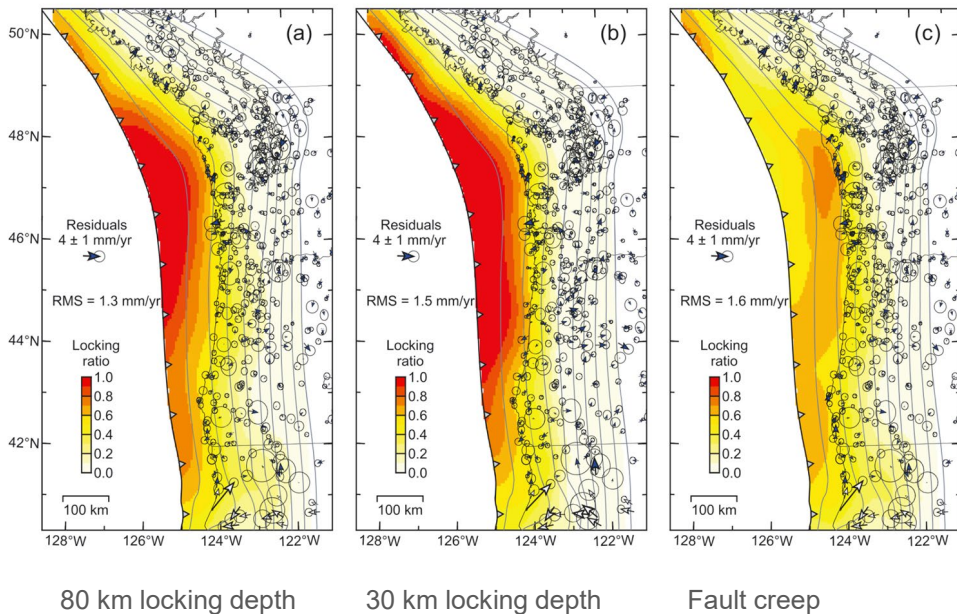


Plate motion velocities offshore of northern Cascadia from five years of seafloor geodesy with the NCSZO

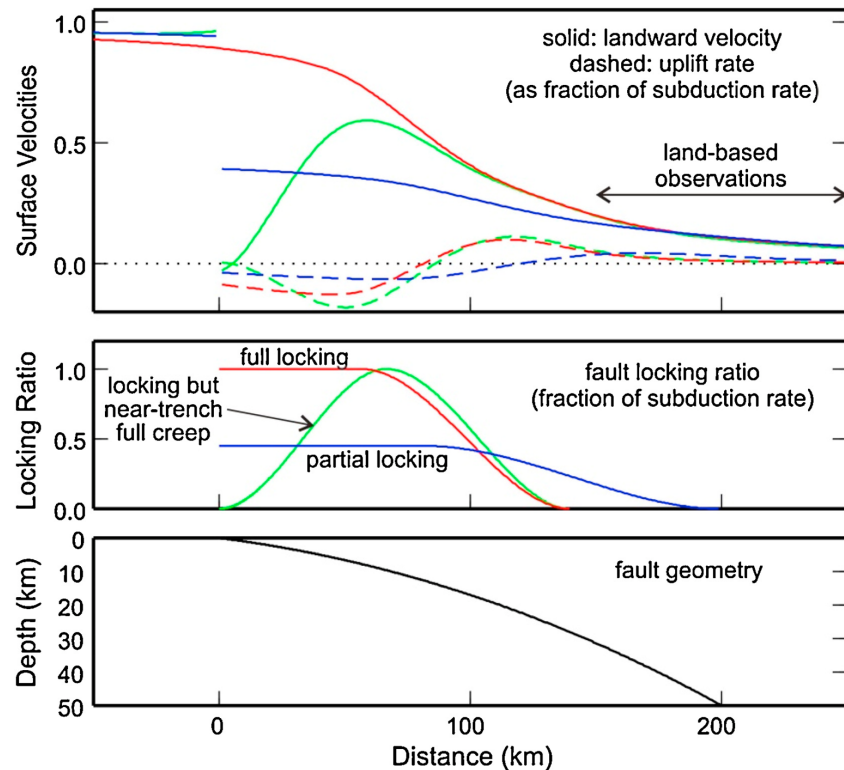
Jesse Hutchinson | PhD | Oct. 27, 2025

Subduction zone locking scenarios



[Li et al., 2018]

GPS measurements on land do not provide sufficient constraints for offshore locking pattern!

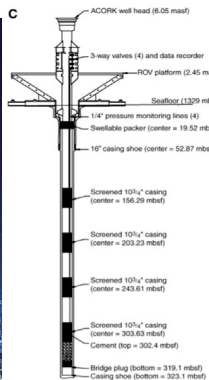
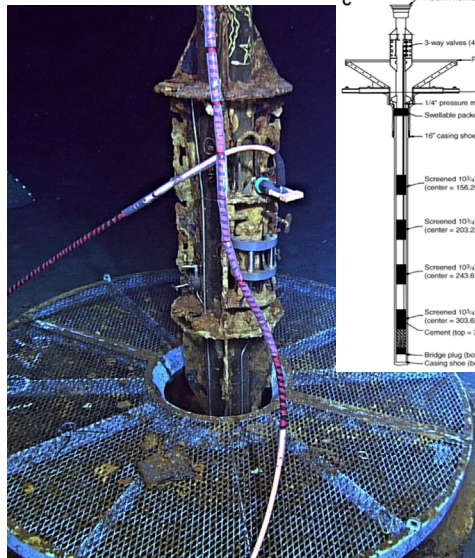


[Wang and Tréhu, 2016]

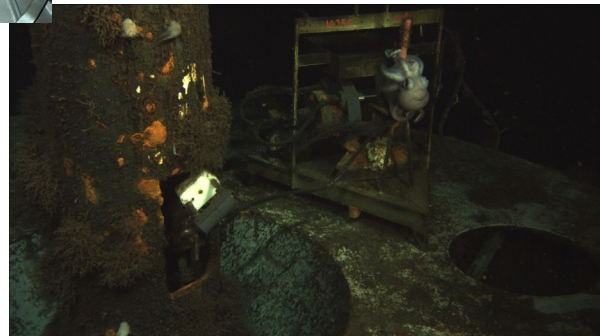
How do we measure deformation?



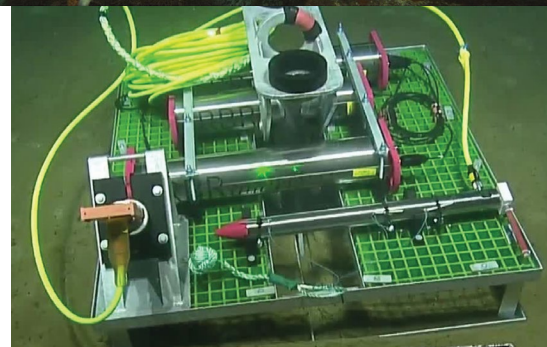
Seismometers



Tiltmeters

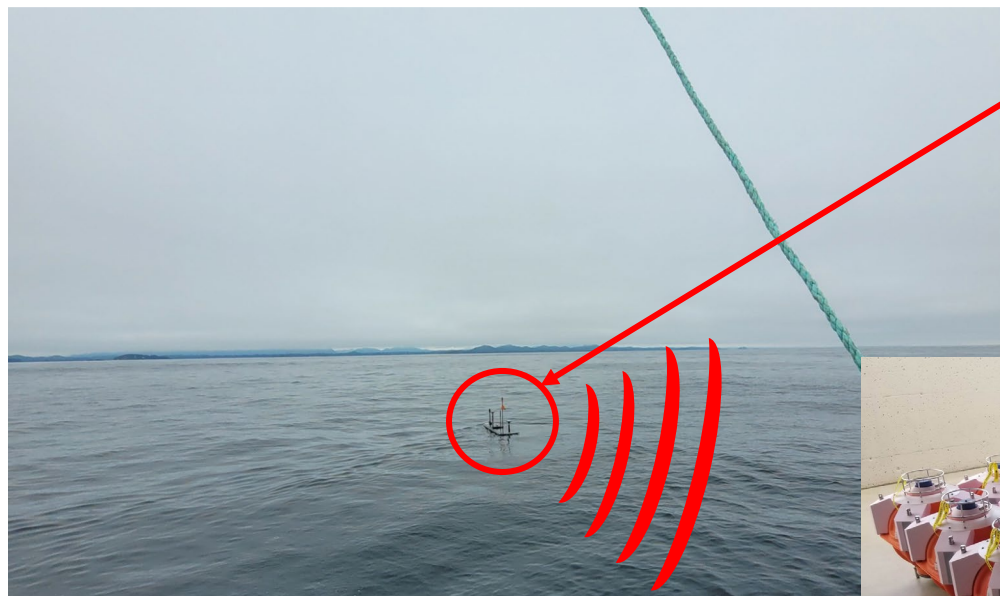


CORKs



Bottom pressure recorders

And...



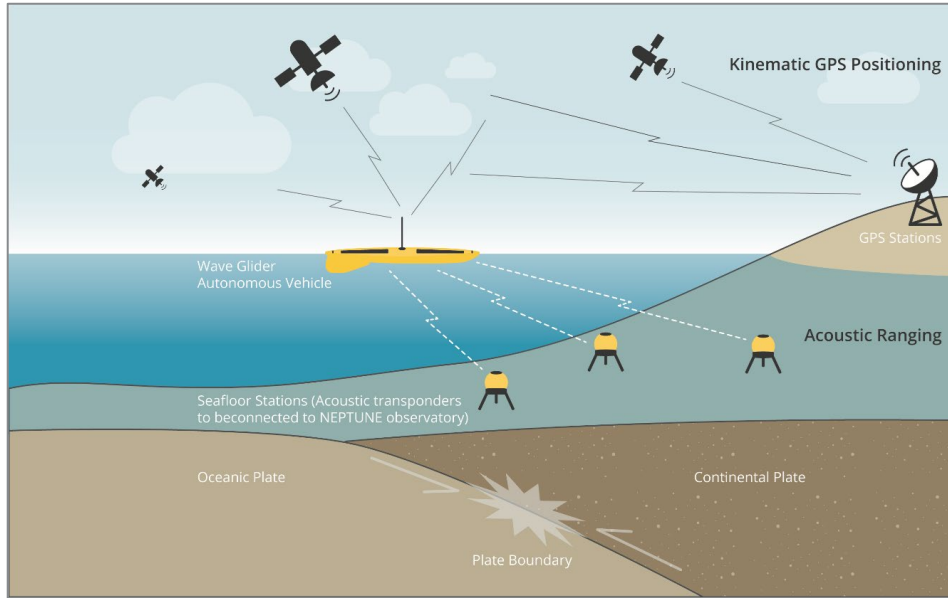
The
WaveGlider

GNSS-Acoustic



FETCH seafloor
transponders

Locating the transponder arrays



- The Wave Glider is highly modular. Currently, we use the equipped antennas track the GNSS-derived position, and use a transducer payload to send and receive signals from the seafloor transponders.
- For accurate location of the seafloor transponders, 10s of thousands of acoustic interrogations are necessary. These allow us to determine the two-way travel time and effectively triangulate the positions of the transponders within several cm accuracy.

NCSZO SEAFLOOR GEODESY SITES

BRITISH COLUMBIA

VANCOUVER ISLAND

Port Alberni

Vancouver

VENUS
Observatory

Clayoquot Slope
1250 m

Folger
Passage
20 m - 100 m

Barkley Canyon
400 m - 1000 m

NEPTUNE
Observatory

Middle Valley
2400 m

Endeavour
2300 m

Cascadia Basin
2660 m

Juan de Fuca
Plate

North American
Plate

WASHINGTON - USA

Pacific
Plate

PACIFIC
OCEAN

- Shore Station
- Node
- Geodesy Experiment
- Wave Glider
- Fibre-optic Cable
- Fault Line
- Spreading Centre
- Subduction Zone

100 km



AN INITIATIVE OF University of Victoria

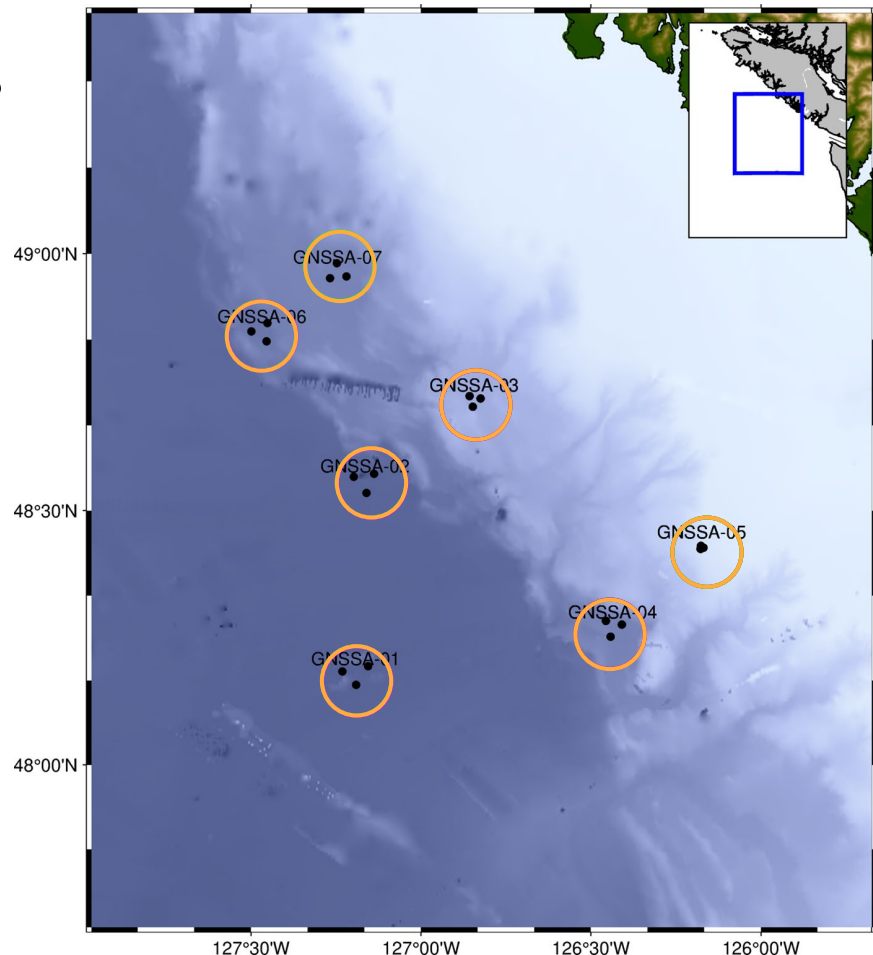
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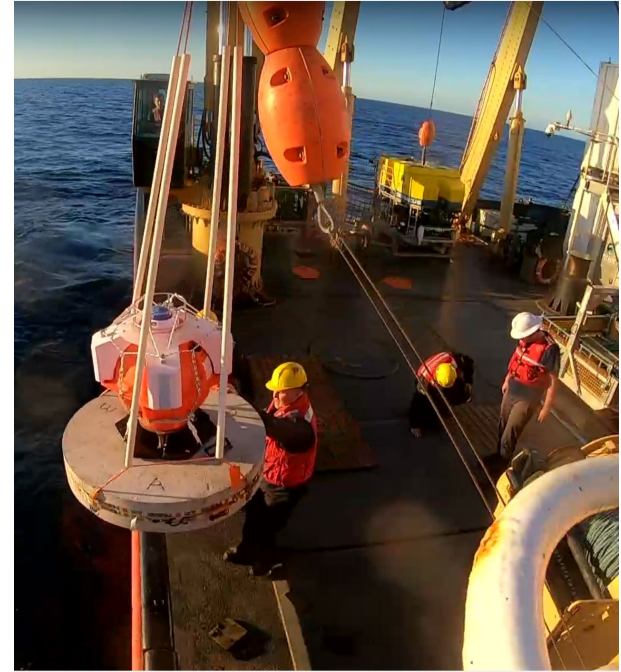
NCSZO Wave Glider Expeditions

- Four Wave Glider expeditions have been completed.
 - 1) Aug. - Sep. 2021. Three sites visited.
 - 2) July - Aug. 2022. Seven sites visited.
 - 3) Sep. - Oct. 2024. Five sites visited.
 - 4) Jun. - Aug. 2025. Seven sites visited*
- Technical issues with power supply to the instrument payload have led to intermittent failures, but perseverance led to the success of these missions.
- There was not a 2023 mission not due to new Transport Canada regulations and a mechanical issue with the thrudder.

*Sites 03 and 04 were visited twice, 05 is missing one transponder



Photos from the deployment of the fourth GNSSA-01 FETCH transponder during 2023



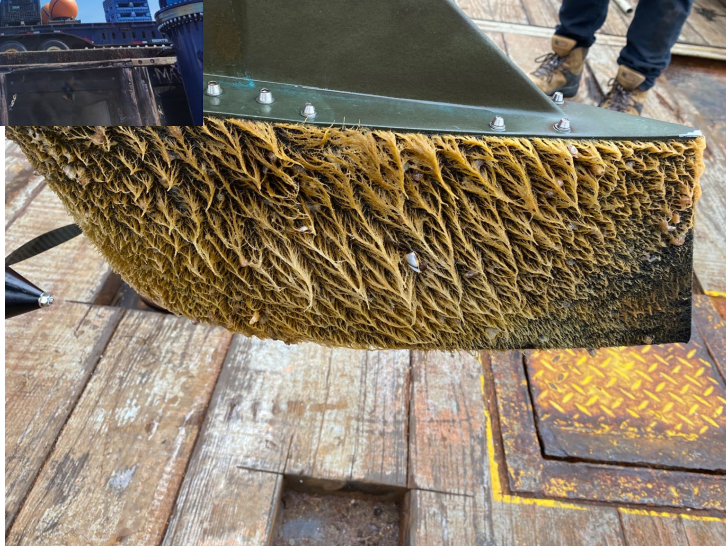
2025 Retrieval



Goose-necked
barnacles



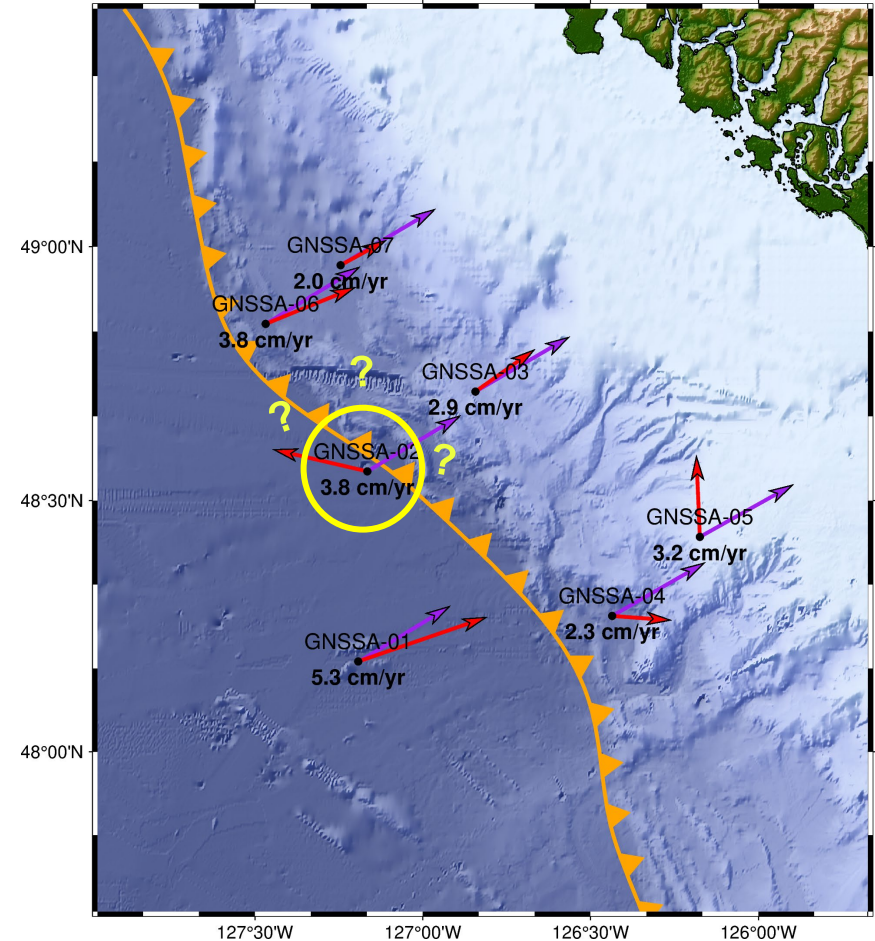
Crabs

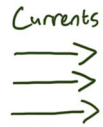
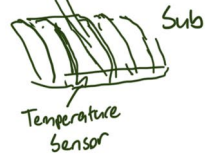
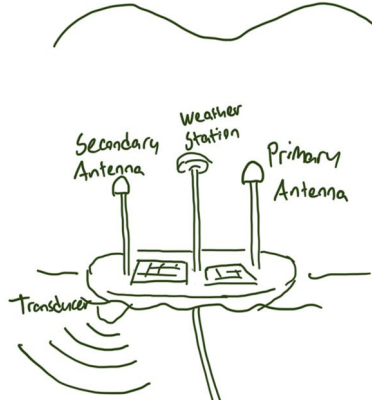


And algae
(?)... oh my!

Determining plate velocities

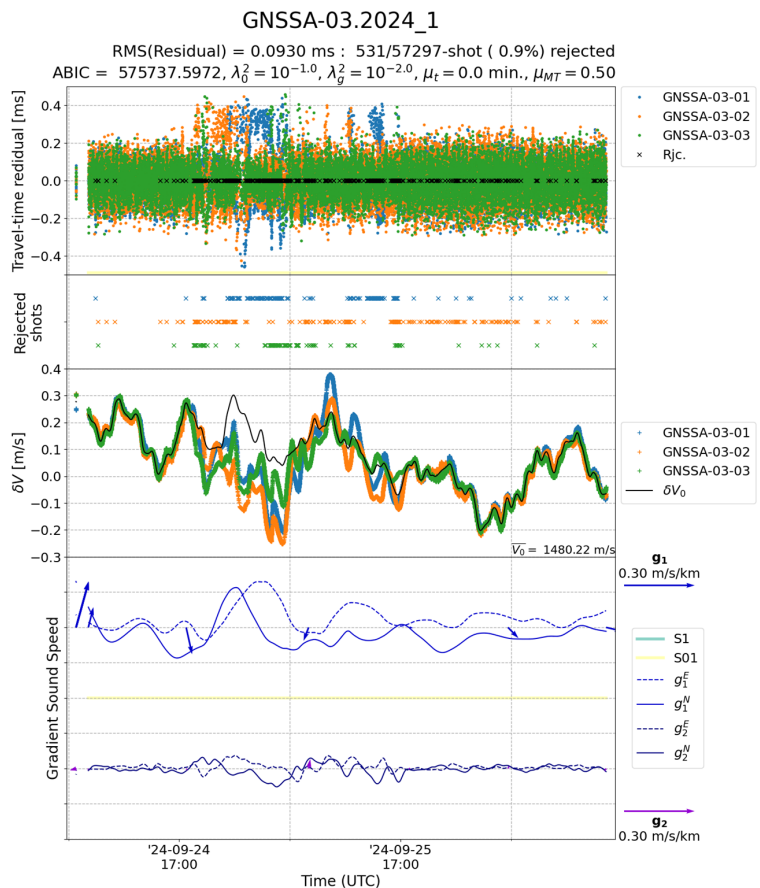
- From two or more surveys, we can begin estimating absolute (global reference frame) plate velocities with GARPOS.
- These velocities can be compared to North America to compute **relative plate velocities**.
- Year-to-year vectors are velocities are converging toward good solutions.
- **Expected velocities** are ~ 4 cm/yr, but we don't know exactly what to expect. These are first-time observations!
- GNSSA-01 results have improved significantly with the addition of a fourth transponder.
- The velocity vector is surprising for GNSSA-02 and bears further investigation.



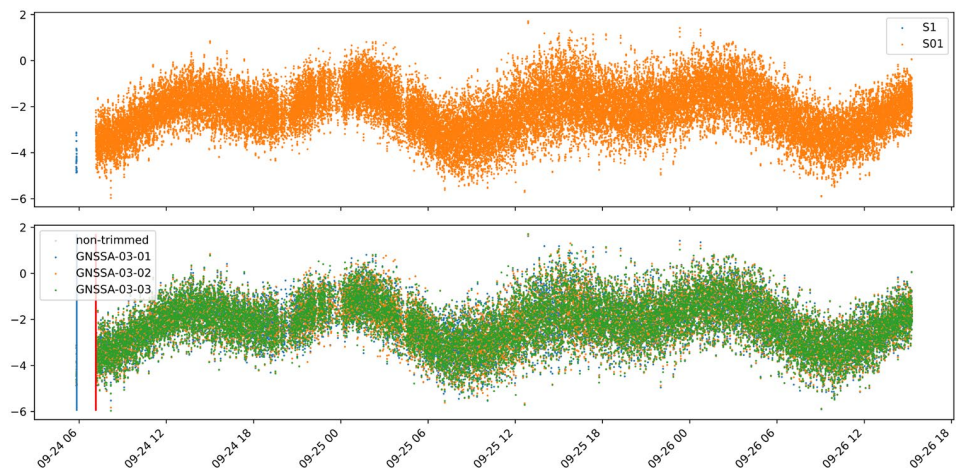


Thank you!

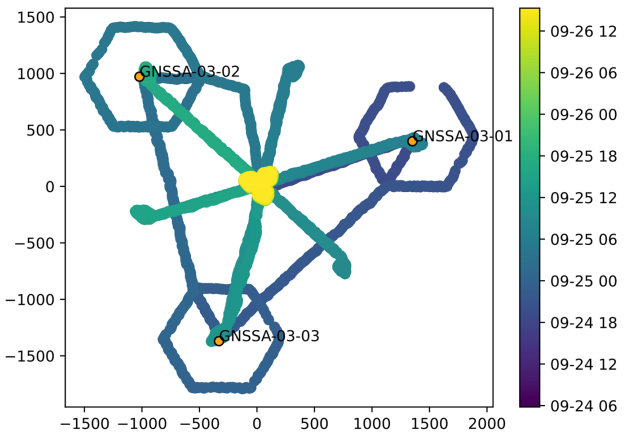
2024 Campaign Results



Good results at GNSSA-03. Could anomalous travel-times be due to internal waves?



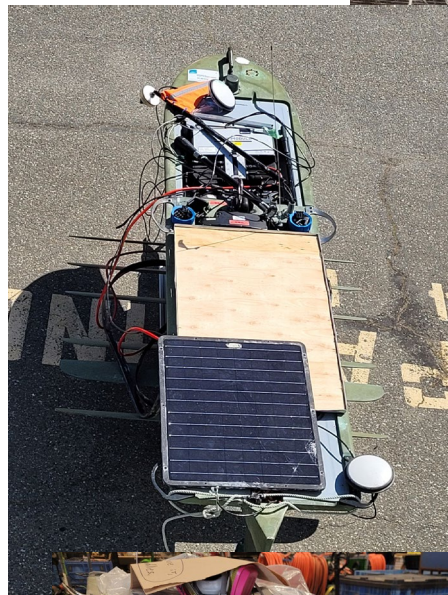
Transducer height vs datetime at GNSSA-03.



Coordinates for the waveglider at GNSSA-03; shows our streamlined sailing pattern.

Technical Difficulties and Challenges

- During the retrieval of the WaveGlider during Oct. 2024, the WaveGlider was damaged, losing both GNSS antennas and masts, the mast with the light and weather station, and a solar panel.
- Our engineers replaced the masts, antennas, solar panel and light within the year, and we were able to successfully deploy in June 2025.
- The payload failure issue plaguing us since 2022 never surfaced during our 2025 campaign.



Technical Difficulties and Challenges

- The GNSSA-05-03 FETCH went offline shortly after the installation of a VPS onsite during May 2025.
 - An autonomous FETCH was deployed in place of the cabled sensor, however, this was not done before the WaveGlider had to be retrieved.
 - As a benefit, the VPS can “talk” to all three seafloor transponders.

