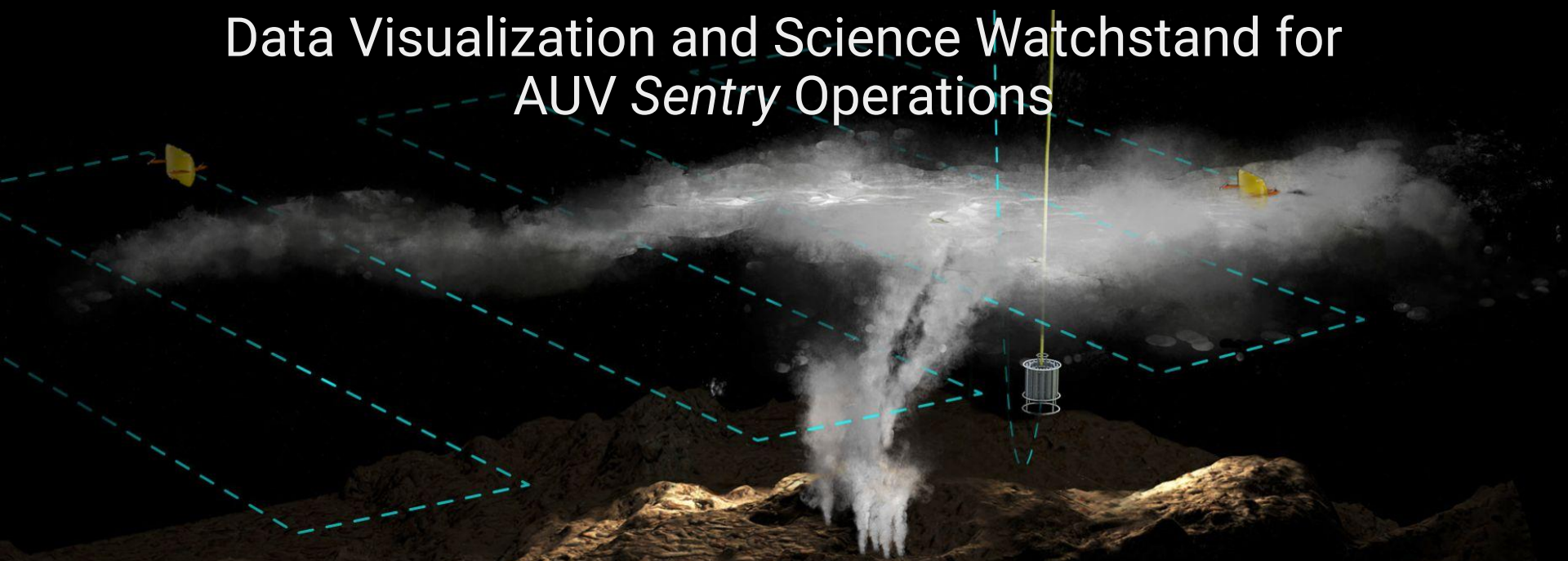
AT50-15

Data Visualization and Science Watchstand for AUV *Sentry* Operations

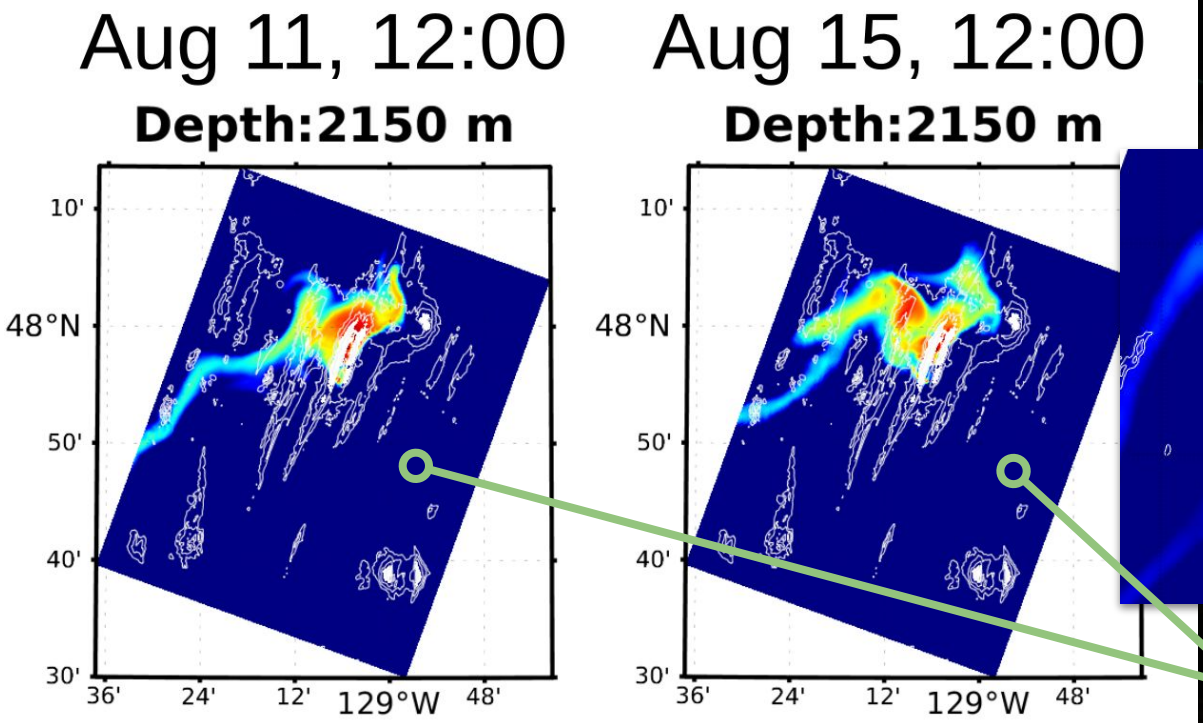


Presented by: Victoria Preston
Northeastern University
Postdoctoral Researcher
v.preston@northeastern.edu

Cruise Chief Sci: Chris German
Woods Hole Oceanographic Institution
Senior Scientist
cgerman@whoi.edu

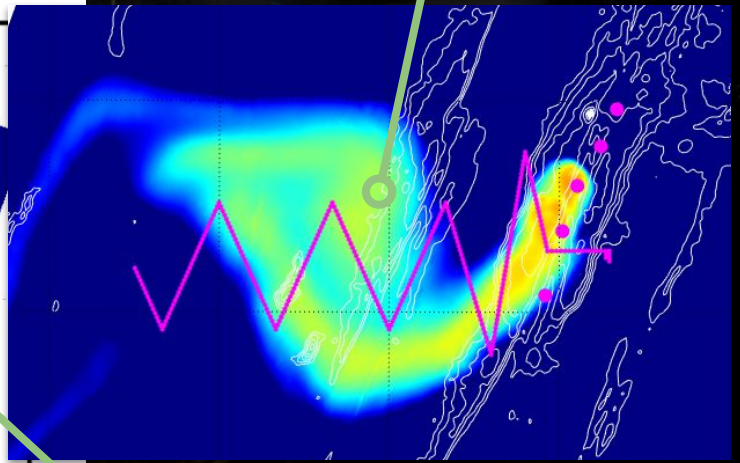
Presentation
OP31G-09 @ OSM

Performing surveys of hydrothermal plumes is technically challenging due to their complex spatiotemporal movement.



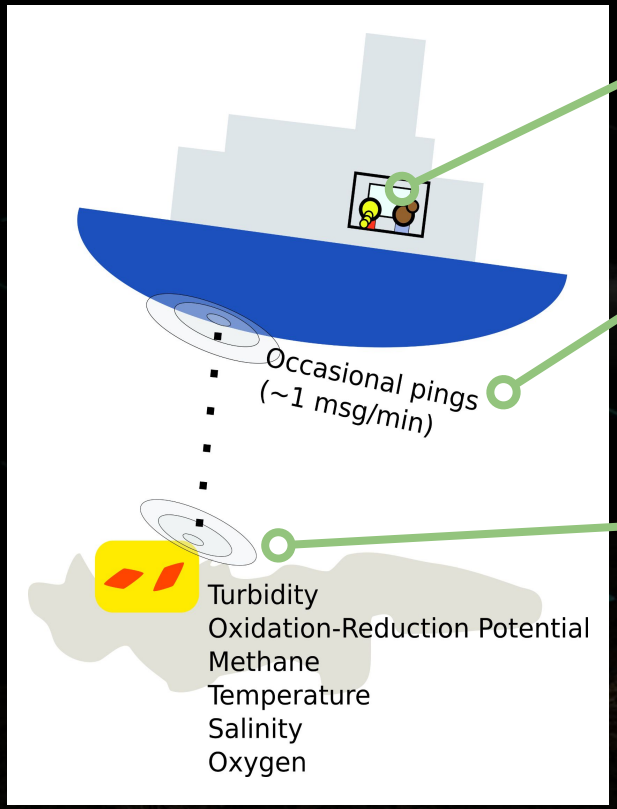
Based on model in Xu and German, Frontiers in Marine Science *2023*.

Pre-deployment hypothetical distribution and path



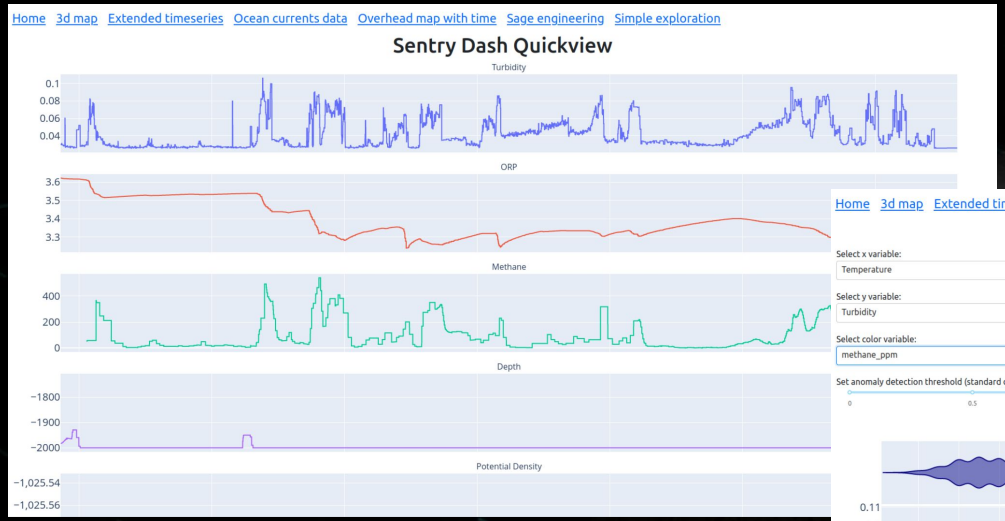
Predicted motion and uncertainty invite real-time adaptation

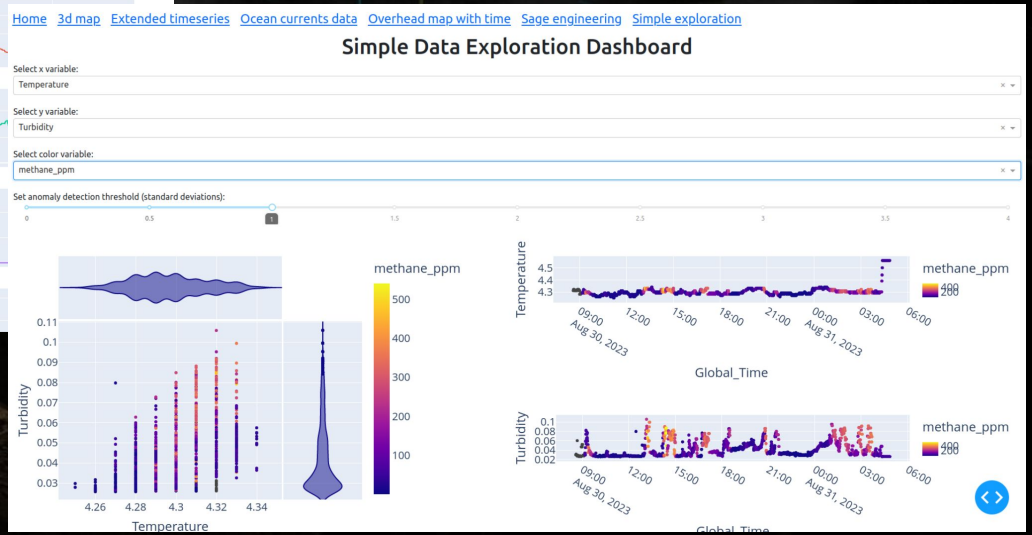
We tested a field prototype for a situational awareness platform to be used with AUV *Sentry* for plume tracking.



- **Local network** on the ship established for AUV *Sentry* operations; network **broadcasts vehicle data** and **repeats ship-side USBL navigation** messages.
- *Sentry* **acoustically** transmits pre-defined data packets at a rate of **~1 msg/min**. ~1500 messages are expected for a 24hr mission.
- **Rotating queues** cycle through different data packets:
  - **Science queue** | Turbidity, ORP, Temperature, Salinity, Oxygen
  - **Specialized Sensor queue(s)** | Methane (x2), Turbidity, SUPR

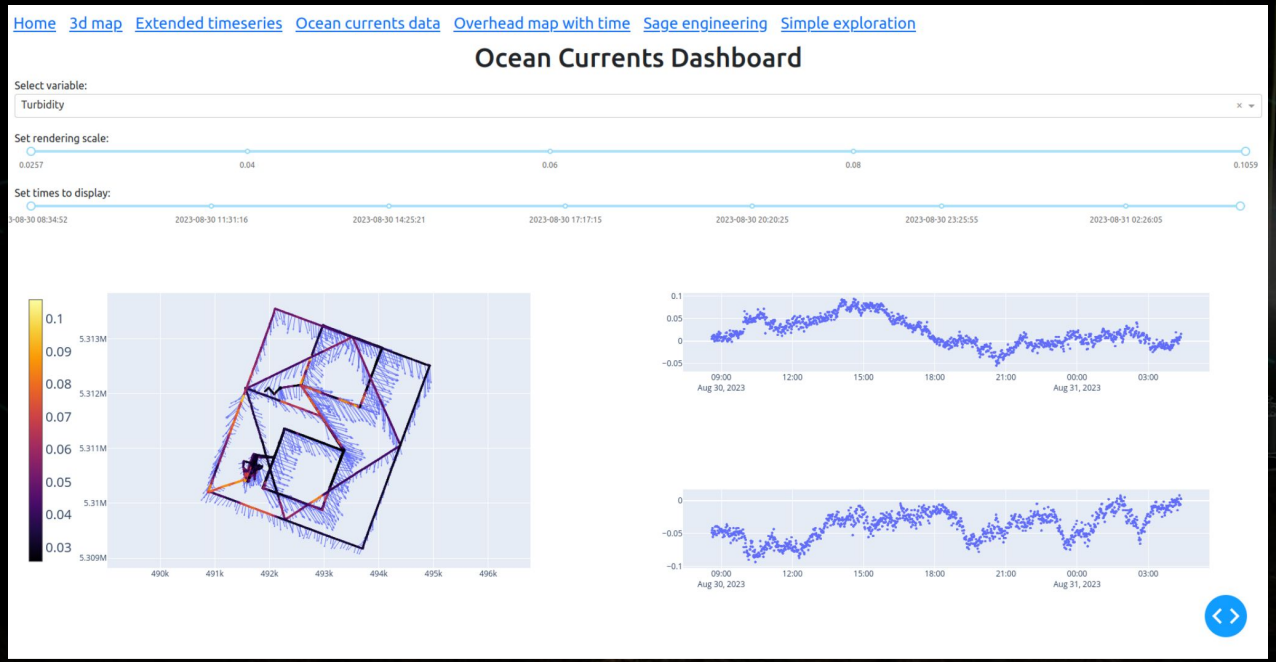
A visualization dashboard allowed the science team to engage with the messages transmitted by *Sentry* to build intuition for plume character.





Patterns, trends, and distributions can be examined in **real-time**.

A visualization dashboard allowed the science team to engage with the messages transmitted by *Sentry* to build intuition for plume character.



Transmitted data is **aligned with spatial location** by interpolating queue messages with USBL pings.

External information **from observatories** can be visualized alongside *in situ* data. This is enabled by **improved bandwidth streaming capabilities** for timely throughput.

We developed a watchstanding routine for engaging with the data dashboard and the *Sentry* operations team for making mission adjustments.

README for Operating Science Watch Stand

The dashboard in this repository is meant to assist with listening to and visualizing acoustic messages transmitted from AUV Sentry (i.e., the science queue) and from the USBL system. Functionality includes:

- listening to sentry-network UDP ports and logging data to file
- parsing UDP messages into sentry status, sentry science, sent files
- simple time-series streaming (live updates) of Sentry sensors
- basic analysis of time-series data (property vs. property plots identification)
- spatial plotting over bathymetry of Sentry sensors and select

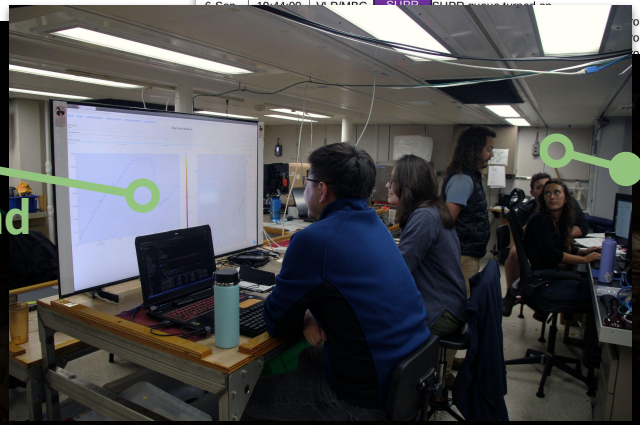
On either the watchstander computer or your own computer, the wor be:

1. Enter into the pipenv environment with pipenv shell from the
2. Start the Sentry listener
3. Start the USBL listener

Date	Time UTC	On Watch	OPS?	Notes
			[See Key]	
6-Sep	18:48:00	VLP	ENG	Last deck tests being run; T-10 minutes until splashdown
6-Sep	18:49:00	VLP	ENG	Powering on the SAGE instrument
6-Sep	18:49:00	VLP	SAGE	Powering on the SAGE instrument
6-Sep	18:51:00	VLP	ENG	Powering on the SUPR instrument
6-Sep	18:51:00	VLP	SUPR	Powering on the SUPR instrument; starts 36 minute internal pumping timer
6-Sep	19:04:00	VLP	ENG	Sentry splashdown; equipped with METS, SUPR, SAGE
6-Sep	19:12:00	VLP/MBG	SAGE	SAGE powered on
6-Sep	19:13:00	VLP/MBG	ENG	Science queue turned on
6-Sep	19:13:00	VLP/MBG	ENG	Scalar queue turned on

?OPS Key:	ENG	SUPR	SAGE	T°C	ORP	OBS
	METS	OXY	SAL	DEN	SPICE	ONC
UTC shortcut:	CMD+;					

op, turbidity bump, methane spike
op, turbidity bump, methane spike



Science Watchstand

Sentry Watchstand

Three shifts of 2 science observers were rotated in a **watchstanding schedule**.

Observer-annotated logs were utilized to **track major events**, and **build intuition** for sensor response, anomaly indicators, and vehicle capabilities.

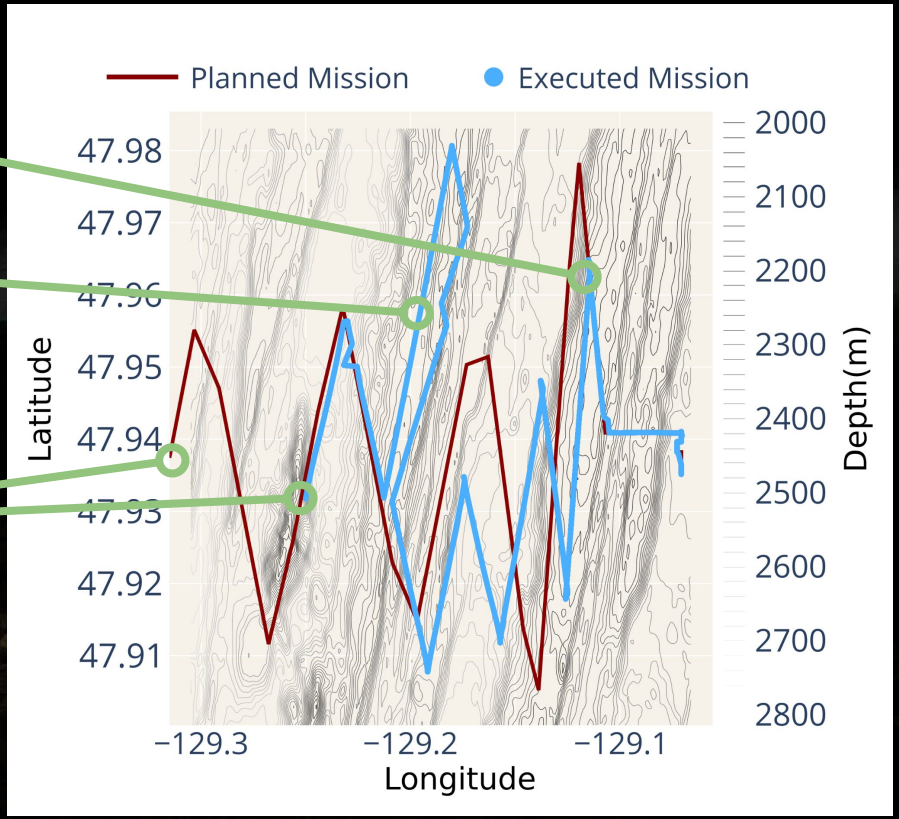
Watchstand was co-located with the *Sentry* operations team.

The dashboard enabled us to adapt Sentry trajectories, select SUPR samples *in situ*, and rapidly identify trace-metal rosette stations before AUV recovery.

First Deviation

Major Excursion for Plume Reconnaissance

Mission spatially "compressed" to cover strategic areas



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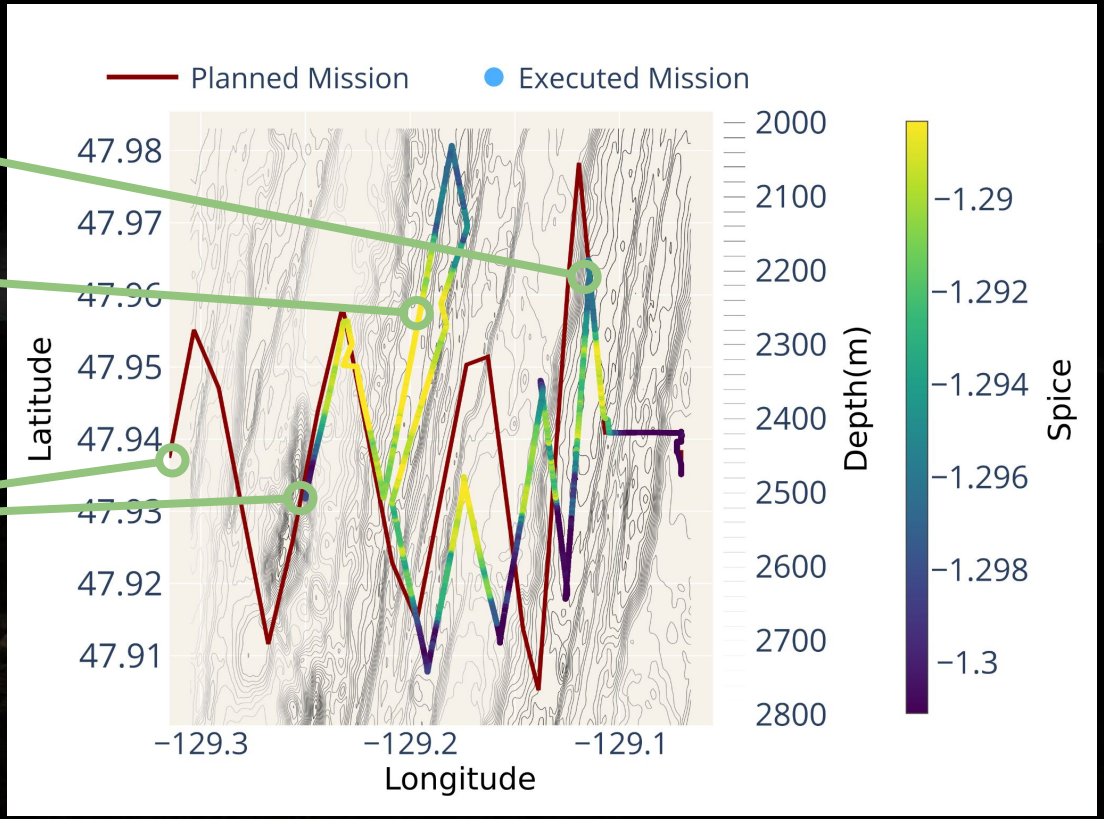

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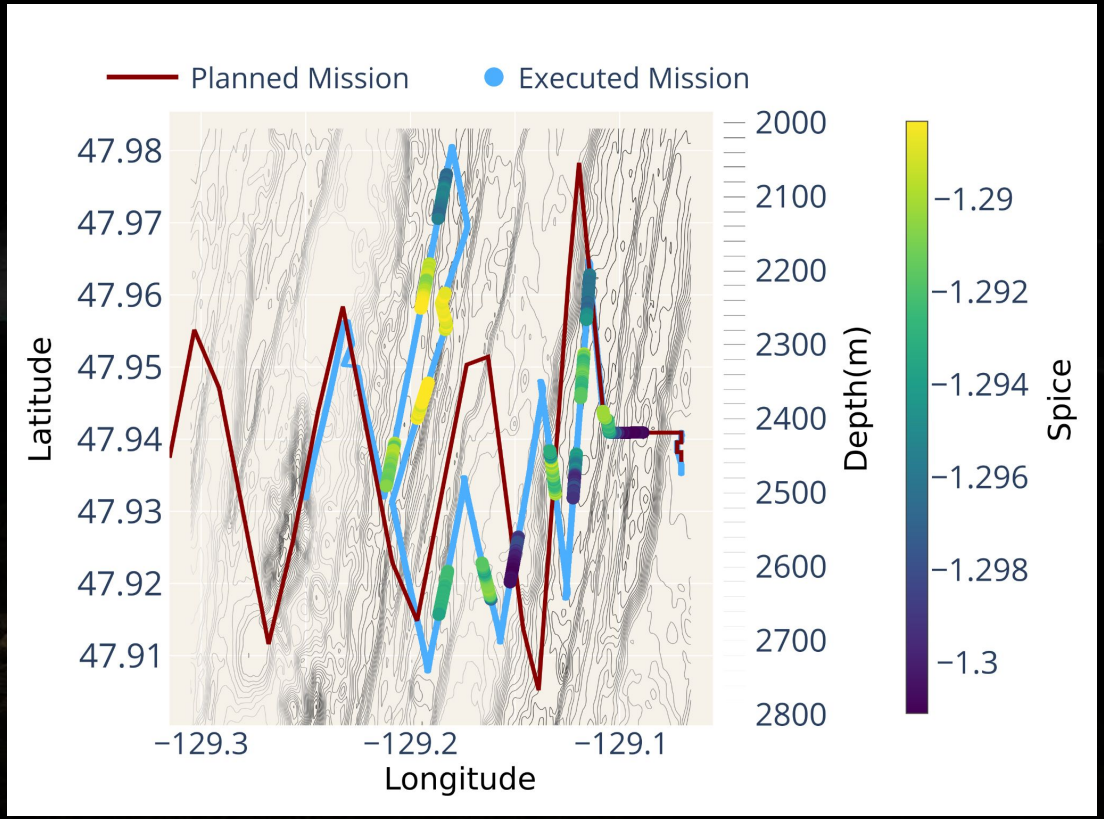
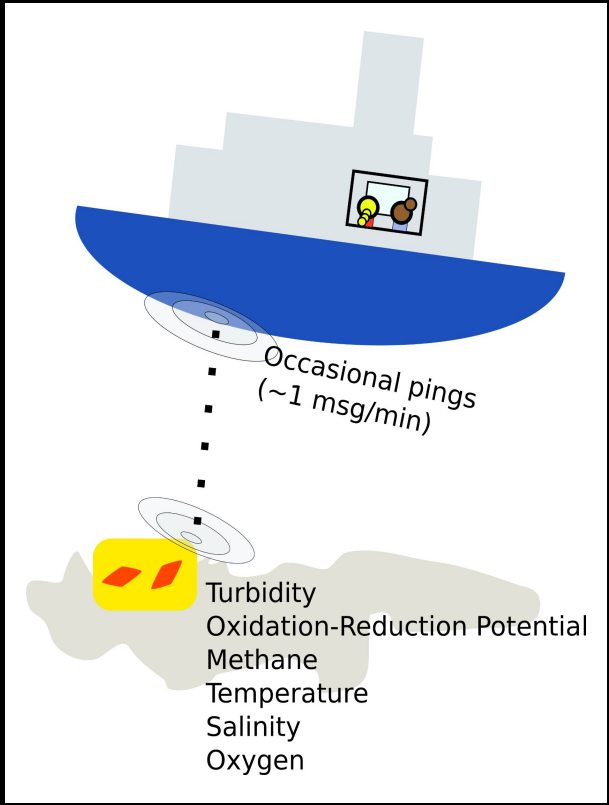
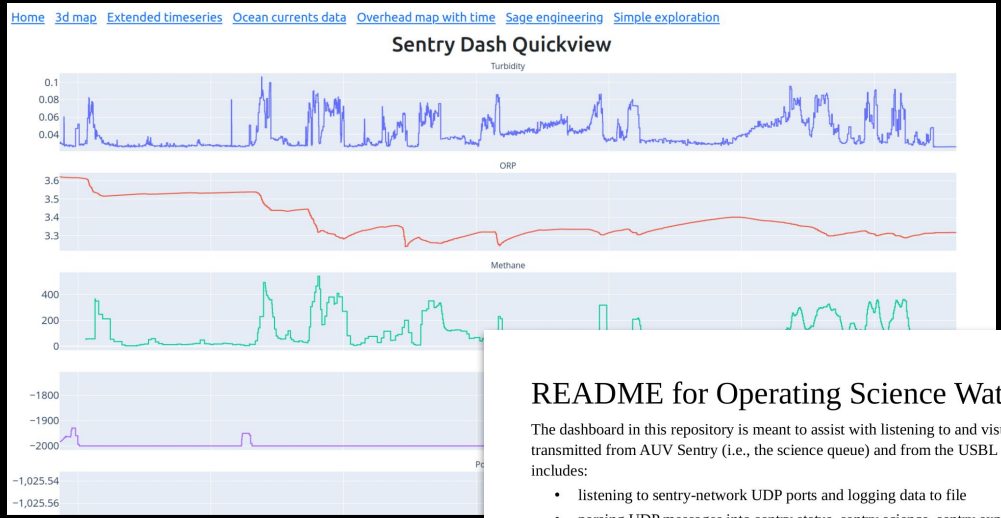


Visualization tools for AUV operations --- during or following dives --- can assist with scientific situational awareness for these assets.





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- parsing UDP messages into sentry status, sentry science, sentry experimental sensor, and usbl files
- simple time-series streaming (live updates) of Sentry sensors and select experimental sensors
- basic analysis of time-series data (property vs. property plots and distributions, outlier identification)
- spatial plotting over bathymetry of Sentry sensors and select experimental sensors

On either the watchstander computer or your own computer, the workflow to initialize from source will be:

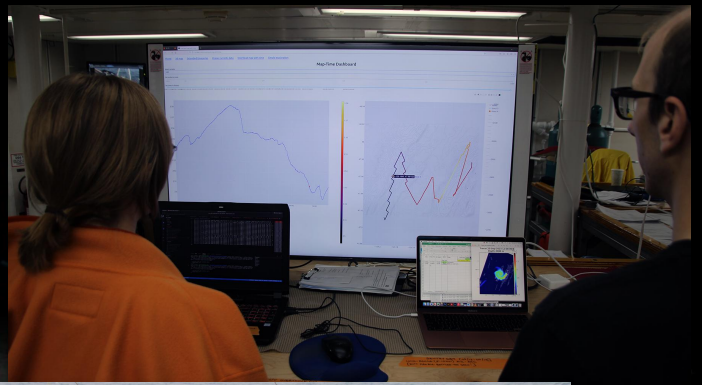
1. Enter into the pipenv environment with pipenv shell from the home directory of the repository
2. Start the Sentry listener
3. Start the USBL listener

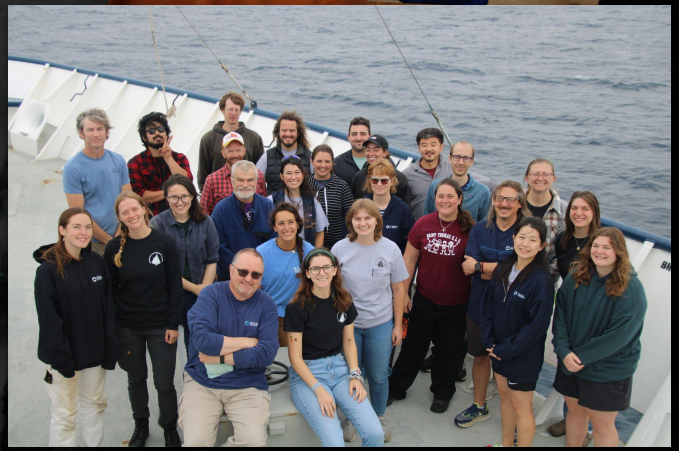
Acknowledgements

Thanks to the captain, crew, and support staff of the R/V *Atlantis* during AT50-15 to the Juan de Fuca Ridge.

Special thanks to the AUV *Sentry* field operations team for AT50-15, Sean Kelley, and the entire *Sentry* staff for supporting multiple iterations of this prototype (AT50-07, RR2107) and enabling these trials.

This project was supported by a Woods Hole Oceanographic Postdoctoral Fellowship and a Future Faculty Fellowship at Northeastern University.





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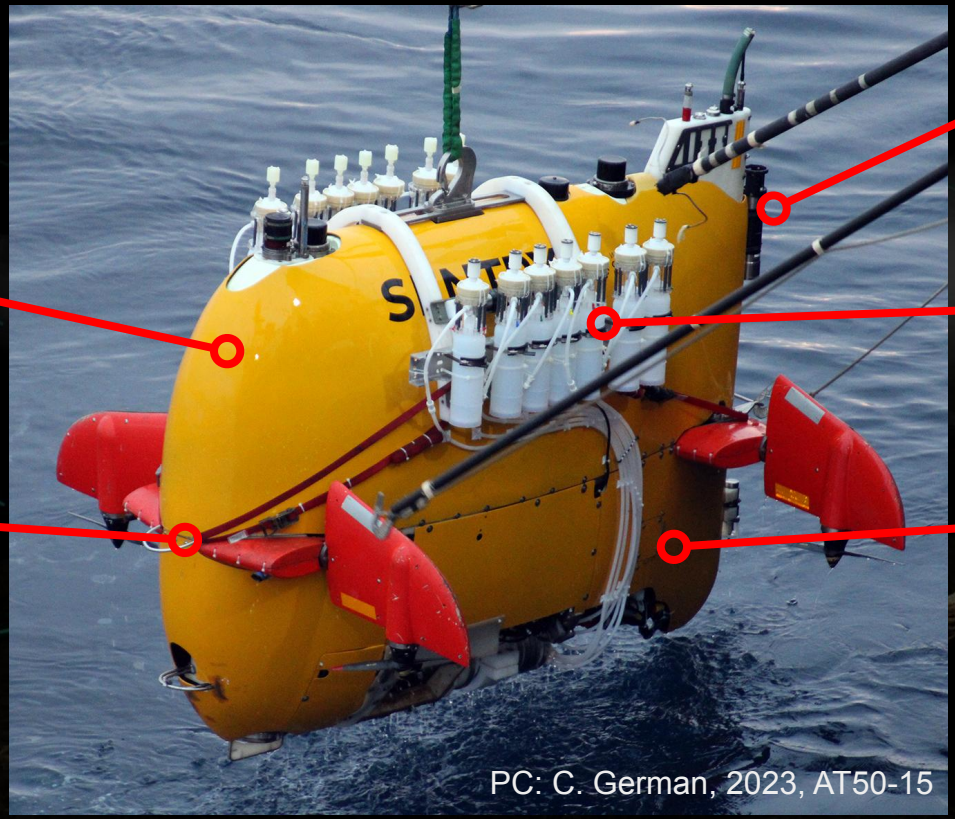
AUV *Sentry* was equipped with an extensive and customizable set of accessory sensors, in addition to the standard science payload.



Vehicle Navigation
Depth, USBL system for lat/lon ranging

Optical Backscatter and Optode
Turbidity, oxygen

MAPR
Temperature, oxidation reduction potential

SUPR Sampler
particulates, water
Presentation OT11A-06

ORP, CTD, Methane
Temperature, salinity, density, oxidation reduction potential, methane

Although sparse, acoustically transmitted messages are sufficient for resolving hydrothermal anomalies while *Sentry* is underway.