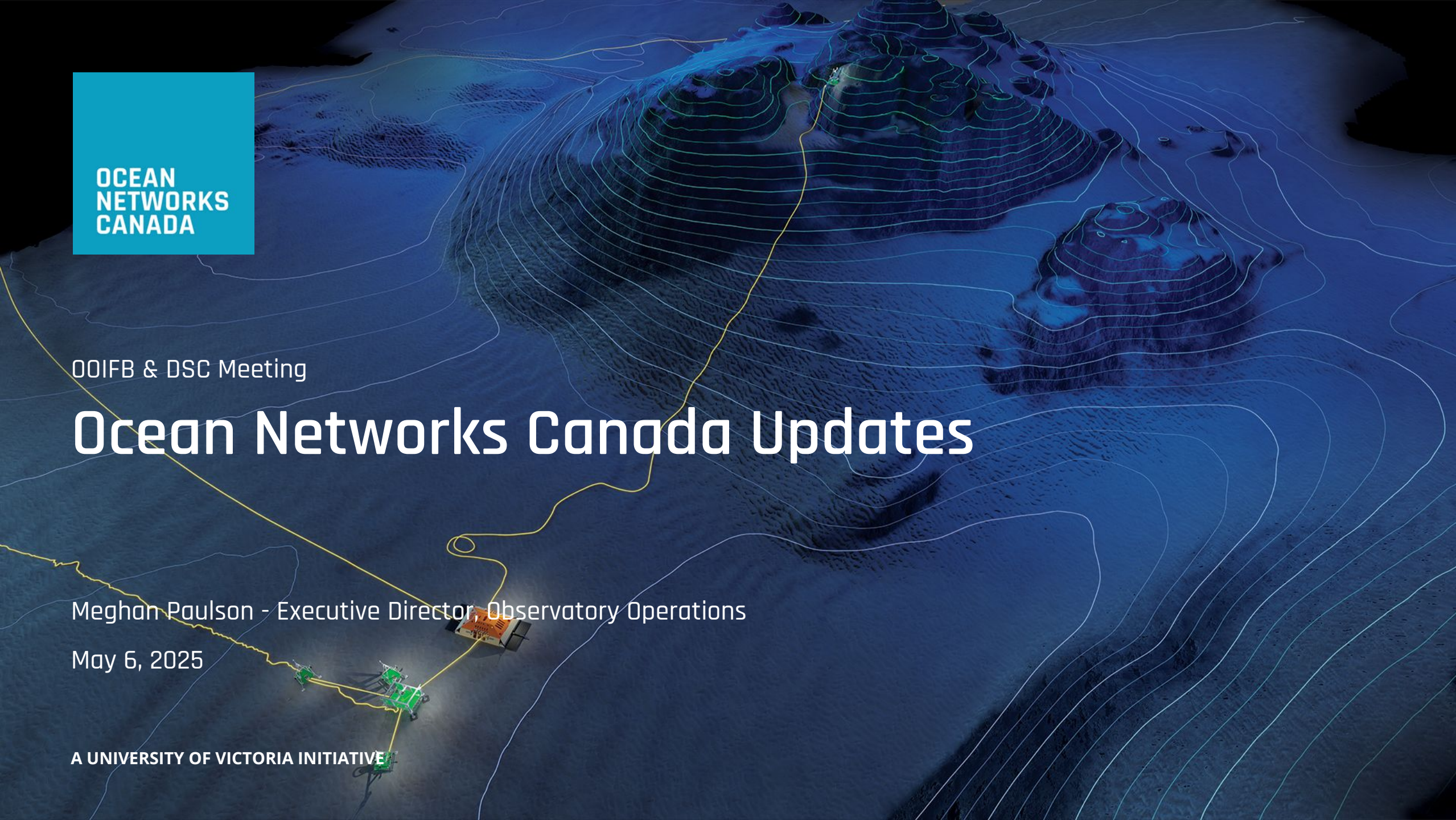


OCEAN NETWORKS CANADA

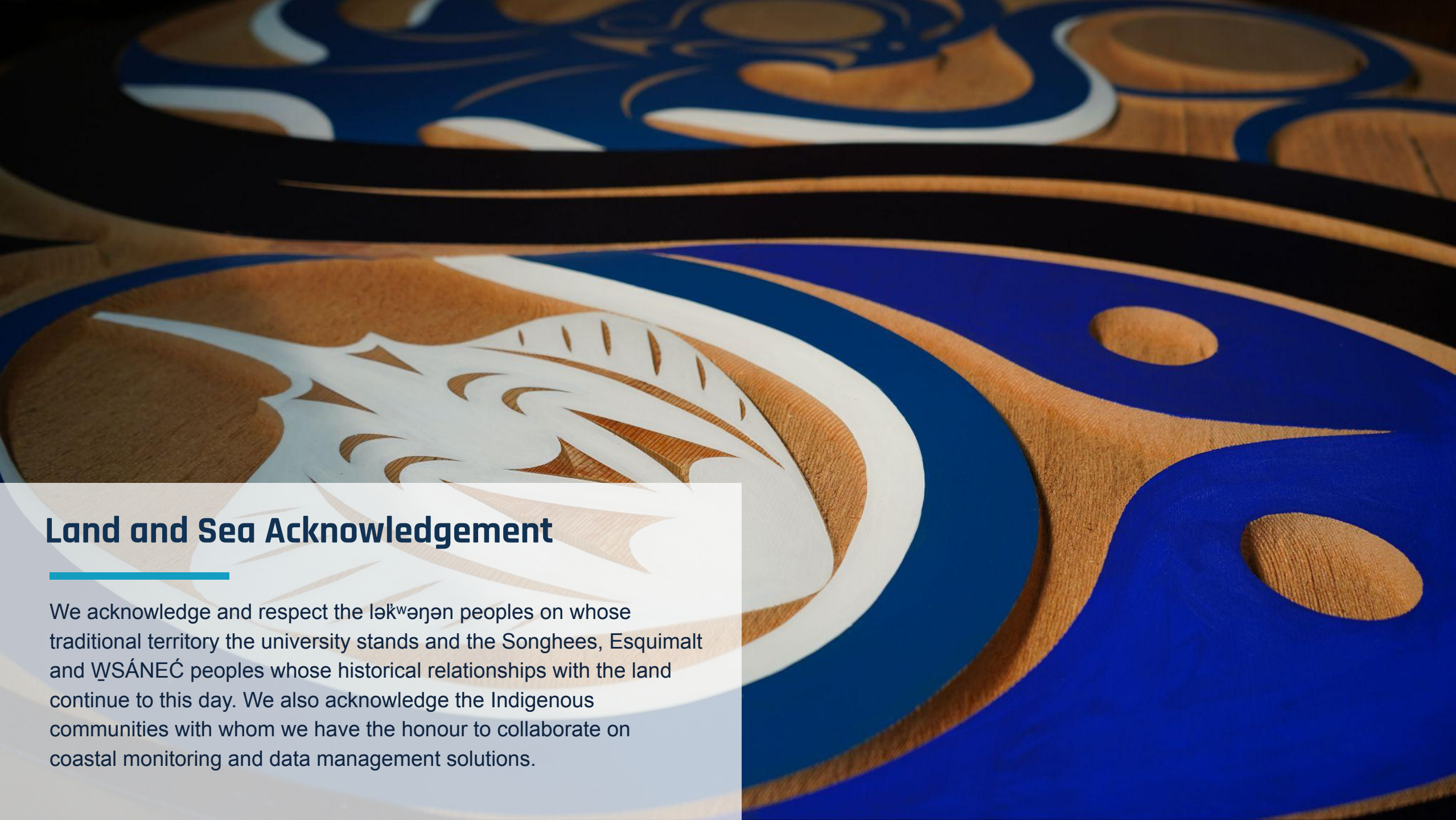
OOIFB & DSC Meeting

Ocean Networks Canada Updates

Meghan Paulson - Executive Director, Observatory Operations

May 6, 2025

A UNIVERSITY OF VICTORIA INITIATIVE

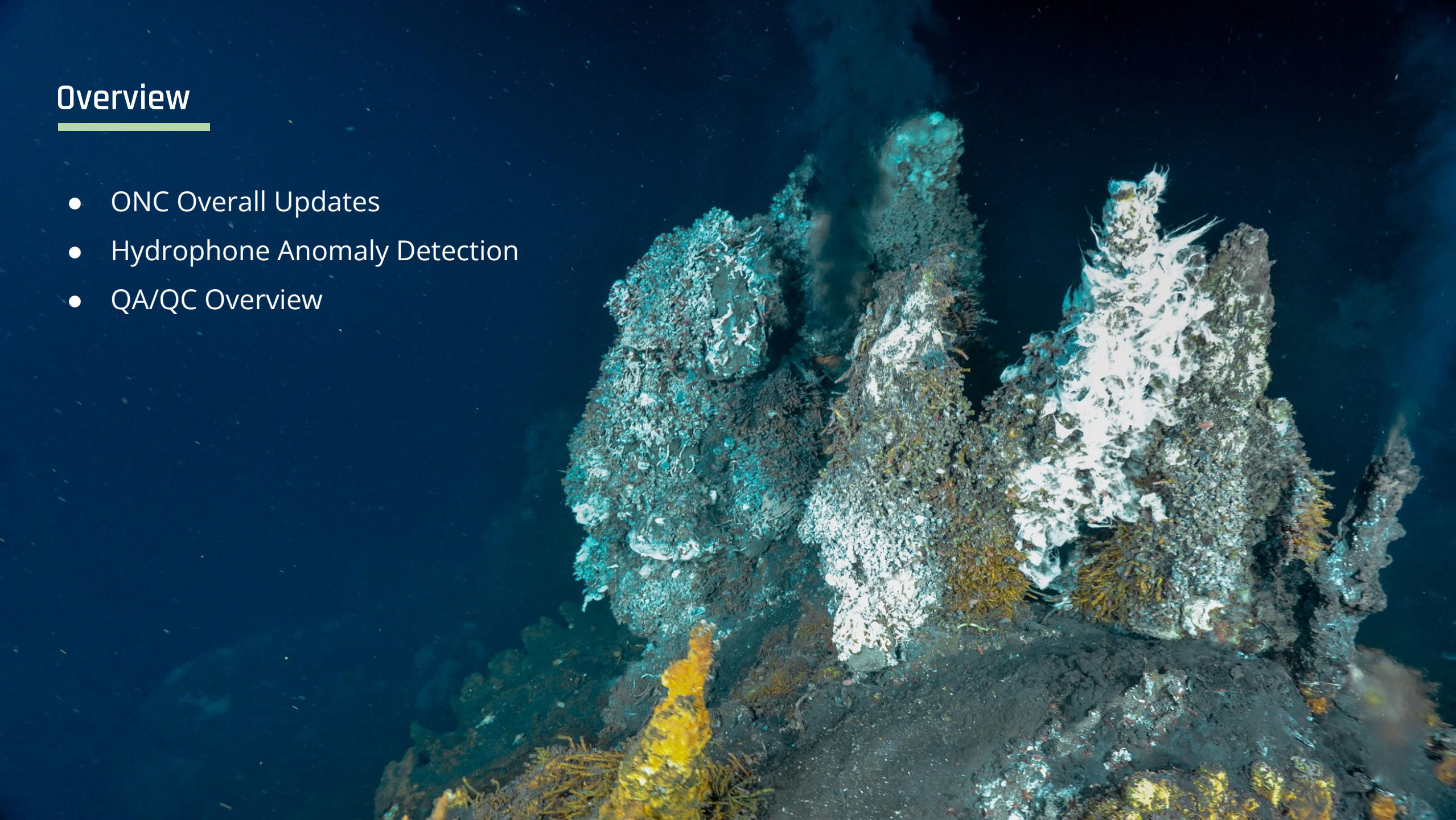


Land and Sea Acknowledgement

We acknowledge and respect the lək̓ʷəŋən peoples on whose traditional territory the university stands and the Songhees, Esquimalt and W̱SÁNEĆ peoples whose historical relationships with the land continue to this day. We also acknowledge the Indigenous communities with whom we have the honour to collaborate on coastal monitoring and data management solutions.

Overview

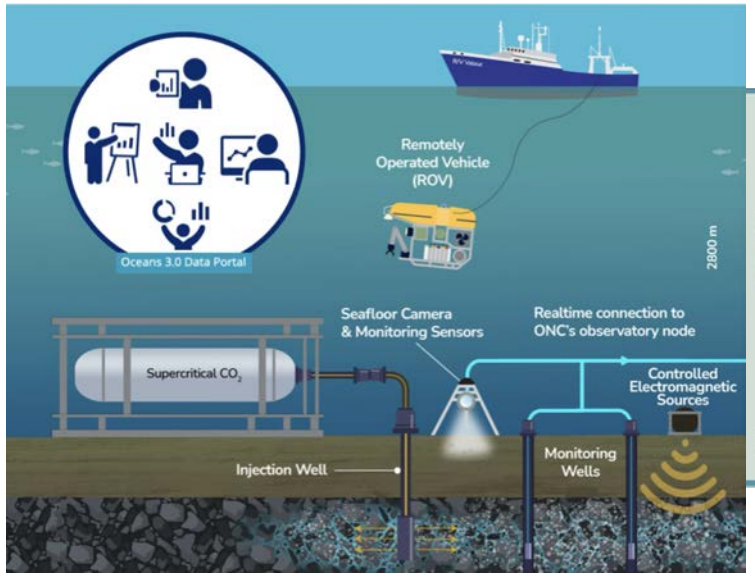
- ONC Overall Updates
- Hydrophone Anomaly Detection
- QA/QC Overview

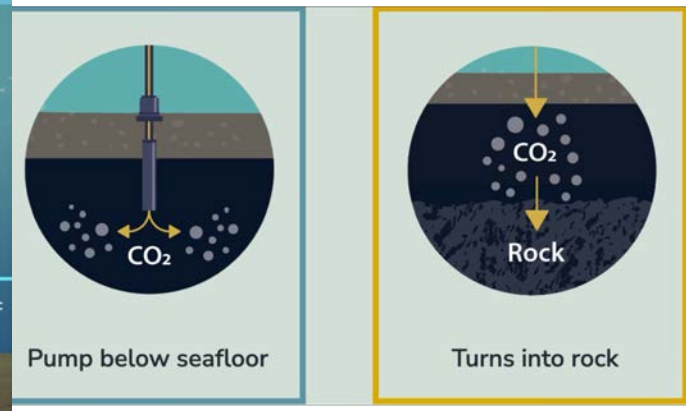


ONC Updates

- Major Research Facility (MRF)
  - Creating 15-year Plan
- ONC Leadership
  - President & CEO
  - Summer 2026
  - https://www.boyden.com/canada/
- Solid Carbon
  - New Frontiers in Research Fund - Transformation
  - 6 Year award - Demonstration Project
  - Transdisciplinary
- Salish Sea Workshop
  - July 15-17
  - Virtual registration available
  - https://indico.oceannetworks.ca

INNOVATION
Canada Foundation for Innovation
Fondation canadienne pour l'innovation





Hydrophone Anomaly Detection

Background

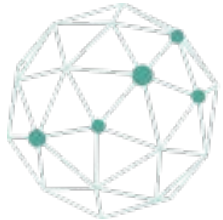
- ONC operates 34 cabled hydrophones
  - 5 x 4 element arrays
  - 2 x 2 element arrays
- Additional autonomous hydrophone data ingested
- Data collected / generated:
  - Source File
  - Audio (.flac archived) (5 minute)
  - FFT (Fast Fourier Transform)
  - Spectrograms
- ~750 TB hydrophone data in archive
- QAQC Checks….are a lot….

Project

- Machine Learning Working group formed out of interest
- Hydrophone QAQC need identified
- Internal project kicked off

Funding Opportunity

- Building Bridges - AI
- June 2023 - March 2026
- Dedicated staff

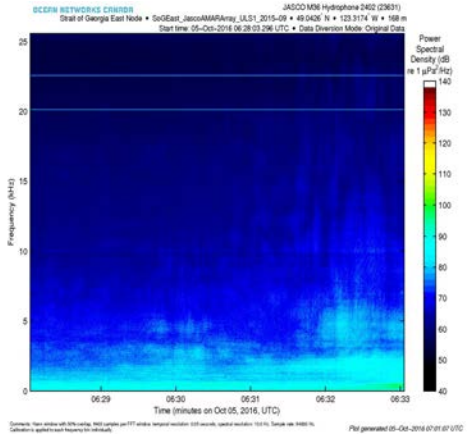


CIOOS
CANADIAN INTEGRATED
OCEAN OBSERVING SYSTEM

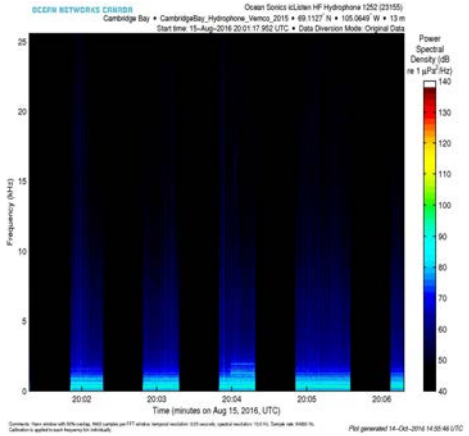
Anomalous Spectrograms

Instrumentation failures (primary interest)

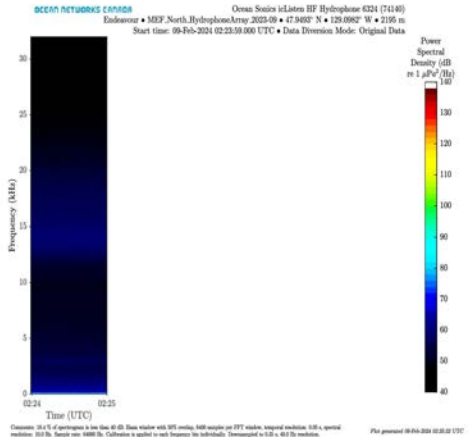
Tonals



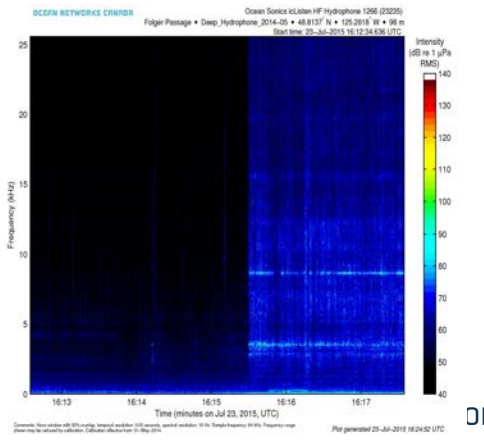
Dropouts



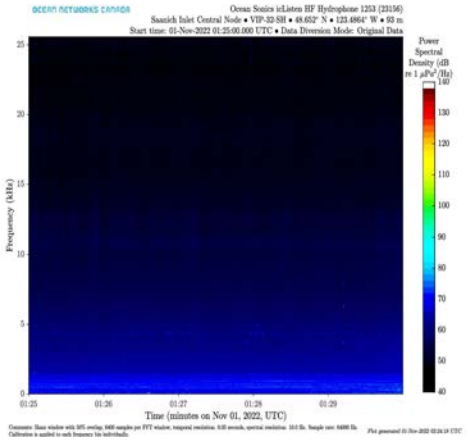
Data gaps



Sensitivity issues (vertical)



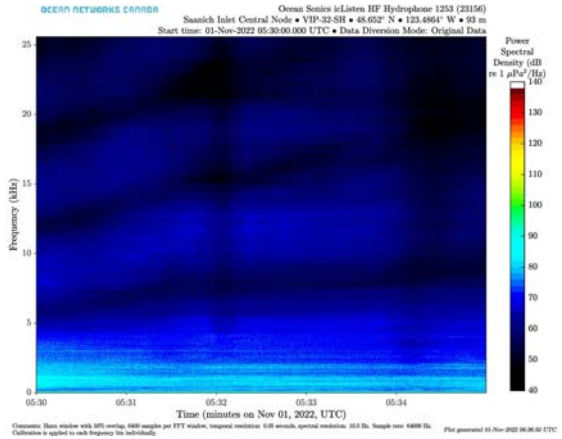
Sensitivity issues (horizontal)



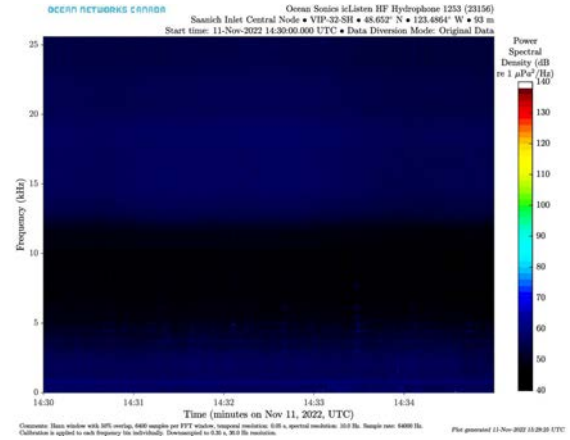
+ Unknown

Features (secondary interest)

Vessel noise



Rain



orld Lea

Spectrogram Processing

Read — Read audio data from source file

Create — Create 5-min window of audio data using an appropriate spectral technique

FFT — Calculate Fast Fourier Transform on the window audio file

Bin — Frequency bins and sensitivity as defined by hydrophone calibration

Correct — Apply calibration sensitivity to correct spectral response

Compensate — Compensate for spectral windowing

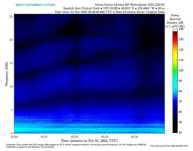
Generate — Generate underlying spectrogram data file (.mat)

Archive — Plot and archive spectrogram image

Processing Complete

END

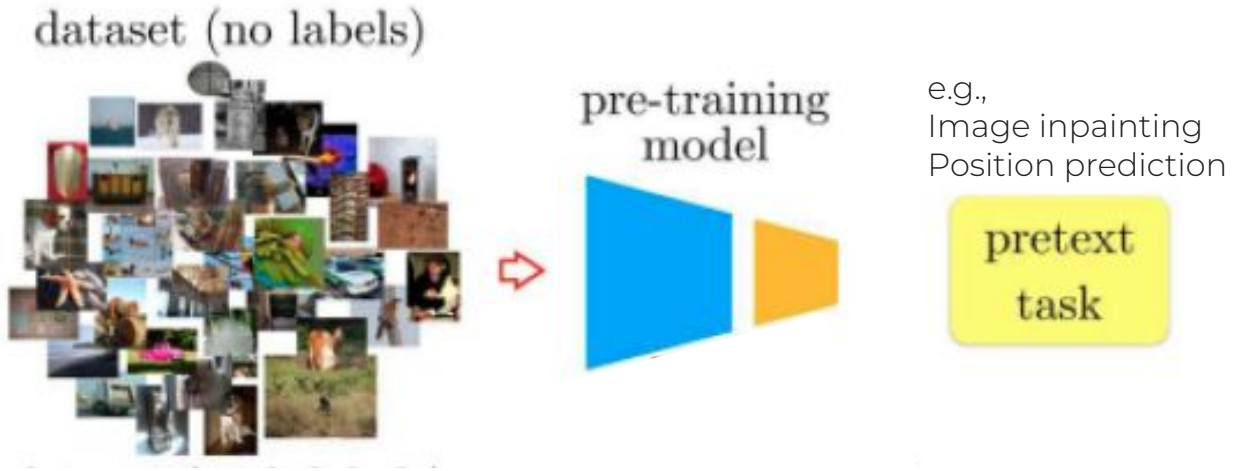
Extract Spectrogram



ML Architecture and Setup: Two Step Process

Self-Supervised Audio Mamba (SSAMBA, Shams et al., 2024)

Step 1



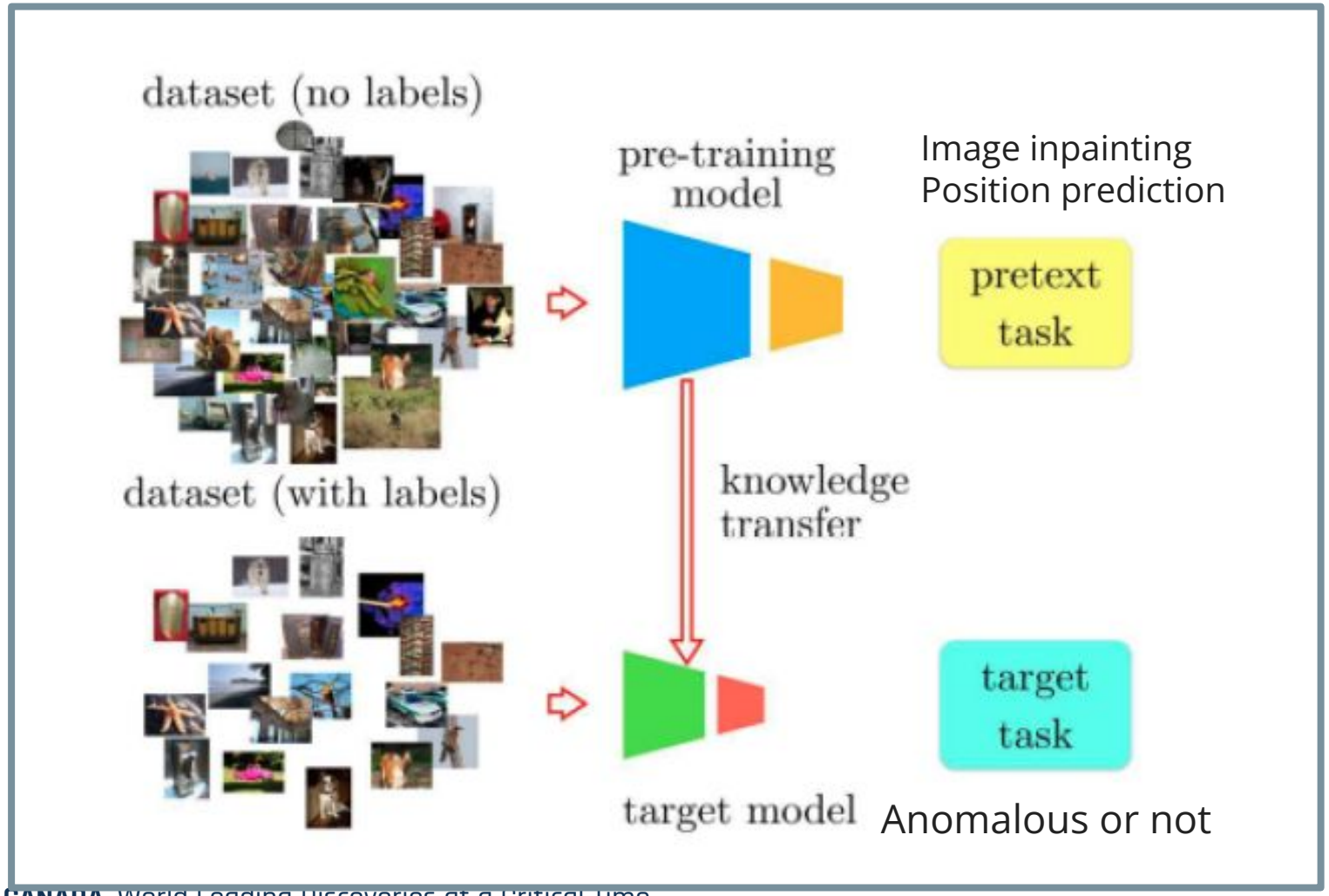
9430 normal samples

ML Architecture and Setup

Self-Supervised Audio Mamba (SSAMBA, Shams et al., 2024)

Step 1

Step 2

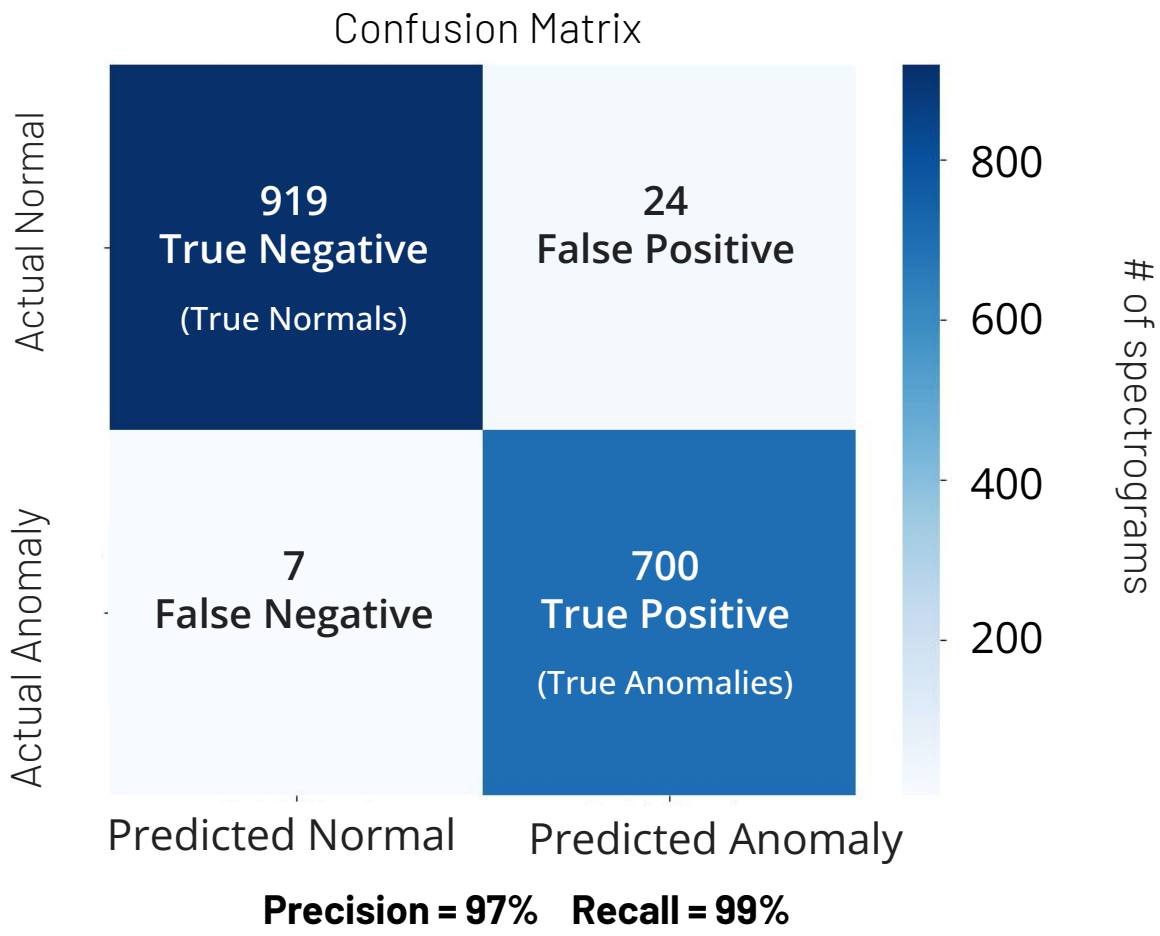


9430 normal samples

6500 normal +
6500 anomalous =
13,000 samples

Results (So far...)

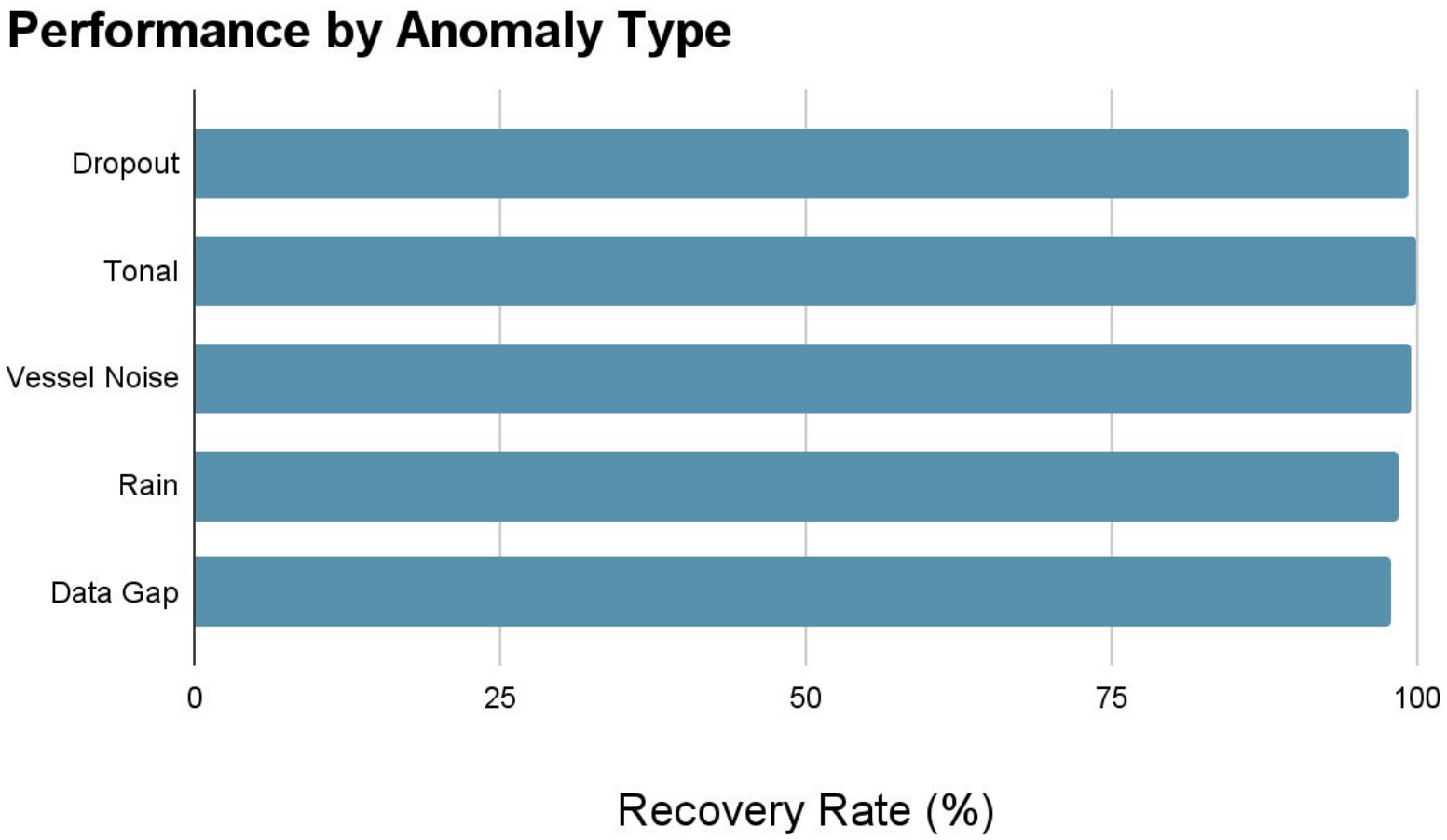
Trained on ~**12,000** spectrograms, testing on ~**1650** spectrograms



Precision = 97% Recall = 99%

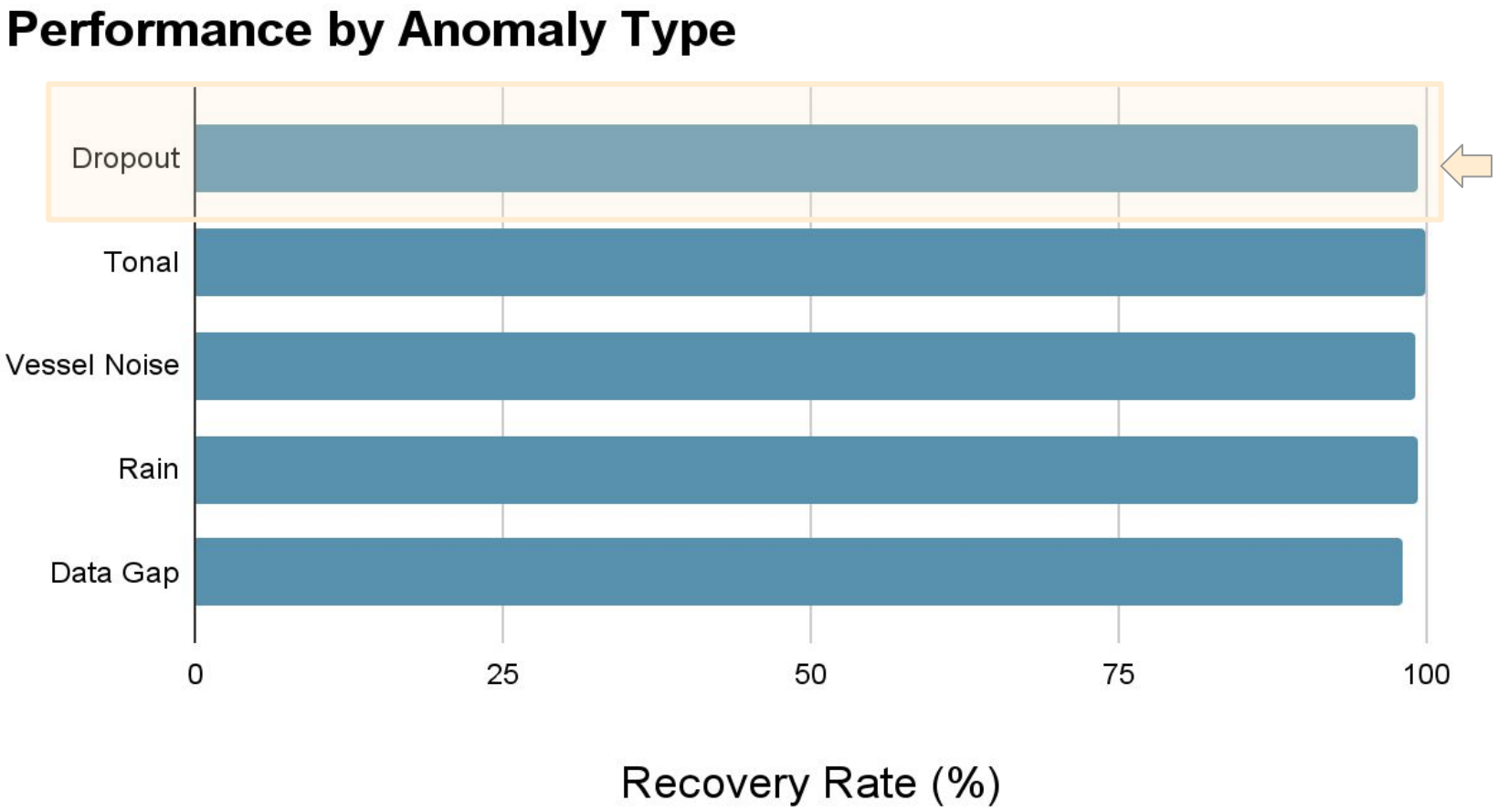
Results (So far...)

Trained on ~**12,000** spectrograms, testing on ~**1650** spectrograms
How well did we recover each anomaly type



Results (So far...)

Trained on ~**11,000** spectrograms, testing on ~**2650** spectrograms:
(dropout removed from training - added to testing)
RESULT: Recover anomaly NOT seen in training

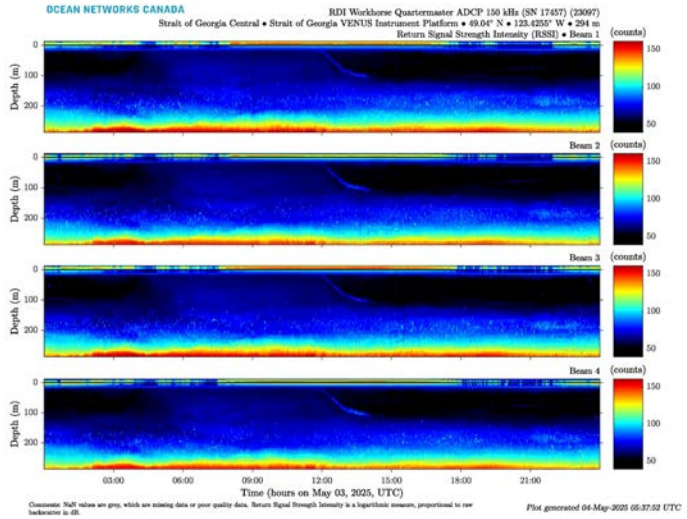


We still recover *almost all* of the dropouts despite the model never learning about them

i.e. the model can generalize

Next Steps

- Operationalize….
- Expand to additional data types
  - ADCP
- Share!



Sounding Out Anomalies in Underwater Acoustics (Hybrid)

May 13, 12:10PM-1PM PDT | 3:10PM-4PM EDT | 4:10PM-5PM ADT

Location: University of Victoria Queenswood Building, 2474 Arbutus Road, Victoria, BC

This session presents a machine learning framework for automated anomaly detection in Ocean Network Canada's underwater acoustic data, applying self-supervised learning to capture key patterns from unlabeled spectrogram data and significantly reducing the need for labeled datasets.

Register Now!

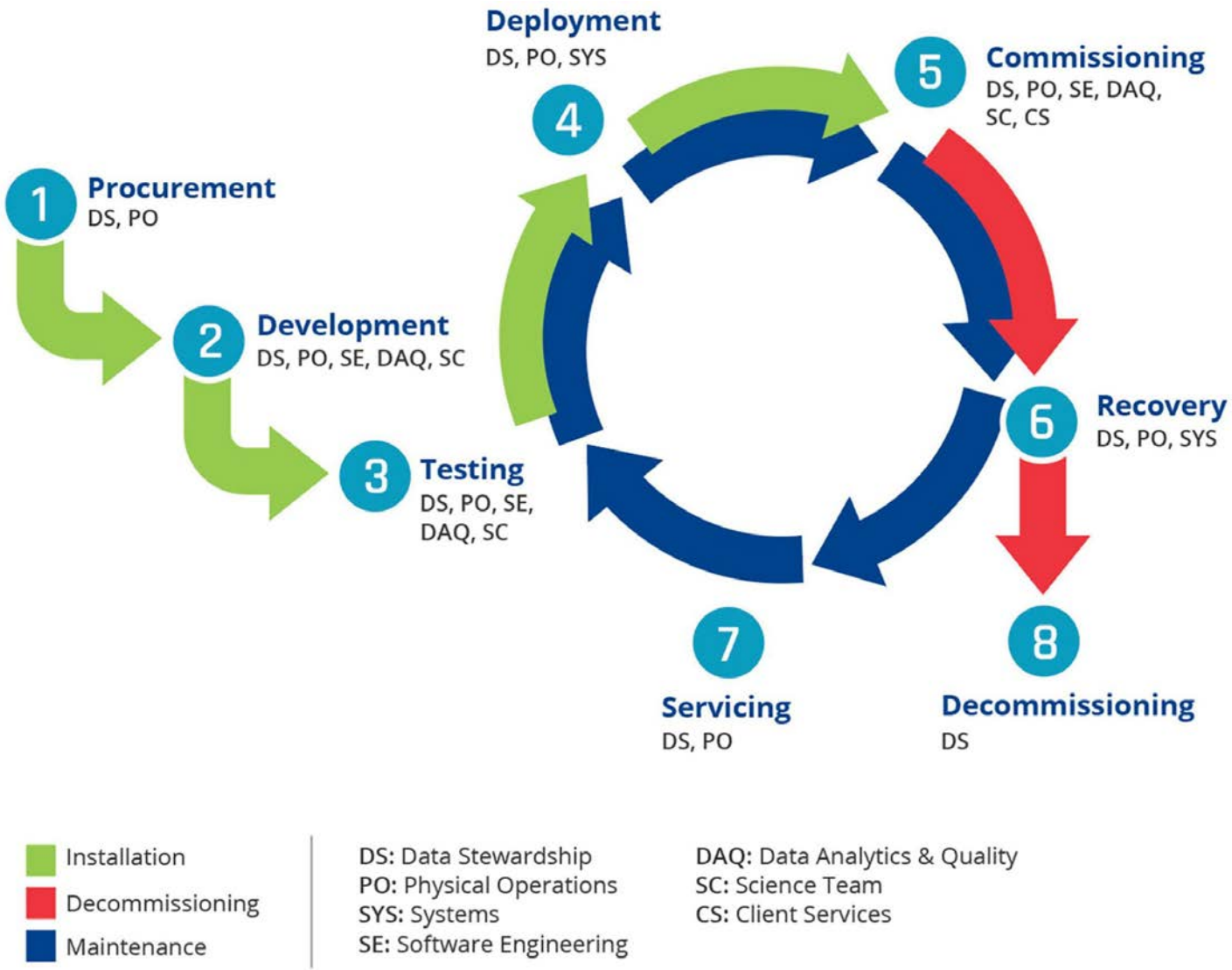
https://cioosatlantic.ca/buildingbridges-diveintoai/

QA/QC at ONC

An Overview

Instrument Workflow

- Applied to all instrument types
- QA/QC Key Decision Gates
  - Pre-Deployment Testing
  - Post-Deployment Commissioning
  - Daily Checks
    - Automated Quality Testing
    - Manual Quality Control Methods
  - Post recovery tests



Data Quality Assurance and Quality Control Model

- Pre-deployment testing:
  - Includes all data/metadata checks performed at the pre-deployment testing point of an instrument - up to actual deployment of instrument
  - Typically performed as bench test then tank test at Marine Technology Centre. Full platform tests with all instruments when required
- Post-deployment commissioning:
  - Includes all data/metadata checks from actual deployment to commissioning of the data as “good” or “compromised”
- Automated data quality testing:
  - Includes all data QC related checks, real-time or delayed, performed via automated quality control procedures while the instrument is deployed
- Manual data quality control methods:
  - Includes all data QC checks performed via systematic manual data assessments and annotation routines
- Post-recovery tests:
  - Includes all post-calibration checks performed during post-recovery and servicing stages of an instrument.

Scalar Data: Auto QAQC

Data Flagging System

Based on QUARTOD

Auto tests based on:

- Sensor type / output
  - Range test, spike test, etc
- Region
  - NE Pacific Shallow
- Auto tests applied during validation and run continuously during deployment
  - Real-Time
  - Delayed mode

Data Quality Flag	Description
0	No quality control on data
1	Data passed all tests
2	Data probably good
3	Data probably bad. Failed minor tests
4	Data bad. Failed major tests
7	Averaged value
8	Interpolated value
9	Missing data

Scalar Data: Auto QAQC

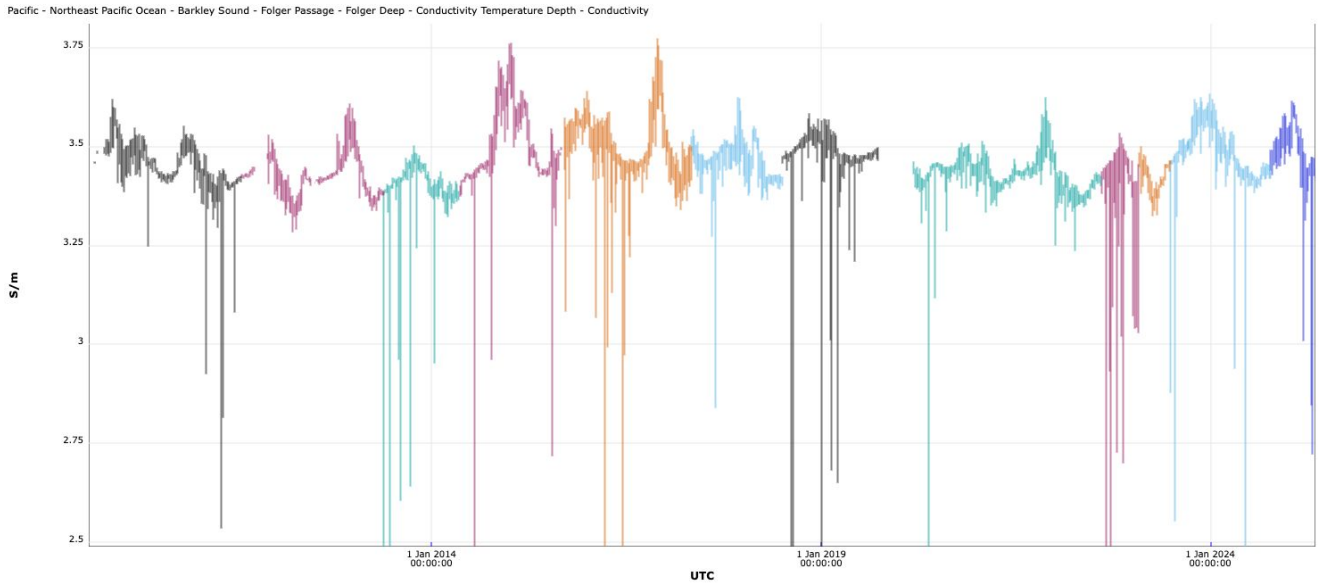
Data Flagging System

Auto QAQC Tests

- New test developed as needed in-house
- QAQC working group evaluates tests
  - Sensor technology changes
  - Firmware changes

Auto QAQC test creates a flag

Flag information is stored in QAQC Results table in separate DB from raw data



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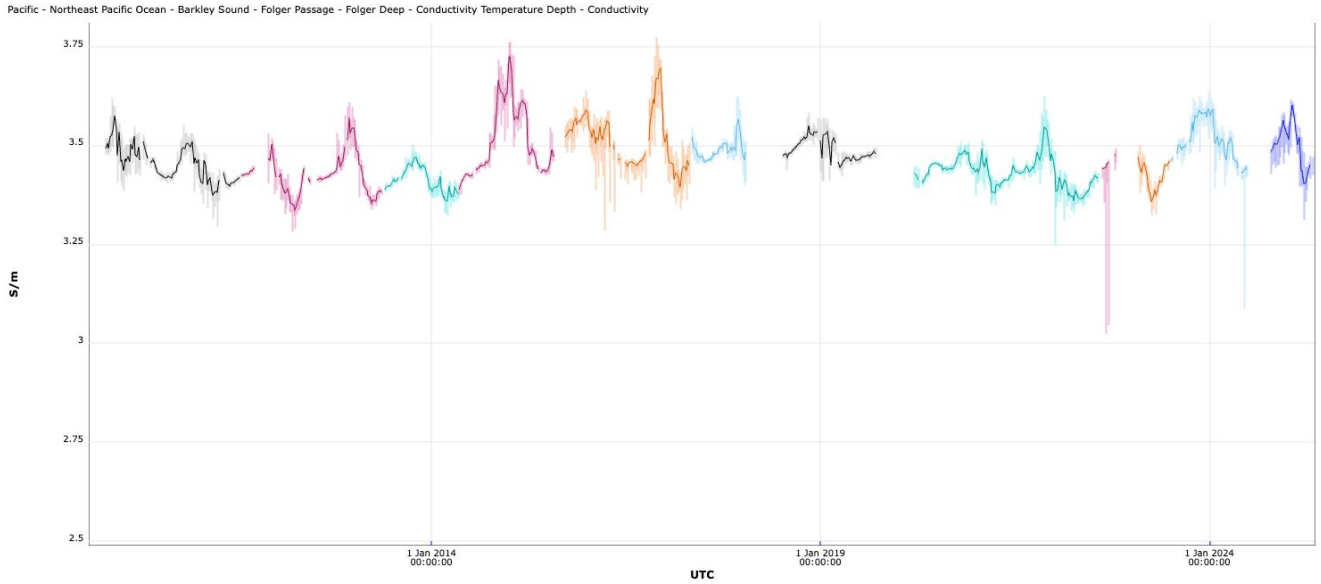
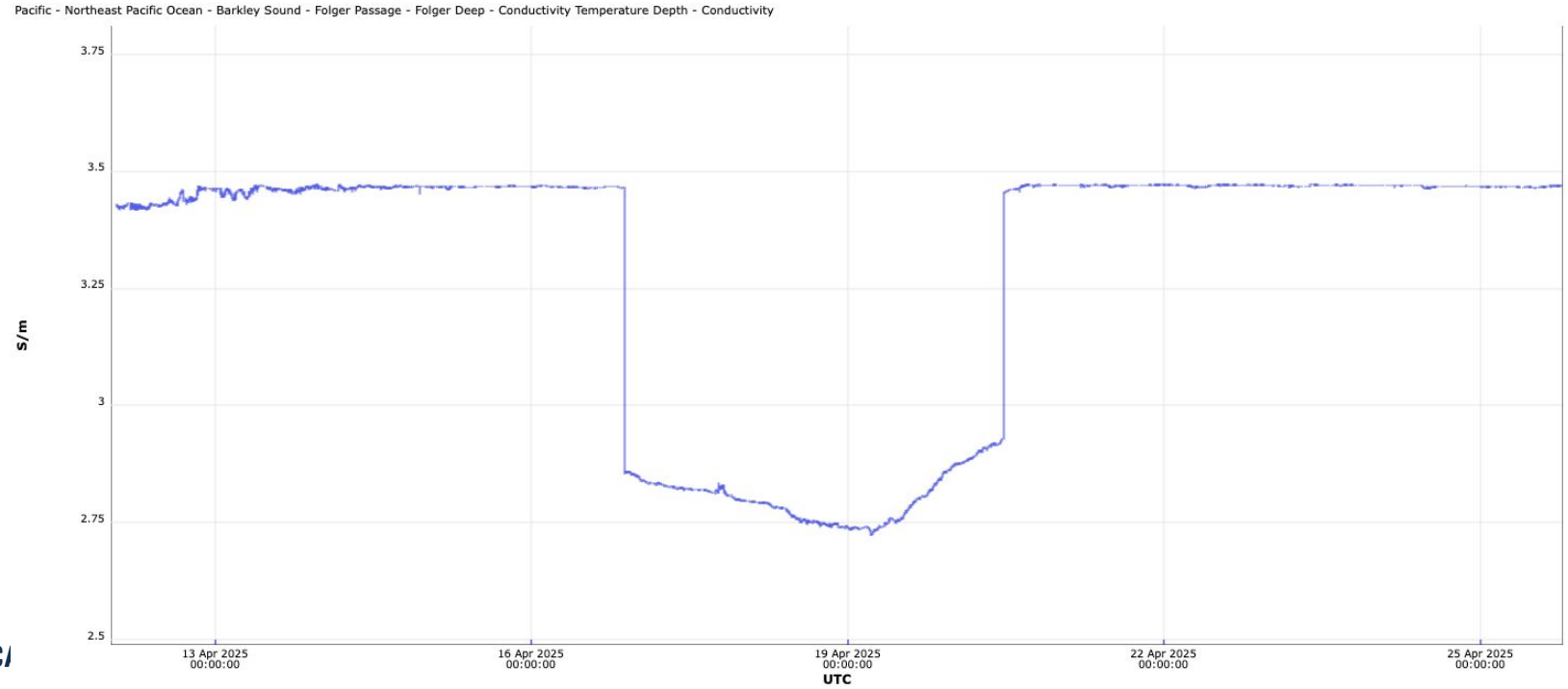


#"Time UTC (yyyy-mm-ddThh:mm:ss.fffZ)"	"Conductivity (S/m)"	"Conductivity QC Flag"	"Conductivity Count"
2025-05-04T19:37:30.000Z	3.419409	7	900
2025-05-04T19:52:30.000Z	3.419386622	7	900
2025-05-04T20:07:30.000Z	3.419440111	7	900
2025-05-04T20:22:30.000Z	3.419467567	7	900
2025-05-04T20:37:30.000Z	3.419544822	7	900
2025-05-04T20:52:30.000Z	3.419350789	7	900
2025-05-04T21:07:30.000Z	3.419090689	7	900
2025-05-04T21:22:30.000Z	3.4190669	7	900
2025-05-04T21:37:30.000Z	3.419038644	7	900

Scalar Data: Manual QAQC

- Daily monitoring (eyes on data)
- Manually creating flags
  - Currently standalone app
  - Active project to merge into Oceans 3.0
- This is ripe for more ML for more active monitoring - move from eyes on data to “human in the loop ML”
- Change Auto QAQC flag usually from 1 to “bad (3 or 4)”



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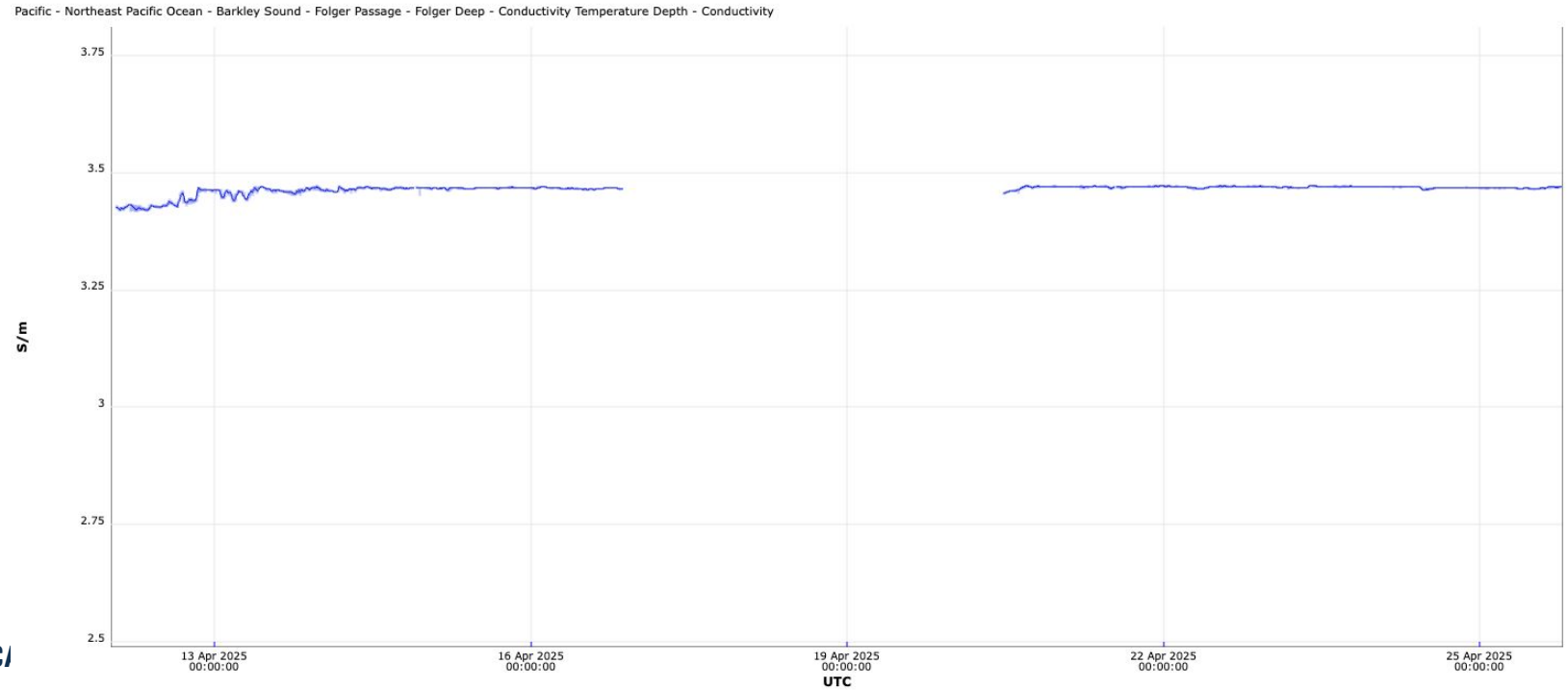
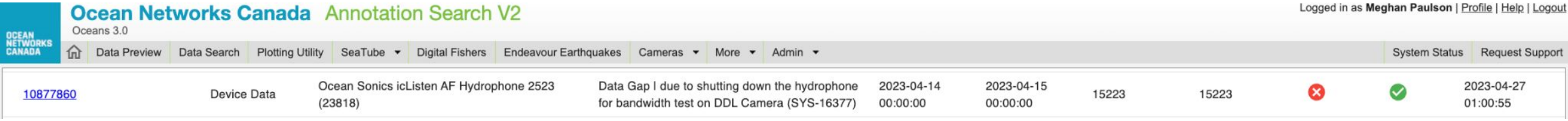


Complex Data QAQC

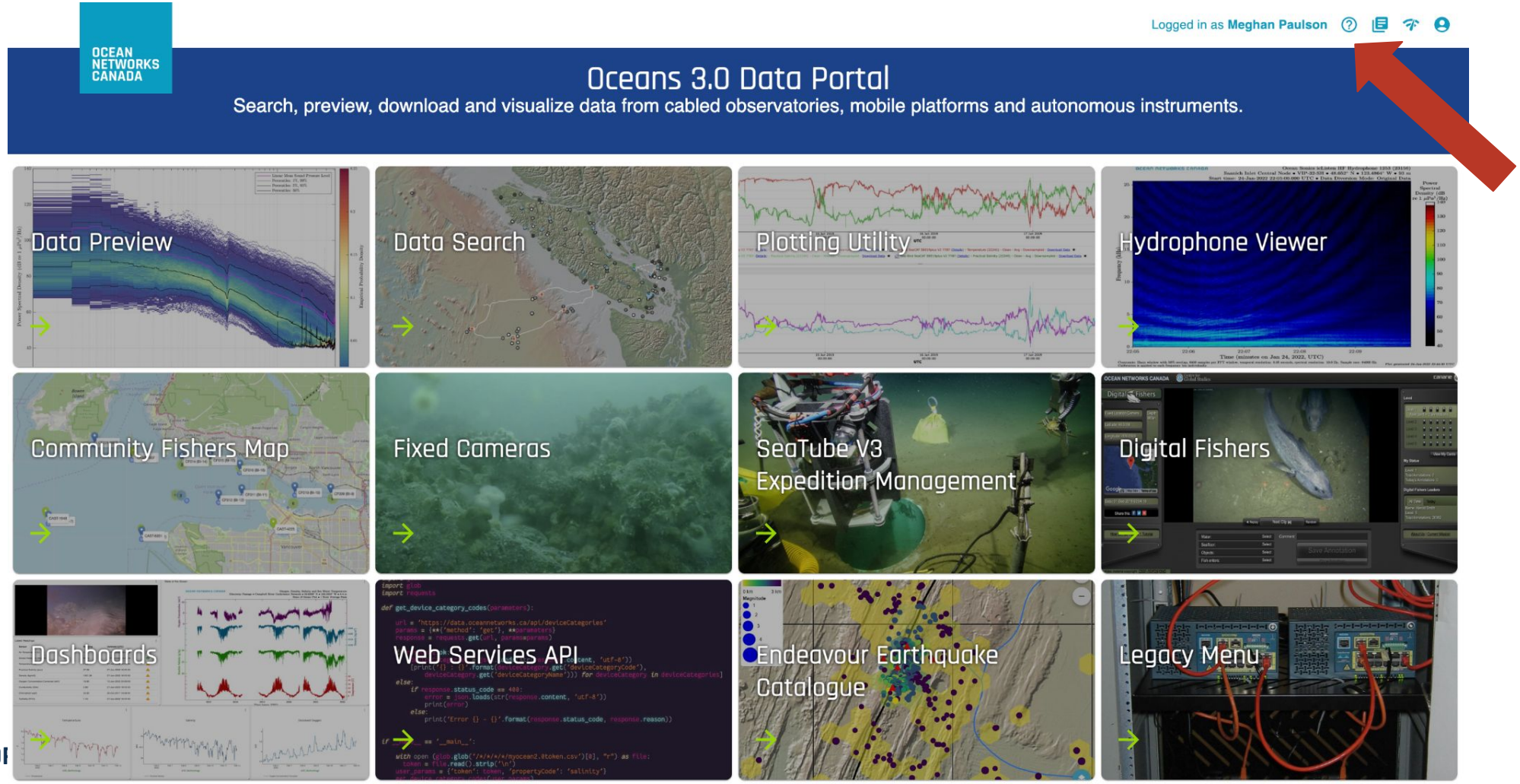
Annotations

- Current: no means for QAQC flags
- Data quality covered by annotations
- Scalar data also uses annotations for non-flag related QAQC and other information



How to get QAQC Help

ONC external wiki documentation:
https://wiki.oceannetworks.ca/spaces/DP/pages/42174414/Quality+Assurance+Quality+Control



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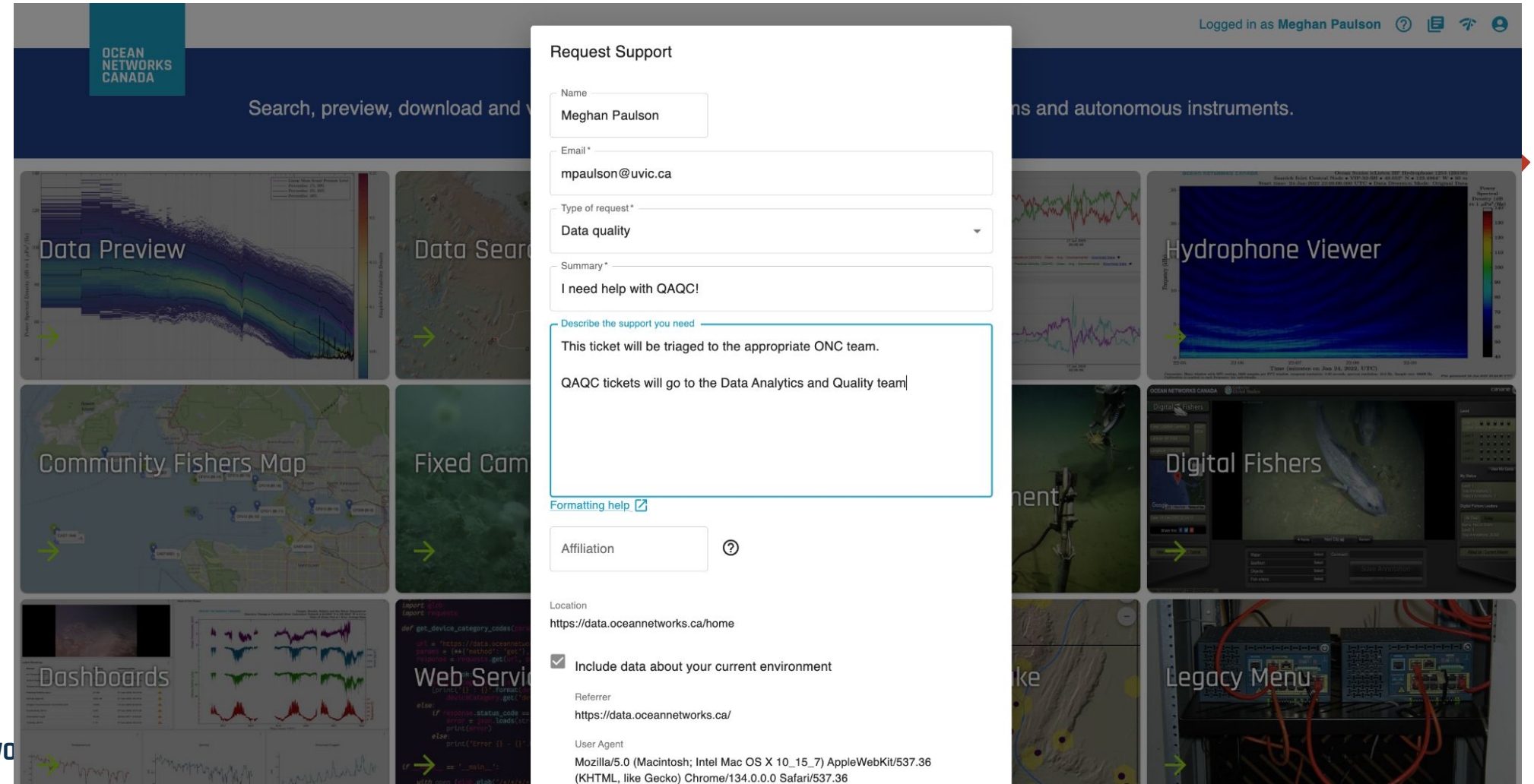

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Thank You!