Regional Cabled Array
OOIFB Meeting May 2019
Deb Kelley and RCA Team

School of Oceanography and Applied Physics Lab
University of Washington
Regional Cabled Array Team: Benefits from Strength of APL

19 FTE's including 7.5 FTE's LOE

50% support outside OOI
100% support outside OOI

Orest Kawka
Research Scientist

Wendi Reuf
Lead Data Evaluator

Mike Vardaro
Data Scientist

Katie Bingham
Data Evaluator

Mitch Elend
Data Specialist

4 Undergraduates

Mike Harrington (0.5)
Dir. EPS Department

Chuck McGuire (0.5)
Chief Engineer

Laurie Bryan
Finance/Compliance

Ken Feldman
Network Engineer

Kellen Roseburg
Software Engineer

James Tilley
Secondary Nodes

Tim McGinnis (0.5)
Deep Profiler

Geoff Cram (0.5)
Shallow Profiler

Eric McRae
Shallow Profiler

Dana Manalang
Instruments

Larry Nielson
BEP/Logistics

50% support outside OOI

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19 FTE's

Including 7.5 FTE's LOE
Regional Cabled Array Team

19 FTE's

- Risk - Breadth but not depth
- Working towards cross training

50% support outside OOI
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Science Data Team

- 4 Undergraduates
- Mike Harrington (0.5)
  Dir. EPS Department
- Chuck McGuire (0.5)
  Chief Engineer
- Laurie Bryan
  Finance/Compliance
- Ken Feldman
  Network Engineer

Engineering Team

- Kellen Roseburg
  Software Engineer
- James Tilley
  Secondary Nodes
- Tim McGinnis (0.5)
  Deep Profiler
- Geoff Cram (0.5)
  Shallow Profiler
- Eric McRae
  Shallow Profiler
- Dana Manalang
  Instruments
- Larry Nielson
  BEP/Logistics

Chris Hoyt
Shore Station
Dennis Manning
Shore Station (0.5)

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How We Operate

- PI-PM-Finance: Talk Daily
- PM-Finance-Engineering: Talk Daily to Weekly
- Data Team Talk Daily; Formal meeting weekly
- Weekly Meeting Data-Engineering Instrument: Metadata, Evaluation - Are Instruments Working?
- Weekly Meeting Control Account Managers: Refurb Status and Budgets
- Monthly All Hands Meeting
- Several Pre-cruise Meetings
5th 2019 Maintenance Cruise
44 days with 14 days of mobe/demobe; >40 dives

**Table 1: 2019 OOI-UW Regional Cabled Array Cruise R/V Atlantis (AT42-12: Newport - Newport All Legs)**

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<td>1 - OTHER (UW) MARUM&lt;br&gt;2 ONR - Remiers Benthic Observer</td>
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- 105 core OOI instruments turned
- 2 Benthic Experiment Platforms
- 6 Shallow Profiler Science Packages
- Repair of Axial Shallow Profiler Mooring
- 3 Deep Profiler vehicles
- 9 PI instruments
- ~16 CTDs verification sampling
- New York Times best seller author
- 19 students
- Live streaming
- New website
- 78 berths to manage
Regional Cabled Array
Leg 1: May 29-June 9
Partial Recovery of Mooring Drove Schedule

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**SHALLOW PROFILER MOORINGS - WORK HORSES, >40,000 PROFILES**

- Now reaches 5 m
- Very smart - will "hide its head" if wave height too large
- May 30-June 9th - First time conducting only a partial recovery of a Shallow Profiler Mooring (platform and 1 Leg) to fix connector damaged by ROV.
Leg 1: Shallow Profiler Mooring Partial Recovery:
Jason Offloaded, RCA 78,000 lbs, Jason and RCA Vans 87,000 lbs

V19 Leg 1
JASON + RCA VAN = 87,000 lbs
RCA Deck + Inside Science = 78,300 lbs
Total = 165,330 lbs
### Regional Cabled Array AT42-12 (VISIONS’19)
May 30-July 12, 2019

**105 core OOI instruments turned**
**2 Benthic Experiment Platforms**
**6 Shallow Profiler Science Packages**
**Repair of Axial Shallow Profiler Mooring**

**3 Deep Profiler vehicles**
**9 PI instruments**
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Cabled Array Operational Status: Blue Ocean Explorer

- Deployment Equipment Table
- 18 Junction Boxes - status, alarms
- Equipment Status Readouts
  - Weathermap
  - Status Plots
  - Blue Reports: Issue description & resolution
- Full Inventory
  - Equipment type (instrument, cable)
  - Description (ADCP-75 kHz)
  - Manufacturers Serial #
  - Cabled Array Serial #
  - Action
- Deployment Timelines
- Logs
  - Equipment Transfer logs (depot, seafloor)
  - Operator
  - User Action Log

Integrated daily operational status, assets, issues, resolutions etc
What Data Are Flowing? (May 16, 2019)

Rutgers syncs RCA data from UW every 24hrs into U-Frame because Port Agent Logs are excluded (IP Addresses)

Axial Seamount

Junction Boxes 100% operational

2 Shallow Profiler Moorings 100%

Axial Connector damaged 2017 or 2018 during ROV work
Deep Profiler Status

- 2018 two moorings turned (Slope Base & Offshore), 3 vehicles turned
- Axial Base: 1,800,000 meters of profiling from July 28, 2018 to April 24, 2019 2600 m to 500 m water depth; May went to 1000 m, data still being sent to shore: data not yet in CI - need playback
- Oregon Offshore: Vehicle worked until March 13, 2019, but either buoyancy issue or fouling on the cable prevented vehicle from rising >1 m above the dock; instruments continued to collect data
- Slope Base failed, developed issues August 16, but was profiling intermittently, system stopped charging September 19, 2018 and vehicle communication lost.

Niskin Verification Sample
Blue Ocean RCA Instrument Status

Weathermap: Status of all Instruments Live Updates

- Operational
- Trouble shooting
- Failed
- Offline
- Not deployed
- Recovered

Number of Instruments

Date:
- 7/10
- 8/22
- 11/9
- 2/1
- 4/10
- 6/7
- 8/12
- 9/19
- 12/14
- 6/6
- 05/13

Years:
- 2016
- 2017
- 2018
- 2019
Cabled Array Operational Status

Cabled Instruments - 84% Operational March 2019

- Operational: 91
- Failed: 4
- Offline: 27
- Trouble Shooting: 2

Number of Instruments:
- 6/6 2018: 117
- Initial Post Cruise: 115
- 8/13: 110
- 10/17: 108
- 12/1: 98
- 3/14: 99

Operational Status:
- Operational: Green
- Uncabled: Gray
- Partial Functionality: Orange
- Trouble Shooting: Yellow
- Data Quality?: Cyan
- Failed: Red
- Offline (may be functional): Brown
- Recovered: Dark Green
NW GigaPop-UW Partnership Operates and Maintains West Coast Cabled Array Network Including Backhaul

Portland Pittock Building now a pass through - all West Coast CI servers moved to UW IT Data Center 5 minutes from Cabled Array Operations Center - efficient “remote hands”

RCA raw data including Port Agents and Logs (Software that “listens” to cabled instruments and places data in a message queue to be uFrame-ingested. Logs contain configuration information in the data e.g., instrument and server IP addresses, port numbers etc) streamed through Pittock, PNW Gigapop directly to Rutgers

Raw data without Port Agents (i.e. no IP addresses) flows to UW-located RCA servers and pushed once a day CI-Rutgers

All PI raw data, products, documents stored at UW-located RCA servers and pushed once a day to CI-Rutgers
Repeat Customers

Unique Addresses

Total Gigabytes Downloaded = 14,857

User base continues to increase ~ 574 repeat customers

Project Eddie Environmental Data-Driven Inquiry and Exploration

Request to NSF to incorporate Cabled Array data into ShakeAlert - Early Warning System for West Coast
Expansion of Cabled Array - PI Instruments

11 PI Instruments Now On Cabled Array

- 2017: Chadwick (OSU-NSF) Bottom Pressure Tilt and CTD - ASHES
- 2018: Bemis (Rutgers-NSF) COVIS Flow Imaging Sonar - ASHES
- 3 uncabled thermistor array* 2019
- 2018: Sasagawa and Zumberge (UCSD-NSF) Self Calibrating Pressure Instrument - Central Caldera
- 2018: Wilcock (UW-NSF) Flipping Tilt Meter Central Caldera
- 2018: Breedlove (ONR) Vent Energy Harvester (platform)* 2019

Transitioned to CORE 2019
Expansion of Cabled Array - PI Instruments 2019 - Legs 3-4

Turn 3 instruments and install PI 4 uncabled and 3 new cabled instruments onto the RCA

- Bemis (Rutgers-NSF) COVIS Flow Imaging Sonar - ASHES - Recover and repair (3 days)
  deploy two 2 m-tall uncabled thermistor arrays, conduct thermal survey 20-50 stations

- Wilcock (UW-NSF) A-0-A Self-calibrating pressure sensor (1 day) - Central Caldera

- Chadwick (OSU-NSF) two additional cabled CTD’S & 8 mini bottom pressure recorders Axial Caldera (1 day each year, 5 years)

- Reimers & Girguis (OSU & Harvard - ONR) Benthic Observer Platform - Recover Offshore, Install new platform Southern Hydrate Ridge, 32 push cores

- Breedlove (Creare - ONR) Vent Energy Harvester - cabled camera & uncabled flow meter (1 day)

- Bohrmann & Marcon (MARUM-Germany) Recover and reinstall overview sonar (now images 700 m distance; install cabled 4K camera (1 day)
Cabled Observatory Vent Imaging System (COVIS) 2017-2022

Bemis (Rutgers) NSF - Heat flow mapping and quantification at ASHES hydrothermal vent field using an observatory imaging sonar

- NSF supplement to fix sonar head
- Install 2 new 2-m tall arrays
Real-time, high resolution monitoring of seafloor deformation at Axial Seamount, extraction of drift component in pressure measurements by measuring ocean pressure compared to pressure ambient inside the housing (valve rotation).

Follow-on applications - vertical deodetic studies of Cascadia subduction zone megathrust: patterns of fault locking, creep and slow slip.
Expansion of Cabled Array - PI Instruments

**NSF** Chadwick (OSU) Phase 2 of Enhancements to the OOI Cabled Array at Axial Seamount (2019-2024) $625,211 6 years (OCE 1928282 recommended)

Test the hypothesis that deep-seated brines (formed during boiling) are flushed from the oceanic crust during diking events/eruptions - linkages to crustal hydrology and the deep biosphere (halophiles).

- Keep Phase 1 cabled CTD at ASHES for 5 years (on data portal)
- Add two more cabled CTD's to expand coverage across caldera
- Includes two additional CTD's for turns each year with ship-ROV-OOI RCA team support
- Build/install 8 additional bottom pressure recorders to replace 4 moored ones now at Axial, and expand coverage across the caldera as part of long-term geodetic monitoring program complimentary to OOI
Instrument Highlight: Axial Seamount Bottom Pressure Tilt
First Volcano Where Eruption May be Predicted

Current Date: May 15, 2019
Latest 12-week diff. inflation rate: 17.67 cm/yr

2015 Threshold difference: -8.45 cm
Inflation remaining: 0.32 cm
Forecast date to reach +20 cm: Feb 2021

Chadwick: https://www.pmel.noaa.gov/eoi/rsn/Forecasts3.html
Instrument Highlight: Axial Seamount Bottom Pressure Tilt
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2015 threshold depth: -8.45 cm
Threshold depth diff.: -8.25 cm
Inflation remaining: 0.32 cm
Forecast date to reach 2015 +20 cm Threshold difference:
Feb 2021 0.52 cm
Aug 2022

Chadwick: https://www.pmel.noaa.gov/eoi/rsn/Forecasts3.html
Expansion of Cabled Array - PI Instruments


- Cabled Camera installed RCA 2019 ASHES
- Extraction platform 2020
- Multiple temperature sensor data will be public

**NASA Exobiology:** J. Sobron (SETI Institute) In situ Vent Analyses Divebot for Exobiology Research (INVADER). Field programs 2020, 2021, 2022 (perhaps 2023); Significant outreach

- Platform with 3 laser spectroscopic and imaging instruments, real-time visualization, validate operational strategies and adaptive sampling, signatures for life in extreme environments genomic and fluid analyses, Large, multi-year award - PDR May 2019 completed
Regional Cabled Array Awards External to OOI

2016-2019

“If you build it, they will come” M. Leinen, 2006 OOI CDR

- 19 PI awards and >10 subawards
- >30 Investigators located at 22 universities/research labs (e.g. JPL, APL); 2 from industry

- Pl instruments added to RCA
- Education with RCA focus
- Development Gift (e.g. Moore Foundation)
- Research focused on using RCA data
- Uncabled instruments

>$19.5 M
Regional Cabled Array Awards External to OOI

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- 19 PI awards and >10 subawards
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$20.6 M

- Pl instruments added to RCA
- Education with RCA focus
- Development Gift (e.g. Moore Foundation)
- Research focused on using RCA data
- Uncabled instruments
- Ship + ROV (assume $75/day)
Virtual Aid to Navigation (AIS - Automatic Identification System)

AIS transmitting information where no physical ATON (aid to navigation) exists (e.g. lighthouses, buoys, moorings)

All our infrastructure is underwater; Offshore site trawled Fall 2018 - Shallow Profiler Mooring

Purchased AIS system from Vesper Marine - modeling indicates at least 100 km coverage

Owned and installed by Lincoln County Emergency Services

Potential partnership with Oregon Coast Repeater Group with addition of OOI antenna on site

AIS broadcasts from shore with the navigation aide seen on a chart display, ships' radar etc. Manual alerts can be sent
Virtual Aid to Navigation (AIS - Automatic Identification System)

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RCA sets up virtual targets with a given radius - when a ship/boat gets within a certain distance to the target, a warning is sent to us/boat
VISIONS: Training Next Generation Students

Over 150 undergraduate and graduate students have participated in the NSF-RCA-UW VISIONS educational program; 19 will participate on VISIONS19

- Entrains diverse population of students - India, China, Taiwan, Korea, Malaysia...
- Develop science and outreach projects, go back to their K12 schools, community ambassadors
- Several senior thesis projects, some leading to AGU, IEE, Benthic Biology etc talks, and publications

M. Rahman “I became obsessed with learning, being open-minded, and curious to the point where my family and friends noticed changes in me when I returned from sea. I embraced the change. Finally, it felt like I was starting to answer the itching question in my mind – who am I and how can I best express myself to do good in this world?”
Launching a new interactiveoceans website
Cloud-based science-education site
Orest Kawaka will present
NSF Education Proposal May 2019
Highly interactive map interface showing RCA assets that serve as entry point into the Data Visualization Portal.

Implementation of proof of concept back and front-end for hosting and serving data from the public cloud (pulled from u-frame).

Data Visualization Portal with enhanced data search and visualization capabilities.

Jargon removed, can plot 4 plots on single page, edit each plot (style), range, multivariable, can plot discrete samples versus cabled instrument data.

Executable Jupiter Notebooks - ability to explore/plot satellite data (e.g. chlorophyl, temperature, dissolved oxygen) and compare to Shallow Profiler 200 m profiler data.

Educational/outreach tools - science stories and galleries of visually arresting photos and figures, games video and citizen science (megaptera - humpback whale call identification).