# A community test of distributed acoustic sensing on the OOI RCA

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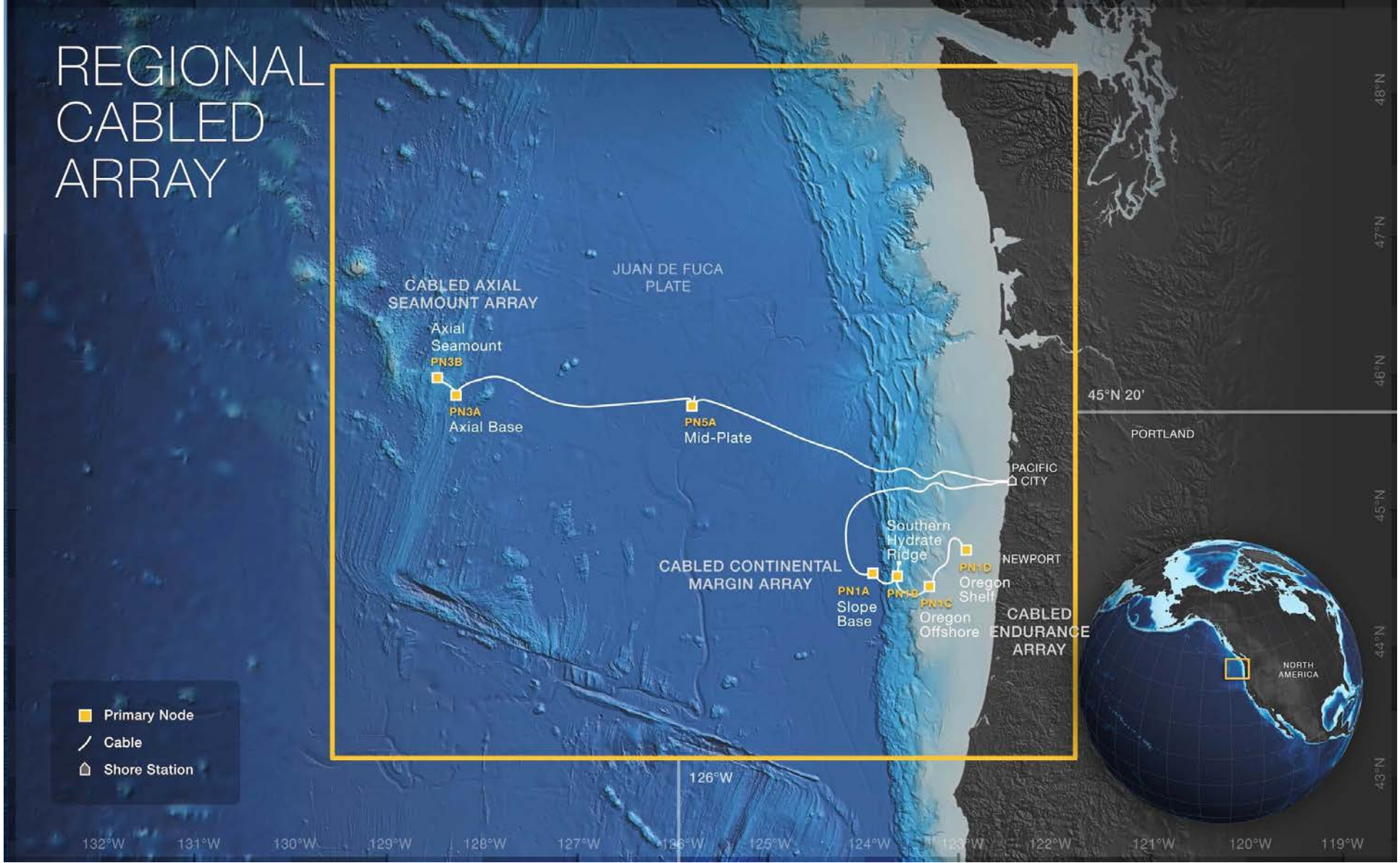
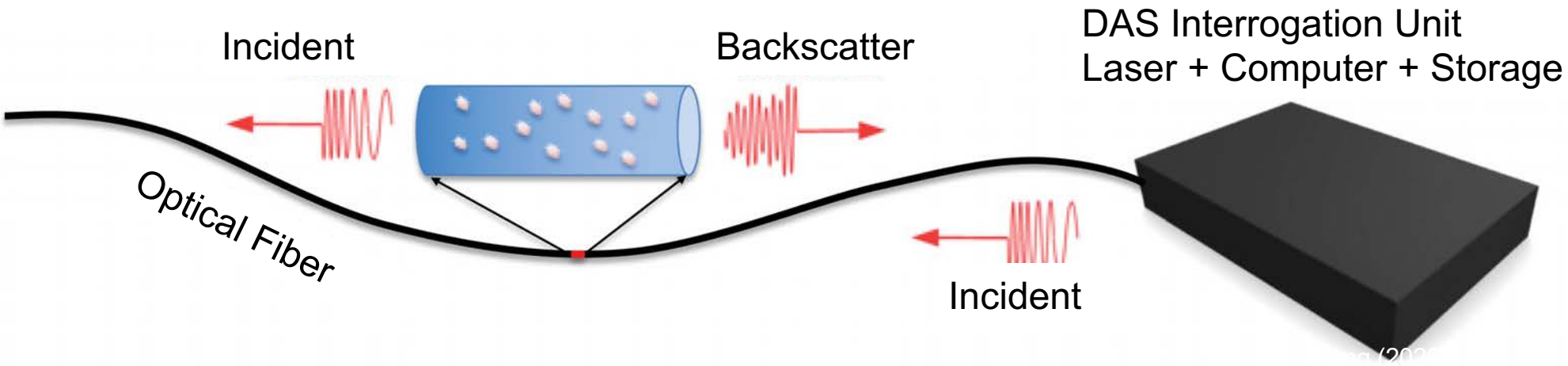

REGIONAL CABLED ARRAY
CABLED AXIAL SEAMOUNT ARRAY
Axial Seamount
PN3B
PN3A
Axial Base
JUAN DE FUCA PLATE
PN5A
Mid-Plate
PACIFIC CITY
CABLED CONTINENTAL MARGIN ARRAY
Southern Hydrate Ridge
PN1A
Slope Base
PN1B
PN1C
Oregon Offshore
PN1D
Oregon Shelf
NEWPORT
CABLED ENDURANCE ARRAY
PORTLAND
45°N 20'
NORTH AMERICA
Primary Node
Cable
Shore Station
126°W
132°W
131°W
130°W
129°W
128°W
127°W
125°W
124°W
123°W
122°W
121°W
120°W
119°W
48°N
47°N
46°N
45°N
44°N
43°N

# Distributed Acoustic Sensing




- One of a number of distributed fiber optic sensing techniques.
- DAS employs repeated laser pulses to observe changes in the phase of backscattered light that are interpreted in terms of  strain rate along the fiber.
- A DAS fiber optic cable thus, behaves similarly to a long line of single-axis broadband seismometers spaced meters to a few tens of meters apart.

## Genesis of the Experiment

April 2019 – Discussions at SSA meeting in Seattle

Challenge the OOI aims to operate continuously and does not often schedule maintenance shutdowns

January 2020 – Notified of planned 1-week shutdown

Planning starts for a short experiment that would compare interrogators

Federally funded experiments must work with the Navy to screen data

November 2020 – Experiment postponed

Navy approval but COVID intervenes

Summer 2021 experiment not feasible given OOI RCA workload

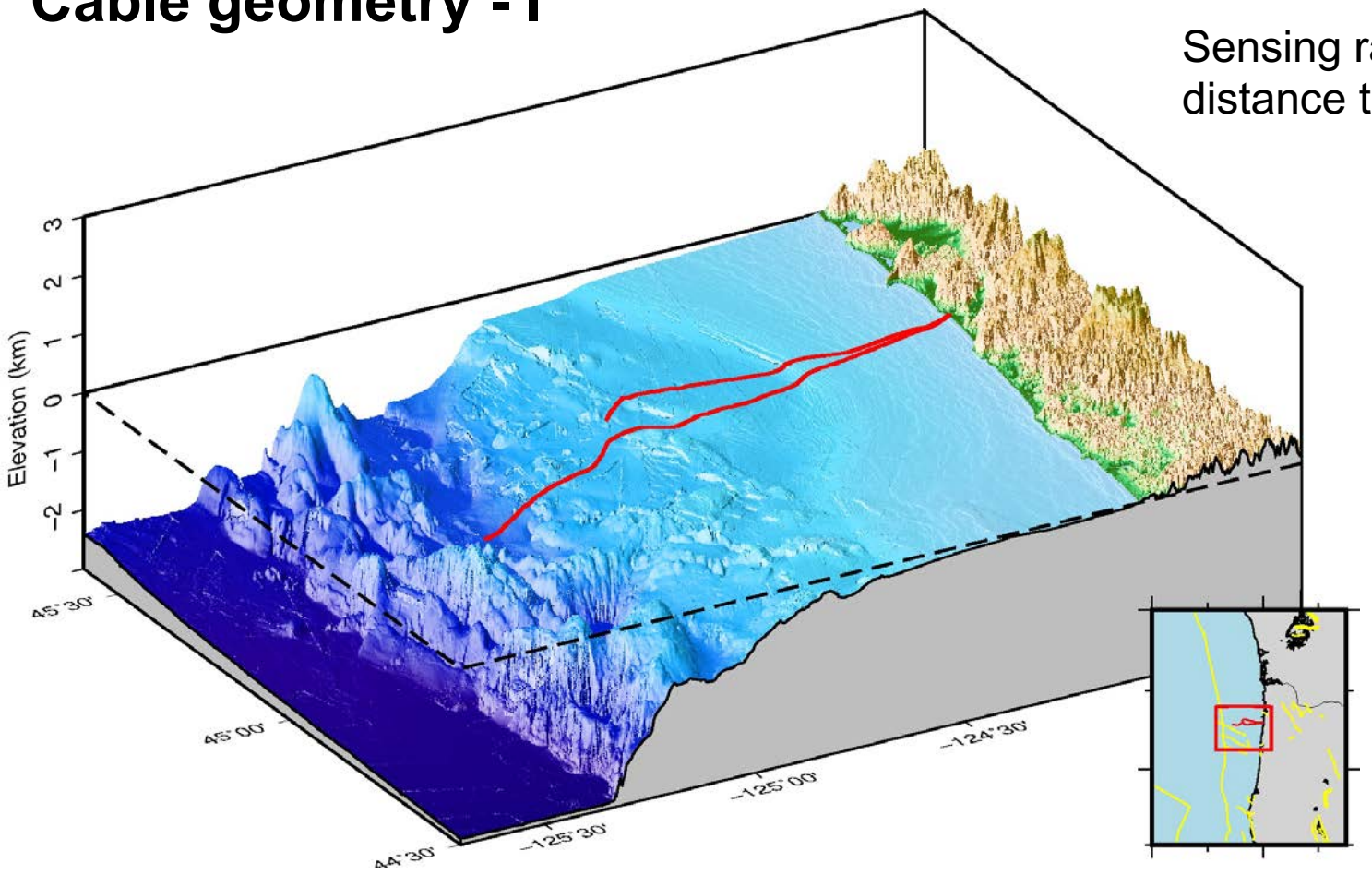
November 2021 – Experiment conducted

Data released after Navy screening

# Experiment Goals

- Collect a community offshore DAS data set
- Enable protocols for Navy Screening of DAS data for federally funded experiments in US waters.
- Potential Applications
  - Ambient noise cross correlation – shallow structure and faults.  Between cables
  - Earthquake signals (including T-phases) and earthquake detectability
  - Ocean wave spectra and compliance
  - Ocean wave directional spectra & ocean currents
  - Infragravity waves & internal waves
  - Whales
  - Ship noise
  - Other

# Cable geometry - I




Sensing range determined by distance to the first repeater

<u>North cable</u>

- 65 km range
- 590 m depth

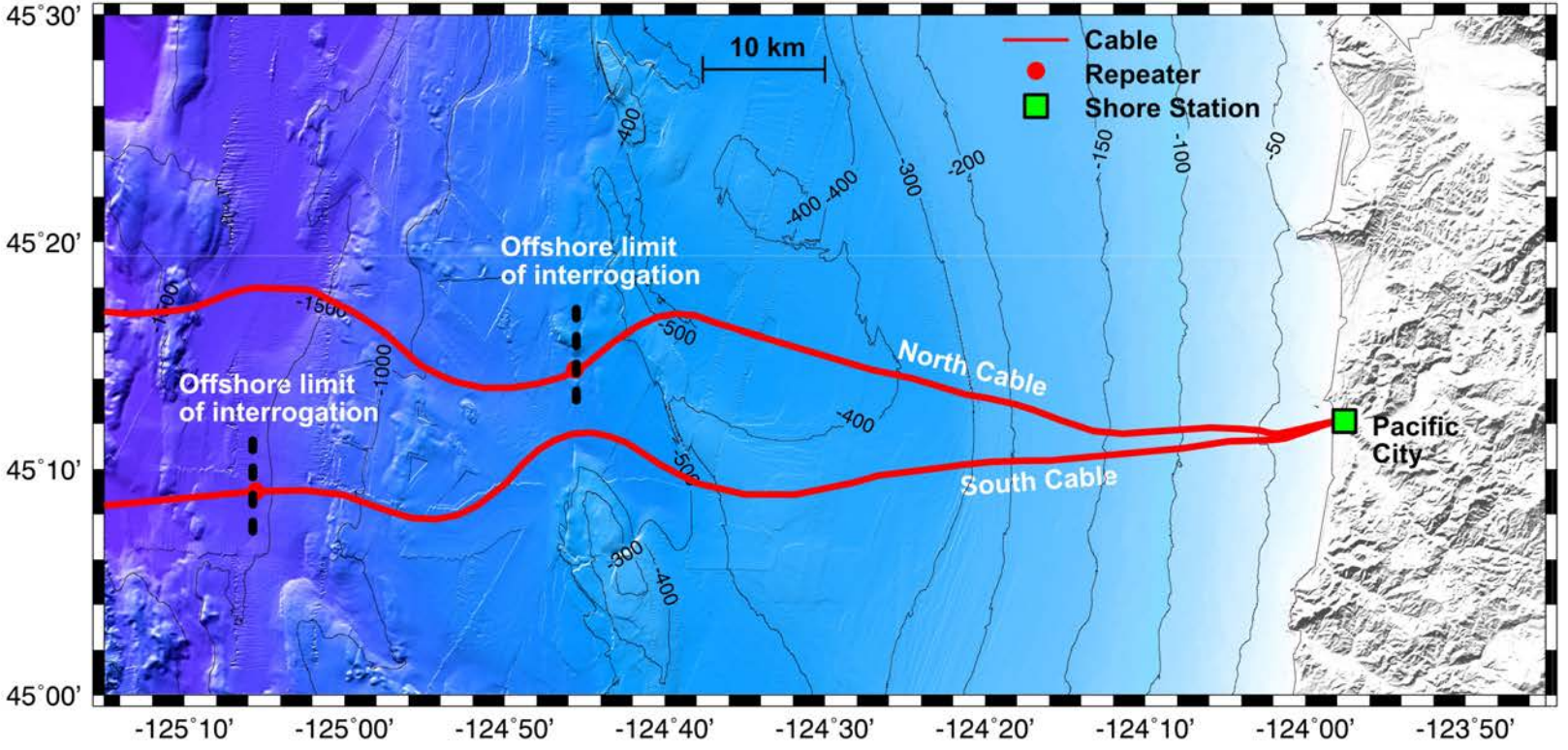
<u>South cable</u>

- 95 km range
- 1575 m depth

Cables are buried continuously up to first repeater, depth not mapped in detail but nominally at 5 feet

# Cable geometry - II

- Significant separation of cables beyond continental shelf
- Curvature leads to segments that are almost orthogonal



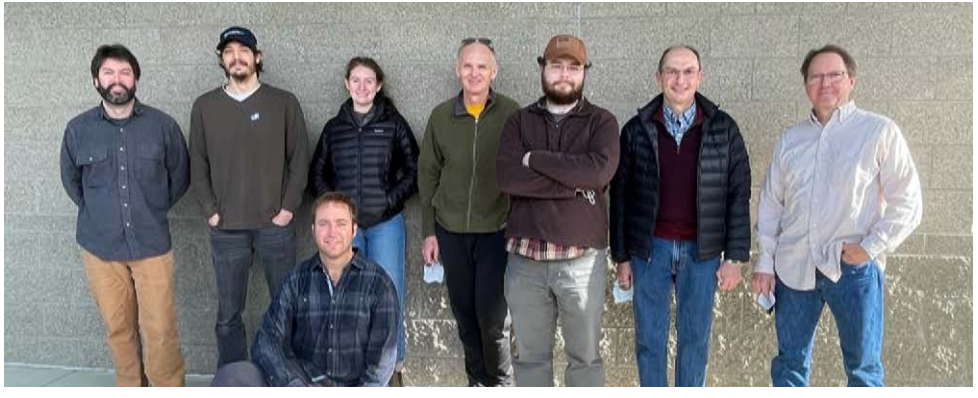

North cable
- 65 km range
- 590 m depth

South cable
- 95 km range
- 1575 m depth

# Data acquisition – Nov 1-5, 2021


Shore station in Pacific City, OR
(~2 km from cable landing point)

Team from UW & Caltech, Silixa and
OptaSense engineers, and Navy observers



<u>4.0 days of data in total:</u>
8 hr of short configuration tests
nearly 4 days continuous recording

## North cable – Transmit fiber

OptaSense QuantX DAS

65.2 km at 2 m channel spacing

Day 1 – 1000 Hz sampling, 30 m GL
Day 2 – 500 Hz sampling, 30 m GL
Day 3-4 – 200 Hz sampling, 50 m GL
(same as South system)


## North cable – Receive fiber

Silixa Ultima DTS

Days 1-4:
- 30.4 km at 1 m channel spacing
- 900 sec averaging period

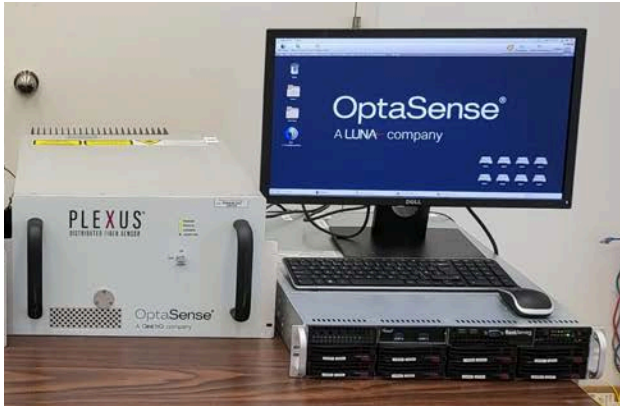
Transmit and receive fibers swapped on both cables for 3 hr on last day

## South cable – Transmit fiber

OptaSense QuantX DAS

95 km at 2 m channel spacing

Day 1-4 – 200 Hz sampling, 50 m GL

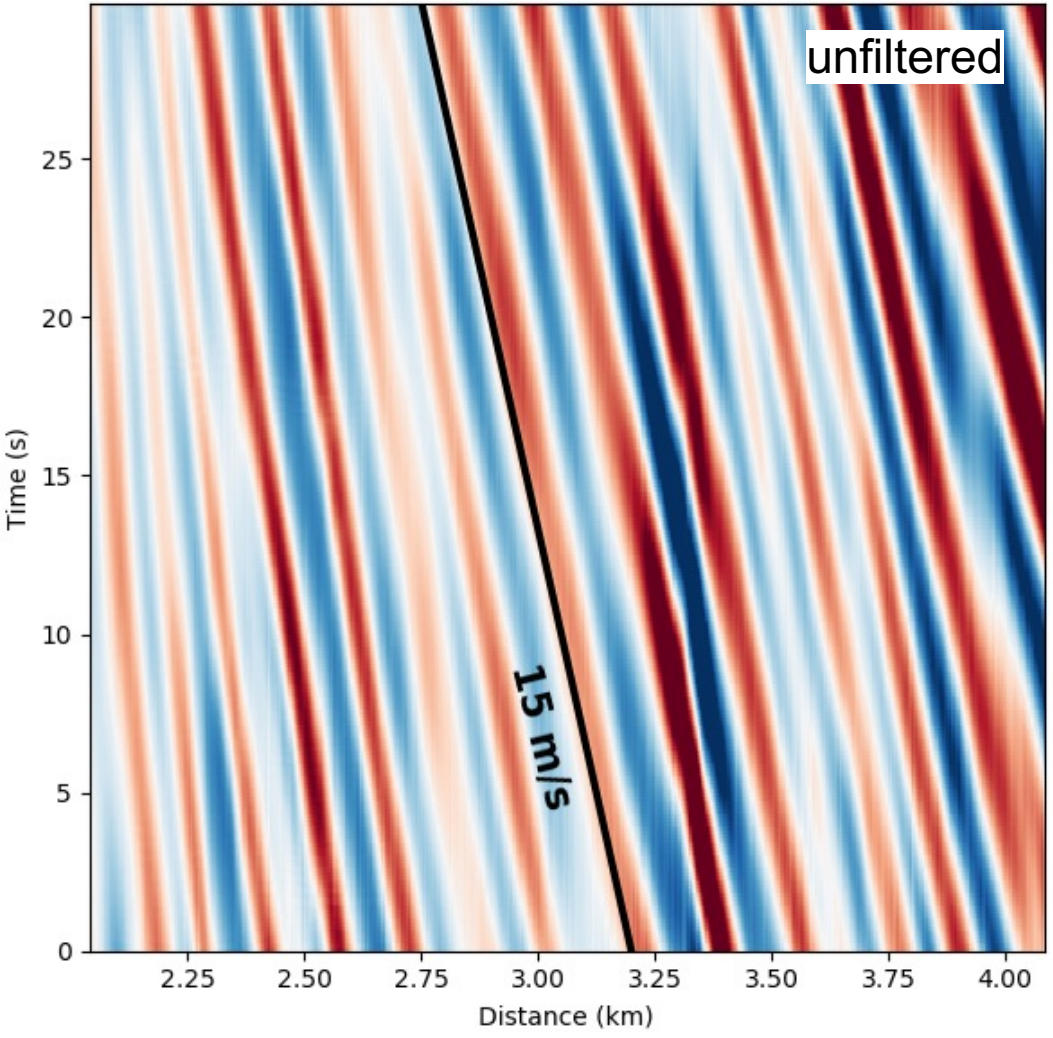



## South cable – Receive fiber

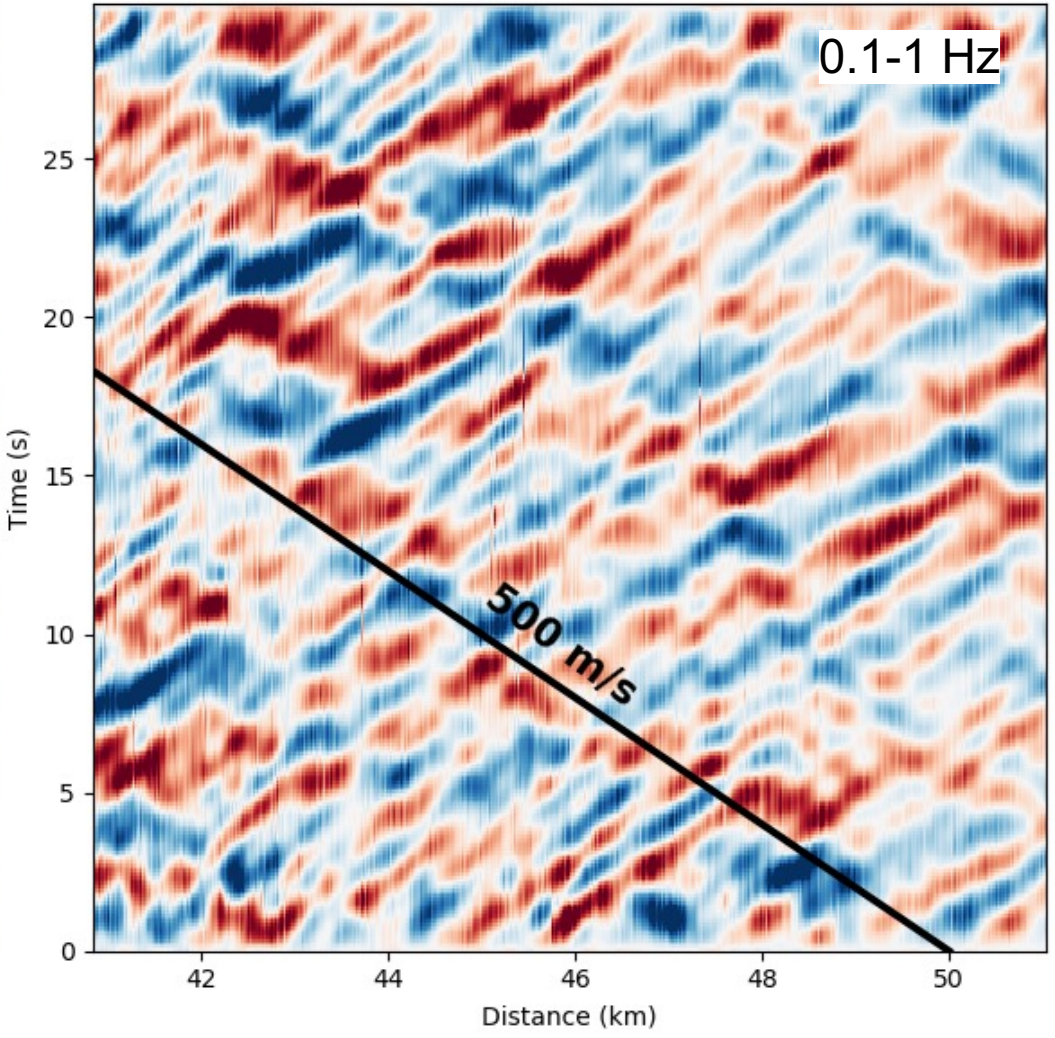
Silixa iDAS v3

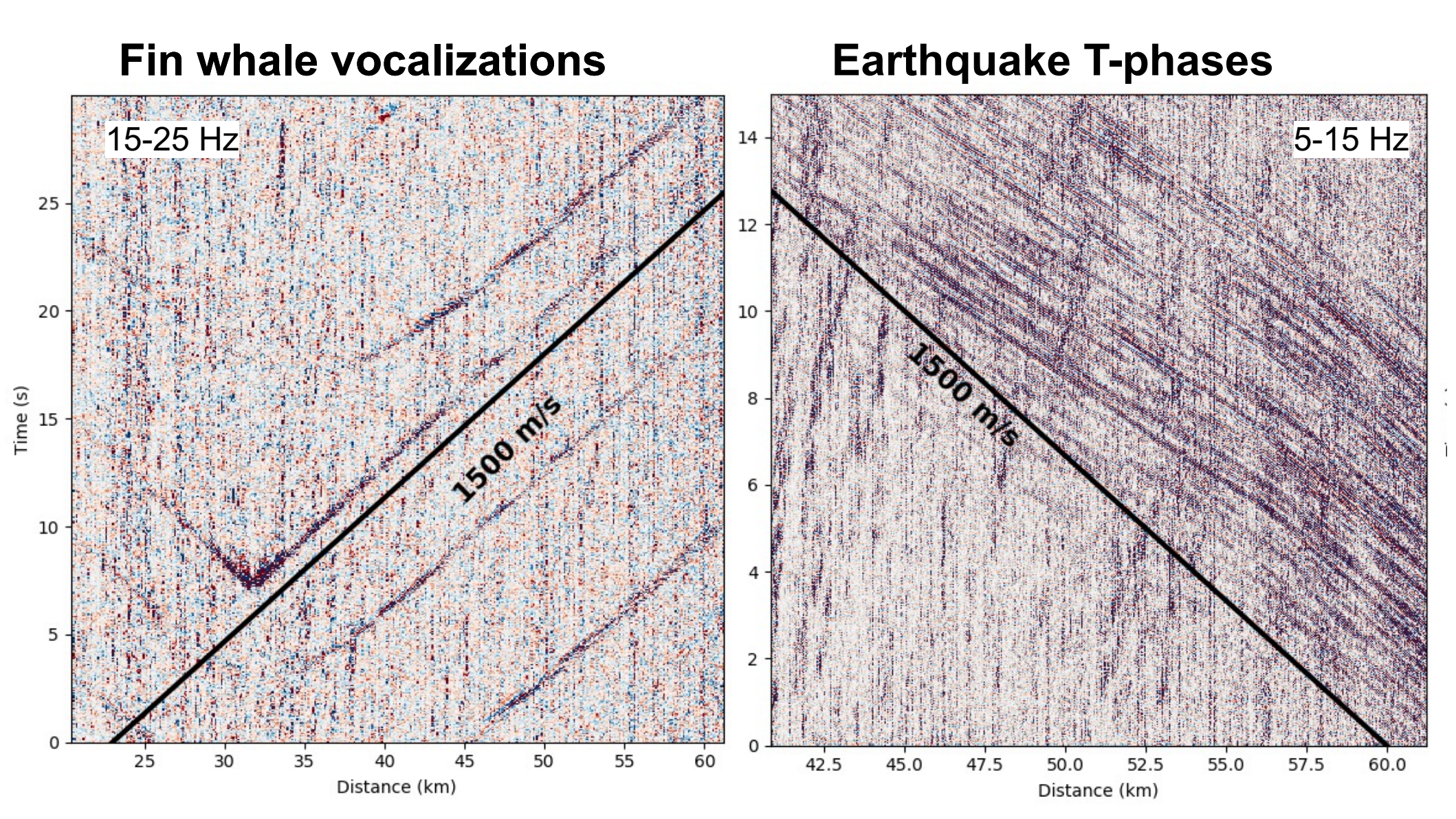
Days 1-2 – 80.6 km at 2 m, 30 m GL, 200 Hz
Day 3 – 40.4 km at 1 m, 10 m GL, 200 Hz
Day 4 – 19.6 km at 1 m, 3 m GL, 1000 Hz

# Ocean surface gravity waves

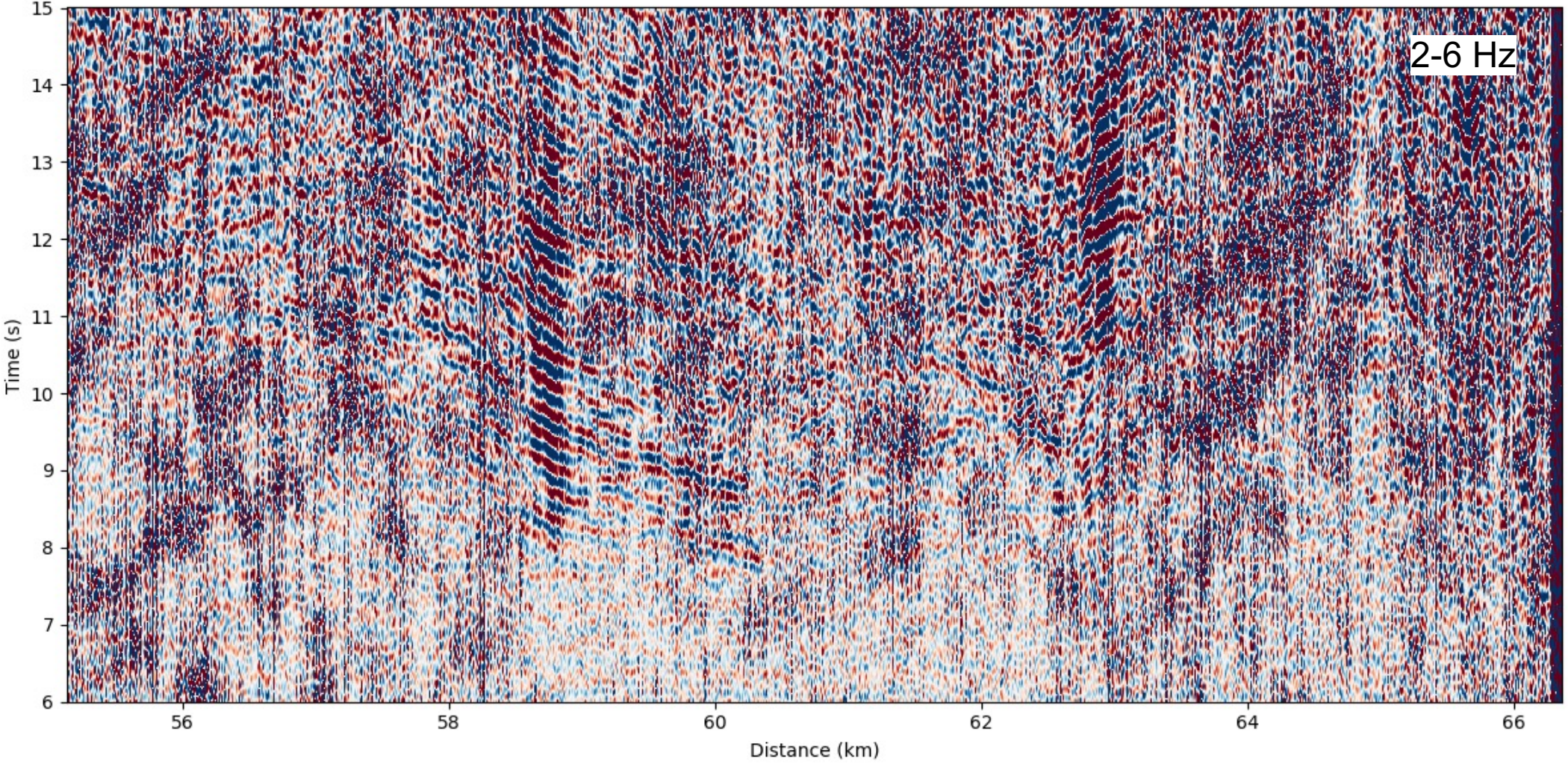



# Ambient seismic noise




Fin whale vocalizations
Earthquake T-phases
15-25 Hz
5-15 Hz
1500 m/s
1500 m/s
Time (s)
Distance (km)
Distance (km)
0
5
10
15
20
25
0
2
4
6
8
10
12
14
25
30
35
40
45
50
55
60
42.5
45.0
47.5
50.0
52.5
55.0
57.5
60.0

# Regional M4.4 earthquake (Δ=540 km, near Petrolia, CA)



# Accessing OOI RCA DAS data

Data and metadata are available for download from the OOI FTP server hosted at UW:

Experiment landing page:
https://oceanobservatories.org/pi-instrument/rapid-a-community-test-of-distributed-acoustic-sensing-on-the-ocean-observatories-initiative-regional-cabled-array/

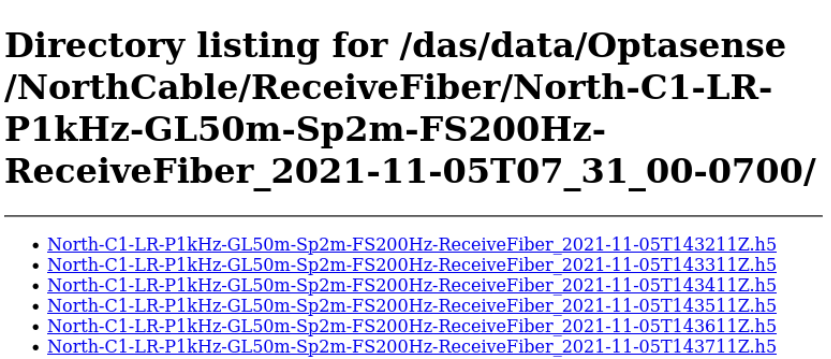
Data:
http://piweb.ooirsn.uw.edu/das/

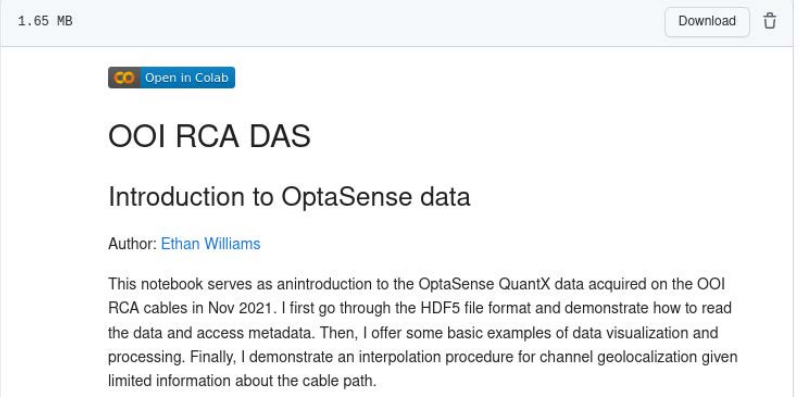
Start with the README file for of information about the experiment design, data formats and organization of data.

Investigators seeking the full 26TB dataset may send hard drives to OOI for copy

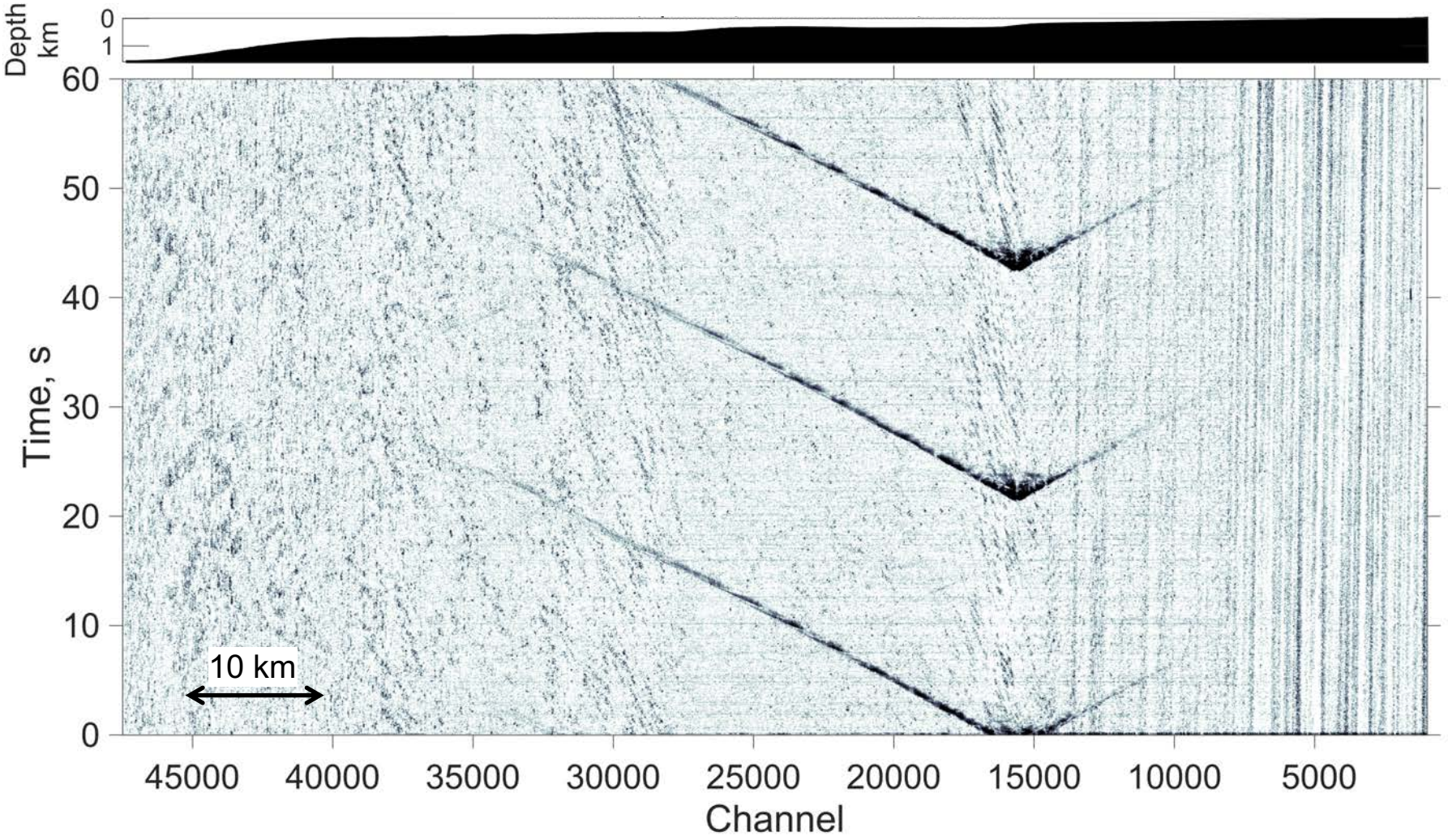
A tutorial IPython notebook for the OptaSense data can be downloaded from Github:

https://github.com/ethanfwilliams/OOI_RCA_DAS_notebook



# South Cable, OptaSense DAS – 16-27 Hz BP & F-K filters



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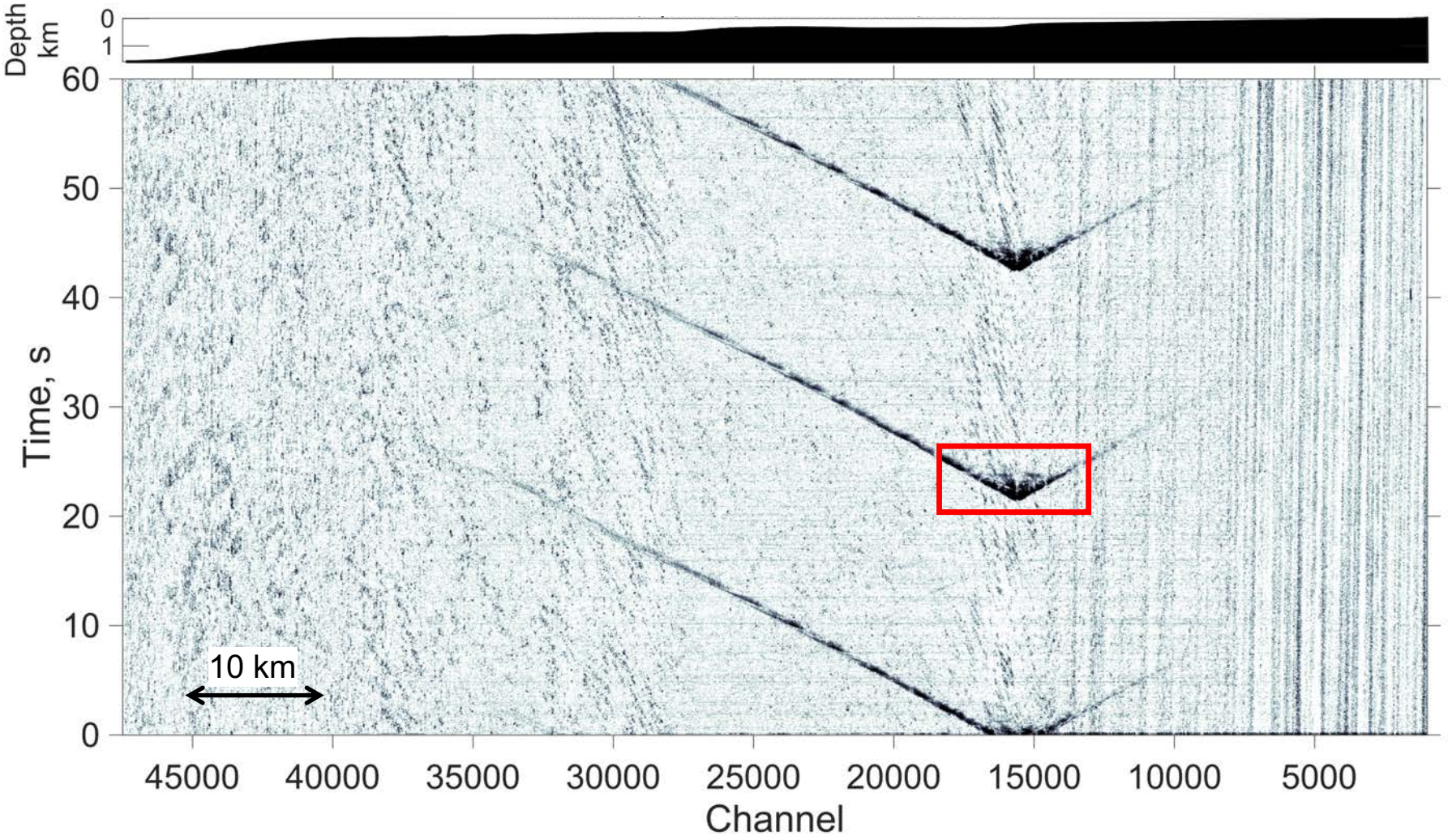
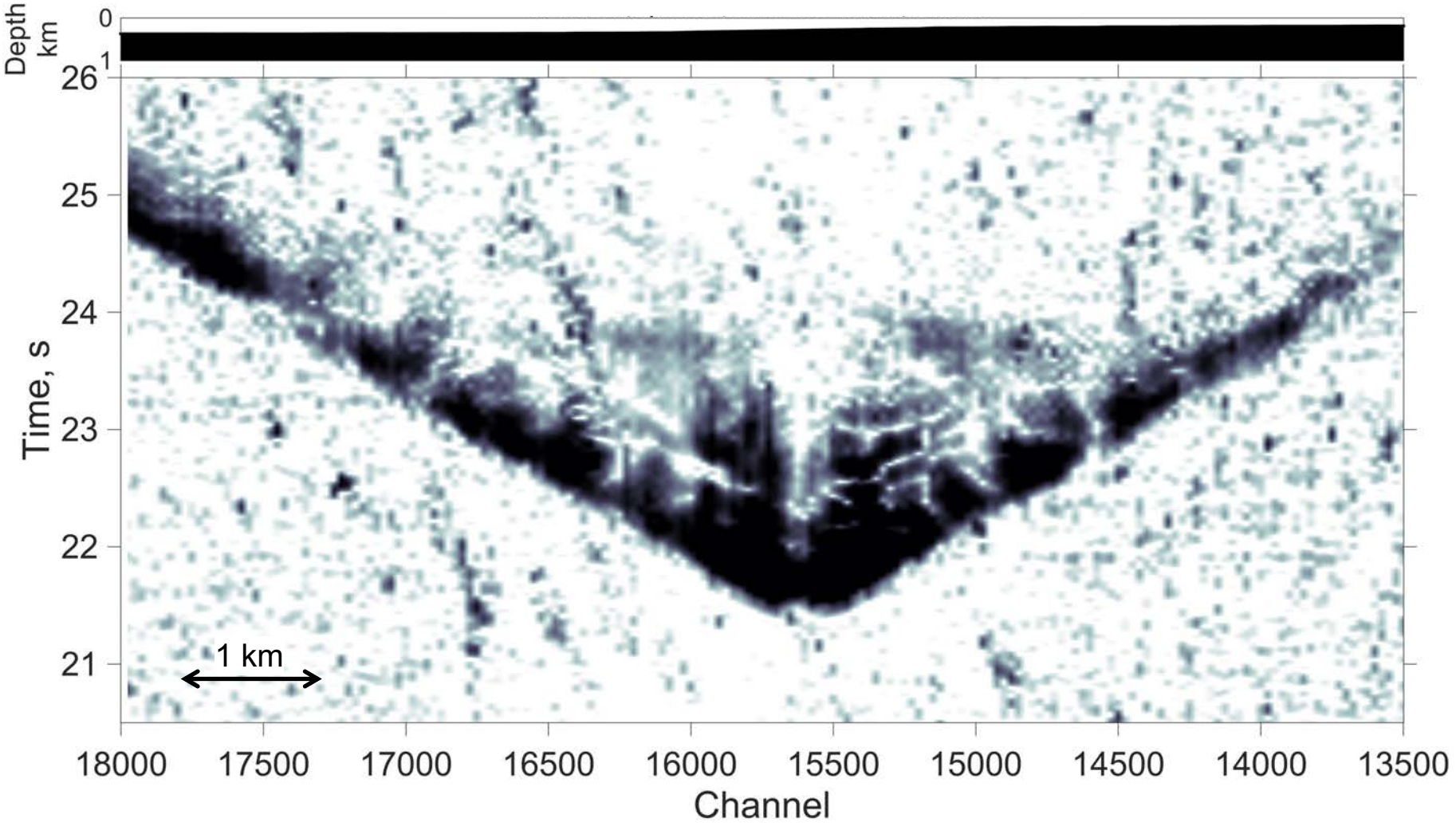
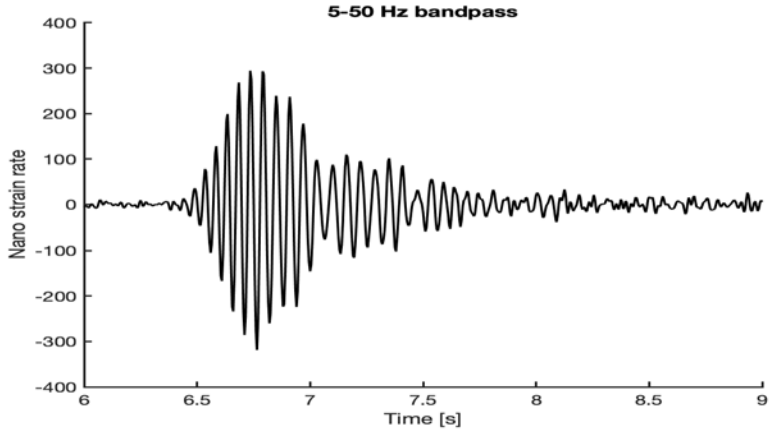
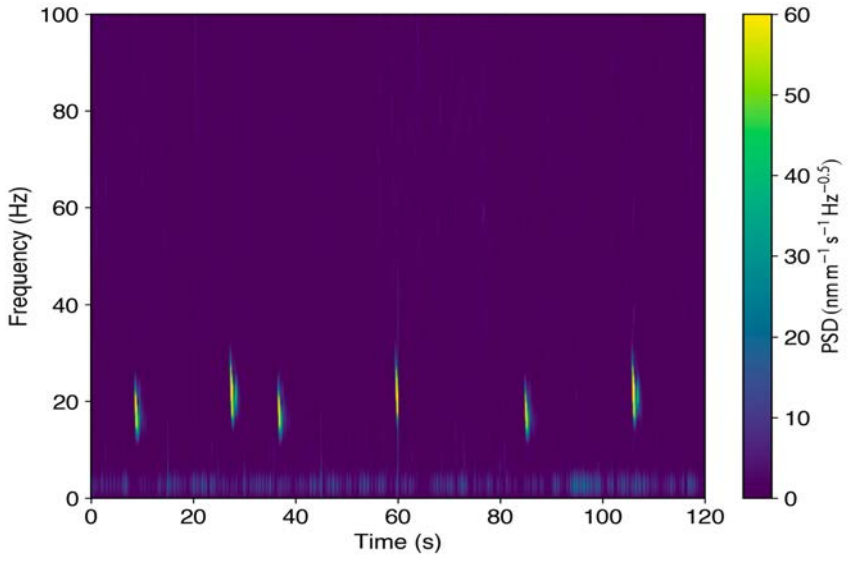


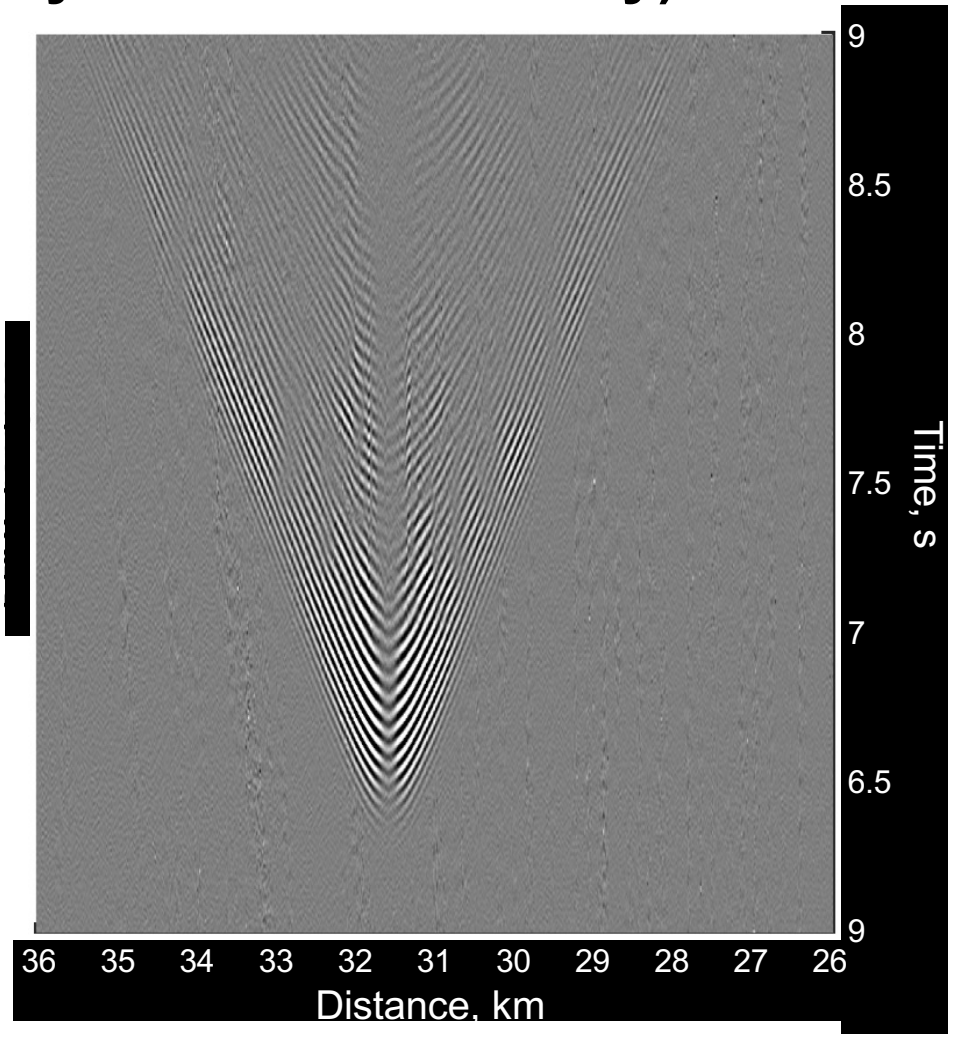
# OptaSense DAS - Fin Whale



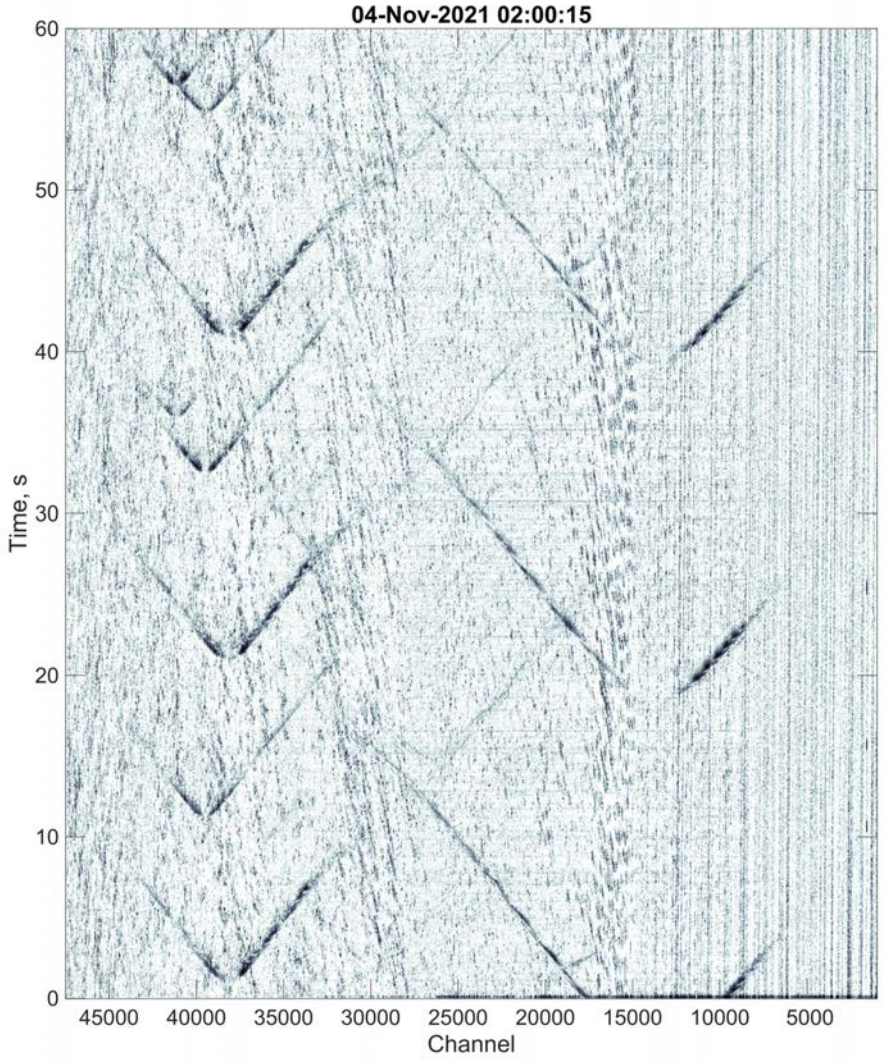
# Fin Whale – Silixa DAS (courtesy of David Podrasky)



# South Cable

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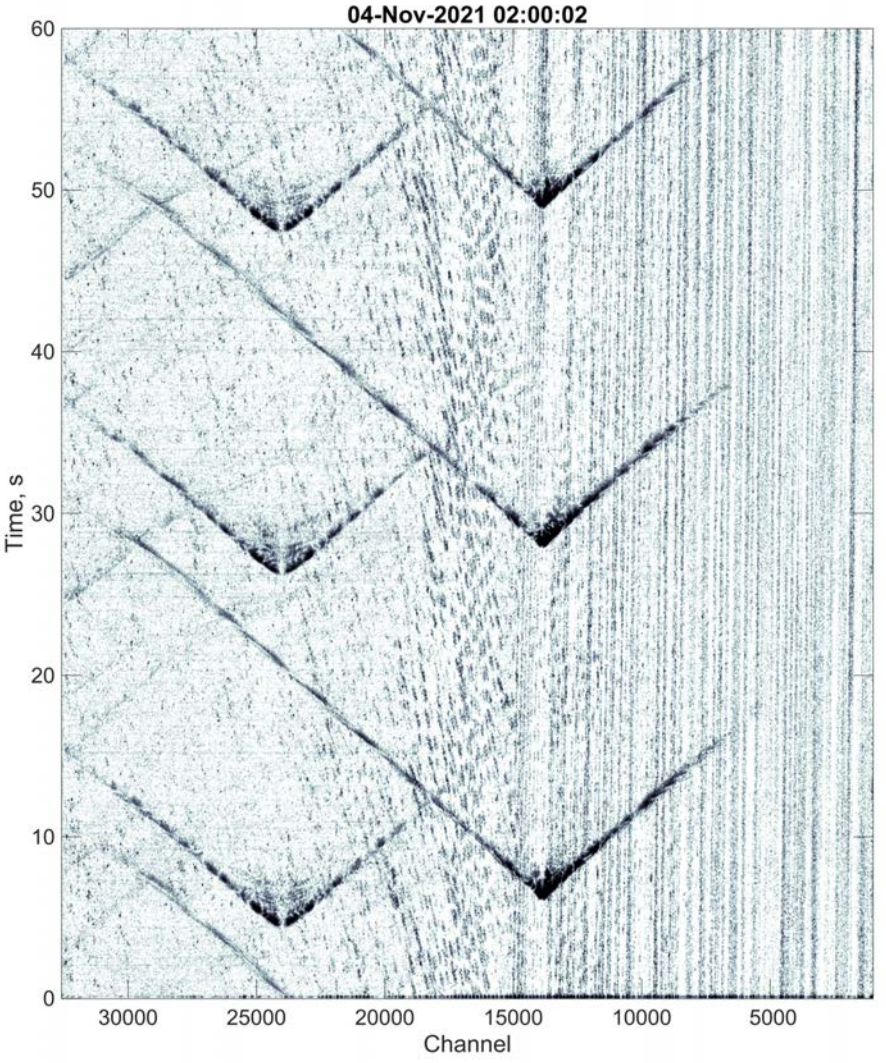

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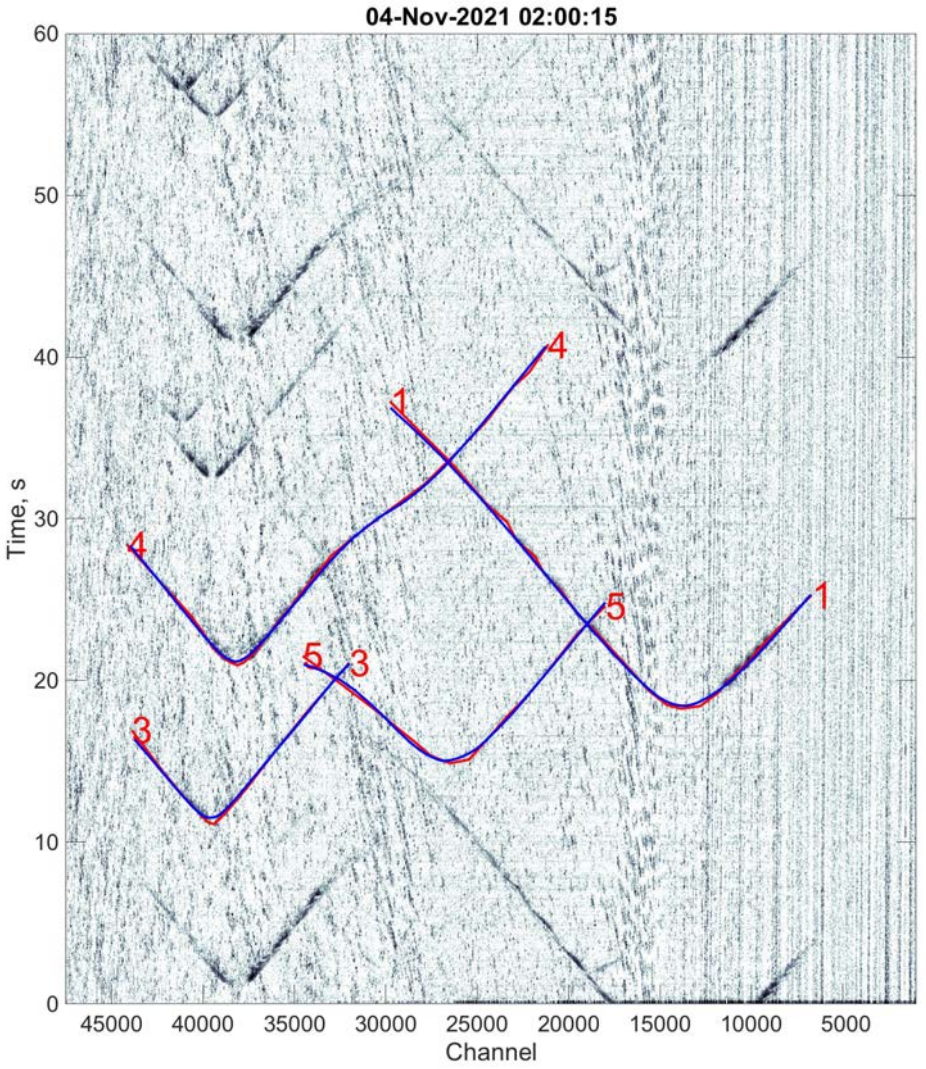


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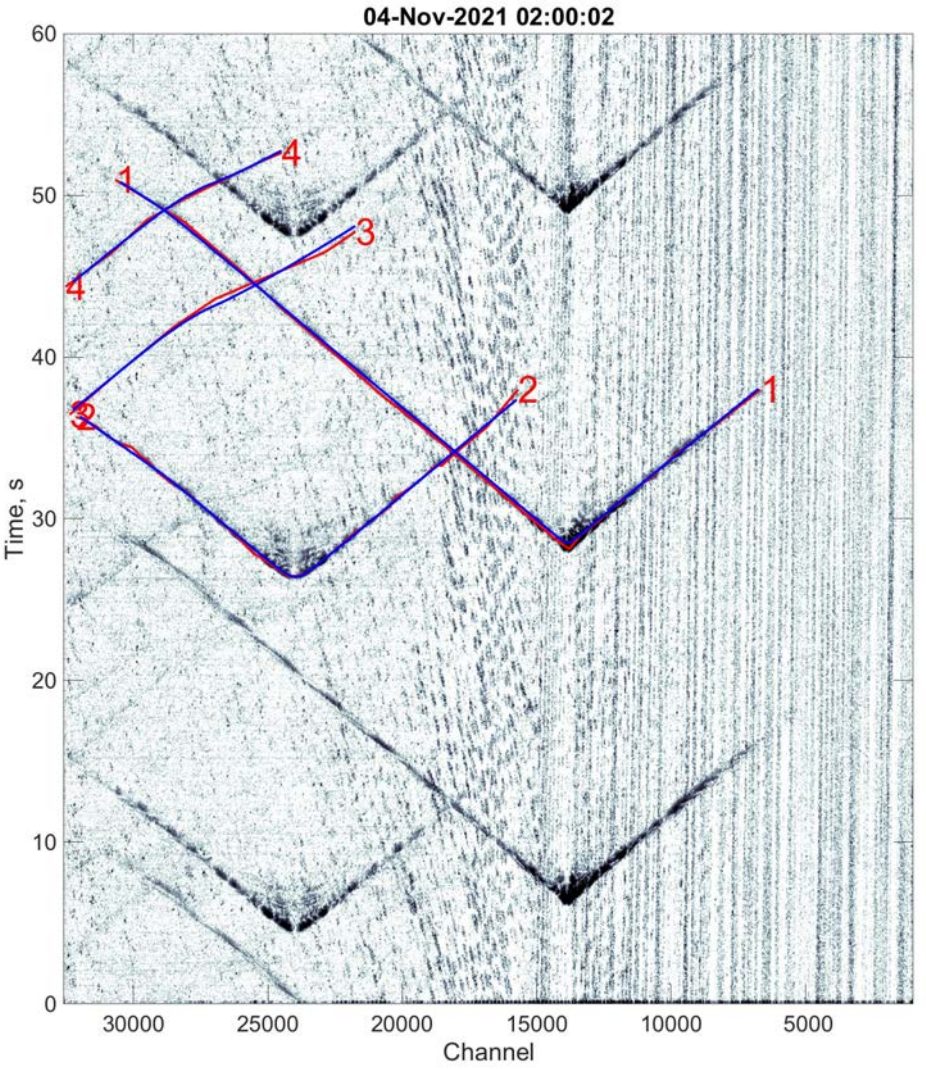

# South Cable

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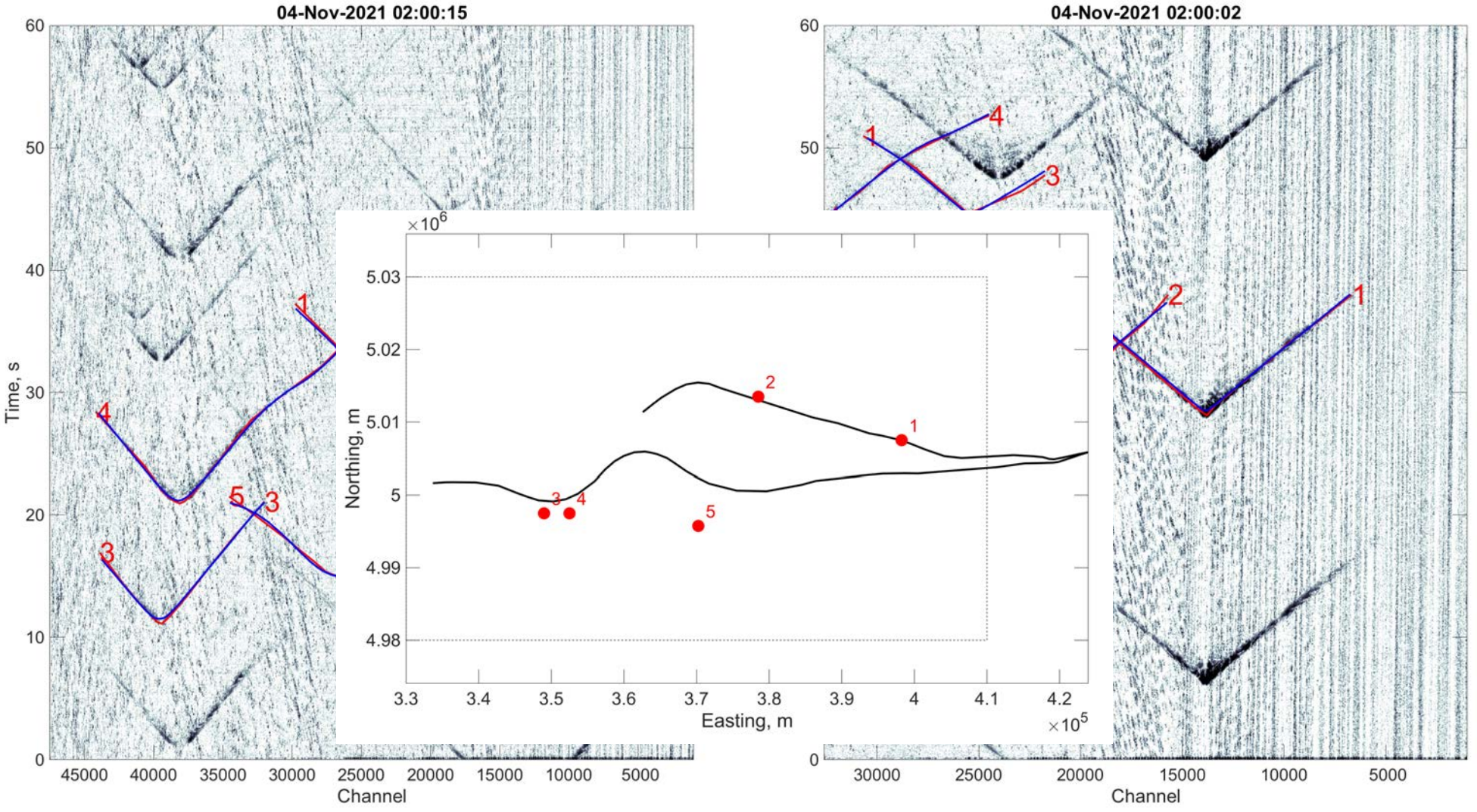

# What's next?

## Build a user community for open access offshore data

Experiment landing page:
https://oceanobservatories.org/pi-instrument/rapid-a-community-test-of-distributed-acoustic-sensing-on-the-ocean-observatories-initiative-regional-cabled-array/
Data:
http://piweb.ooirsn.uw.edu/das/

## Coordinate Analysis

Join the mailing list
http://mailman.u.washington.edu/mailman/listinfo/OOIDAS2021

## Permanent DAS on the OOI Cabled Array?

System was designed with spare communication frequency bands