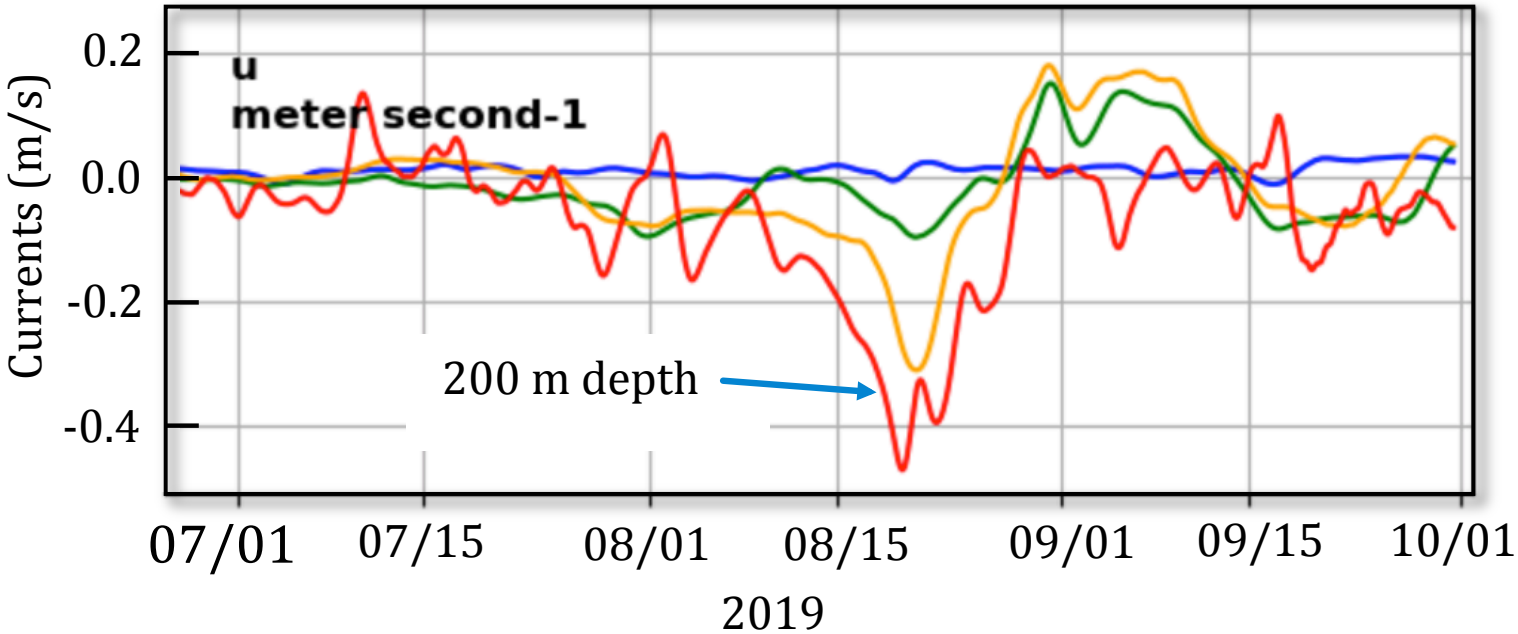
Emerging LiveOcean and RCA Collaboration

Origin of Blow Down Events



LiveOcean Output at 200 m Slope Base

Strong currents from the east at 200 m



Comparison of LiveOcean Output at 200 m

Blue Water
Cabled Moorings

Slope
Base

Axial
Base