

A photograph of a sunset over the ocean, taken from the deck of a ship. The sun is low on the horizon, casting a golden glow across the sky and reflecting on the water. The ship's railing is visible on the right side of the frame.

# The Multibeam Advisory Committee and Ocean Mapping Community Wiki

*FEMME 2023 - Edinburgh  
28 September 2023*

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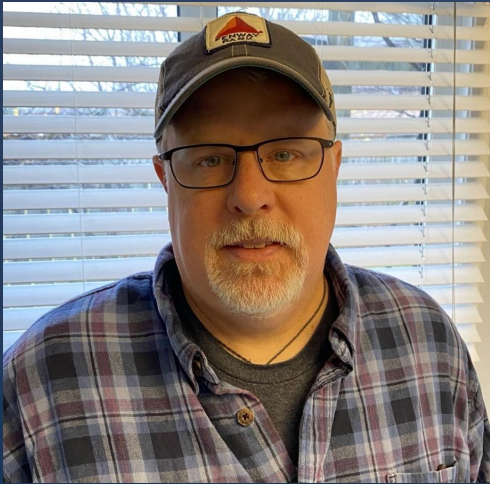
*MAC supported under NSF grant 1933720*





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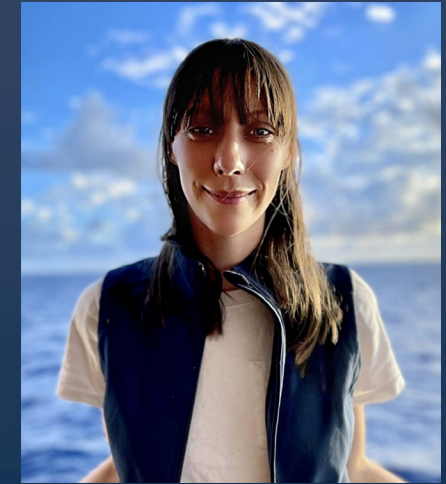
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# The Multibeam Advisory Committee (MAC)

- Established 2011 with funding from NSF to ensure the consistent collection of high-quality multibeam data across the U.S. Academic Research Fleet (USARF)
  - *Standardize system performance testing*
  - *Publish performance and share best practices*
  - *On-board & remote support for ships*
- Technical Reports & Resources
  - Sea Acceptance / Quality Assurance / RX Noise
  - Host Non-USARF reports
  - Assessment tools, survey guidance

Website: [mac.unols.org](https://mac.unols.org)

Help desk: [mac-help@unols.org](mailto:mac-help@unols.org)

Wiki: [github.com/oceanmapping/community/wiki](https://github.com/oceanmapping/community/wiki)



Ship Info	Sonar System Info
 Atlantis (WHOI)	Kongsberg EM124 (12 kHz, 150°, 1×1° beams)
 Blue Heron (UMN)	Reson SeaBat 8101 (240 kHz, 150°)
 Healy (USCG)	Kongsberg EM122 (12 kHz, 150°)
 Hugh R. Sharp (UDEL)	Reson SeaBat 7125 (200 kHz, 400kHz, 150°)
 Kilo Moana (UH)	Kongsberg EM122 (12 kHz, 150°) Kongsberg EM710

**Tech Reports**

Ship Sonar System ANT QAT SAT

**2023**

- 2023 R/V Kilo Moana EM122/EM710 QAT Report  
2023, EM122, EM710, Kilo Moana, MAC, QAT
- 2023 R/V Sally Ride EM124/EM712 QAT  
2023, EM124, EM712, MAC, QAT, Sally Ride
- 2023 R/V Langseth EM122 QAT Report  
2023, EM122, MAC, Marcus G. Langseth, QAT
- 2023 R/V Sikuliaq EM302/EM710 QAT Report  
2023, EM302, EM710, MAC, QAT, Sikuliaq

**2022**

- 2022 Healy EM122 QAT Report  
2022, EM122, Healy, MAC, QAT
- 2022 Kilo Moana EM122/EM710 QAT Report  
2022, EM122, EM710, Kilo Moana, MAC, QAT
- 2022 Sikuliaq EM302 / EM710 Calibration Report  
2022, EM302, EM710, MAC, QAT, Sikuliaq
- 2022 Nautilus QAT Report  
2022, EM302, Nautilus, QAT

**2021**

- 2021 Sikuliaq QAT EM302 and EM710  
2021, EM302, EM710, MAC, QAT, Sikuliaq
- 2021 Sally Ride EM124-SAT EM712-QAT  
2021, EM124, EM712, QAT, Sally Ride, SAT
- 2021 R/V Thomas G. Thompson EM302 QAT



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# Mapping Systems in the U.S. Academic Research Fleet

- **12 Vessels with MBES**
  - 11 Research Vessels
  - 1 USCG Icebreaker
  - 10 Kongsberg EM-equipped
- **16 Deep water EM systems**
  - EM710 / EM712 (40-100 kHz)
  - EM302 (30 kHz)
  - EM122 / EM124 (12 kHz)
- **2 Shallow water systems**
  - Reson
  - EM2040 (soon)
- **3 RCRVs (6 MBES) in 2023+**
  - EM304s & EM2040s





# Kongsberg Systems in the U.S. Academic Research Fleet

Ship	System(s)	Arrays	Life Cycle	MAC Visits (Recent)	2024 Plans
<i>Atlantis</i>	<u>EM124 (g)</u>	2021	Early	SAT* (2021), QAT* (2022)	QAT
<i>Healy</i>	<i>EM122</i>	2010 / 2023 RX	Late	ANT, QAT/SAT* (2022-23)	QAT
<i>Kilo Moana</i>	EM122 / EM710	2012	Late	ANT, QAT* (2023)	QAT
<i>Marcus G. Langseth</i>	EM122 (g)	2007 TX / 2010 RX	Late	ANT, QAT (2023)	QAT
<i>Nathaniel B. Palmer</i>	EM122	2015	Mid	SAT, ANT, QAT (2015)	TBD
<i>Neil Armstrong</i>	<i>EM122 / EM710</i>	2016	Mid	SAT, QAT* (2020)	EM124 / 712
<i>Roger Revelle</i>	EM124 / EM712 (g)	2020	Early	SAT*, QAT* (2023)	QAT
<i>Sikuliaq</i>	<i>EM302 / EM710</i>	2014	Mid	SAT, QAT* (2023)	EM304 MKII
<i>Sally Ride</i>	<u>EM124</u> / EM712	2016	Mid	SAT (2021), QAT* (2023)	QAT
<i>Thomas G. Thompson</i>	<i>EM302</i>	2018	Mid	SAT, QAT* (2023)	TBD

(g) indicates gondola installation

\*Indicates remote support

**Underline = recent install (2021)**

*Italic = pending replacement (2023+)*

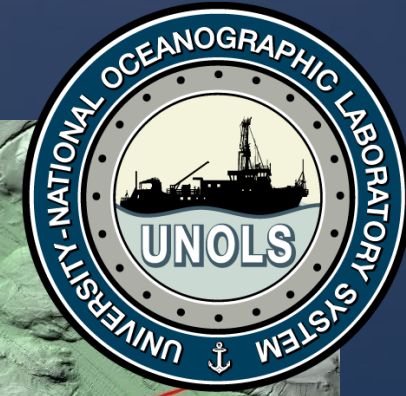
Green = visited in last two years



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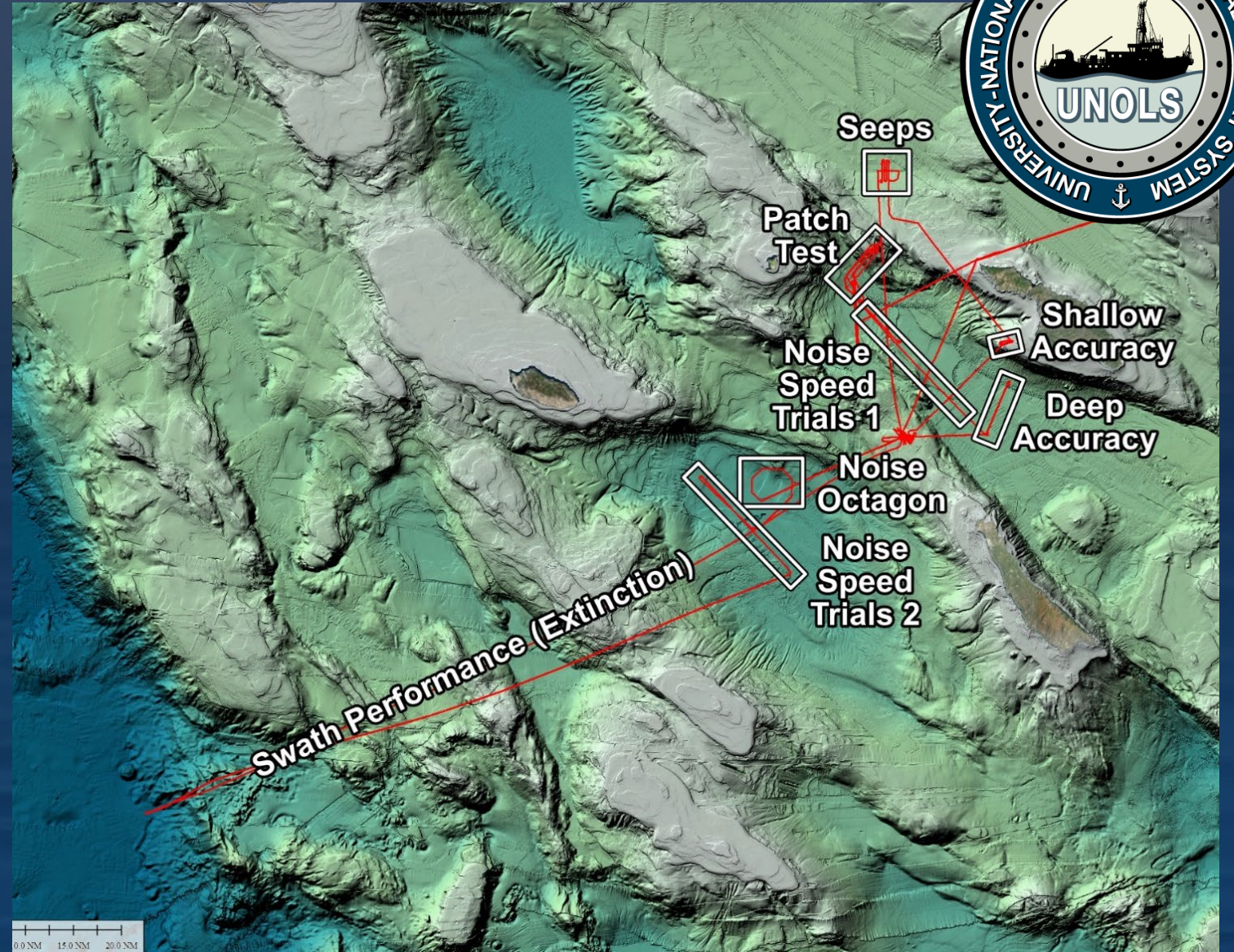


# System Performance Testing



## SAT and QAT procedures

1. Hardware health (impedance)
2. Geometry / config. review
3. Calibration ('patch test')
4. RX noise vs. speed/seas
5. Swath coverage (extinction)
6. Swath accuracy
7. Water column evaluation
8. Backscatter normalization
9. Public reporting (MAC website)





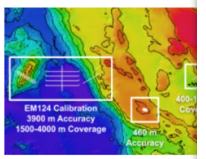
# SAT / QAT Checklist

Standardized (but flexible!) procedures in order of priority  
 Collaborative planning → data collection → follow-up

Multibeam Advisory Committee  
 Mapping System SAT/QAT Checklist

Roger Reville EM124 / EM712  
 San Diego, October 2020

General  
[Shared documents for RR 2020 SAT plan](#)  
[Reville IMTEC survey docs](#)  
[MAC geometry review](#)  
[MAC assessment tools in development](#)



Notes for next planning call

- Vessel offset review and SIS/Sea
- Updated reference surface survey
  - Added reference lines for
  - Added 460 m site
- Coverage line and transits may be different line
- Expectation for PHINS calibration
- Marine forecast and early predict
- MAC: provide updated noise test
- MAC: provide crossline settings
- MAC: provide data trimming procedure
  - Tested with the latest SIS

SAT/QAT Procedures

- System geometry review
  - Vessel survey review
    - Multibeam
      - TX
      - MU
      - TX
      - Pe
      - Pe
    - Positional
      - GN
      - Pa
      - Mo
      - Mo
      - Pe
- Develop test plan
  - MAC and vessel performance desired ports of call
  - MAC develops more
  - MAC and vessel performance SAT/QAT operation

RR: Provide vessel survey and position/altitude system

RR: Use previously shared Overview:

  - EM712
    - Calibration
    - Shallow Accuracy
    - Deep Accuracy
    - Swath coverage
  - EM124
    - Calibration
    - Shallow Accuracy
    - Deep Accuracy
    - Swath coverage

MAC: Review survey/con

Post-SAT / Pre-SVC Review (Discussion)

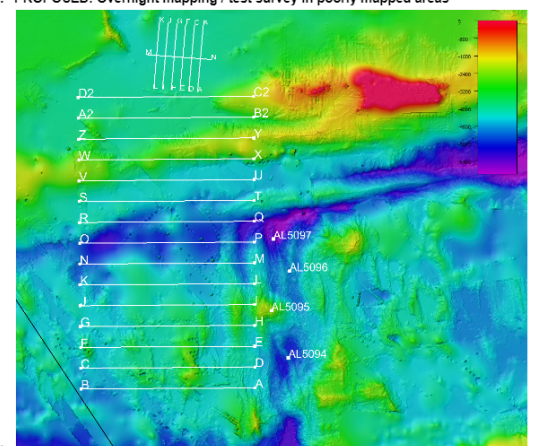
These topics help to ensure an up-to-date understanding of the mapping system and adequate/complete plan for testing, taking into consideration any changes since the SAT or last QAT.

- What has changed since the last MAC visit or review?
  - Any sensors replaced, removed, and/or reinstalled?
  - Any damage or repairs?
  - Any upgrades to hardware or software?
- Is there any new documentation?
  - Updated survey of vessel
  - Updated guidance or service
  - Any performance notes from
- Is there any recent data that can be used?
  - Ideally, these data would be used for profiling, data covering a wide depth as an early indicator
  - Any recent 'problem' data as appropriate

6. DONE! RX noise testing (data collected 20 July 2022)  
 For Kongsberg systems, RX Noise and RX Spectrum Build-In Self-Test (BIST) testing assesses the vessel, machinery, and flow noise characteristics as perceived by each multibeam echosounder; data acquisition generally follows the [MAC approach for routine noise testing](#).

- Tested in 2021 (worthwhile to redo and compare to 2021 results)
  - Noise vs. speed testing is performed over a wide range of speeds in calm seas; with typical engine configurations online, the vessel starts drifting and increases speed in 1-2 kt increments up to maximum speed (~1-2 hours, depending on number of speed steps and time to settle at each speed)
  - This test should be repeated underway to ensure there have been no major changes to the vessel's noise environment since the SAT
  - See 'Noise vs. Speed' section under [RX Noise Logging](#)
- Untested:
  - Noise vs. heading testing is performed at eight headings (separated by 45°) relative to the prevailing swell; these tests are conducted at typical speed and engine configuration for normal mapping operations (~2 hours, depending on sea state and time to settle at each heading)
  - This test requires deep water (>1000 m) and a slightly elevated sea state (3-5 ft or greater) to generate swell impact noise and bubble sweep, while remaining within the range of sea states where mapping ops would be expected/accepted
  - See 'Noise vs. Azimuth' section under [RX Noise Logging](#)

7. PROPOSED: Overnight mapping / test survey in poorly mapped areas



- There are large unmapped tracts nearby that would provide a useful demonstration survey and contribute to the global grids (blurry areas with wild single beam artifacts)
- This can arguably be considered a both test survey and/or 'routine mapping' - so please check that it would not run afoul of your permits in Cayman waters
  - Waypoint (B) remains just inside the Cayman EEZ; please double check on board
- The survey plan is meant for simplicity to pick up on any lines that are close to your dive sites
- Lines are 80 km long, or just over 5 hrs at 8 kts; it might be possible to run one pair of adjacent lines west and then east per night (speeding up to 10 kts if necessary)
- Line spacing is conservative (10000 m) for lots of overlap even in the shallowest parts; this also helps with refraction correction later down the pipeline (no processing expected on board)
- At least one XBT (or XCTD, XSV, or CTD - any real sound speed profile) should be collected throughout the survey each night, preferably near the middle of the survey area

Recommended/Prioritized Post-SAT / Pre-SVC Review

- EM124 updates
  - Kongsberg has released several issues; **the EM124 should**
    - Download links and <https://github.com/Kongsberg/EM124>
    - Known issues with recent software
      - <https://github.com/Kongsberg/EM124>
      - Related: Update to Sound
        - <https://www.hydroflow.com>
- Dockside testing and review
  - Prior to departure, the MAC should
    - Seapath and EM124
    - line plan review with
    - pre-cruise system test
- Antenna calibration
  - Seapath antenna calibration
    - Antenna calibration at least two hours prior to departure
    - antenna baseline, and average baseline re

[GNSS antenna baseline calibration](#)
- DONE! Swath coverage testing
  - Seapath coverage data are collected. Additional time should be planned perpendicular to contours for establishing potential complications (e.g., noise) follow the [MAC instructions for swath](#)

The 2021 SAT covered a limited depth of the utility of this dataset for coverage of the guidelines in the SAT report (runtime parameters) is available

Notes from 2020/10/08 planning call

All: update these notes with any other thoughts/concerns/clarifications

- Initial RX Noise BIST testing should be prioritized as soon as ship reaches 500+ m, ideally 1000+ m
  - Machinery lineup is all new; initial testing is to confirm no limitations on data quality for calibration and accuracy testing; provide time for troubleshooting ahead of SAT items
  - More detailed speed and heading noise tests can be conducted as sea state / other operations allow (ideally, calm for noise vs speed, 3-5+ ft swell for heading test)
- Order of EM124 and EM712 calibrations is flexible, depending on weather windows, etc.
- Follow-up needed:
  - Is it correct to assume Seapath is the primary position, attitude, and attitude velocity feed to EM124/EM712, with PHINS strictly as a backup? If PHINS is working (received by SIS without errors) and logging in the kml files, then the calibration data will provide angular offsets for both Seapath and PHINS motion sensors in SIS. However, the cal and accuracy data will not be 100% representative for the PHINS performance because attitude velocity is still from the Seapath. If the PHINS is used in the future as the sole/primary feed, a calibration should be run





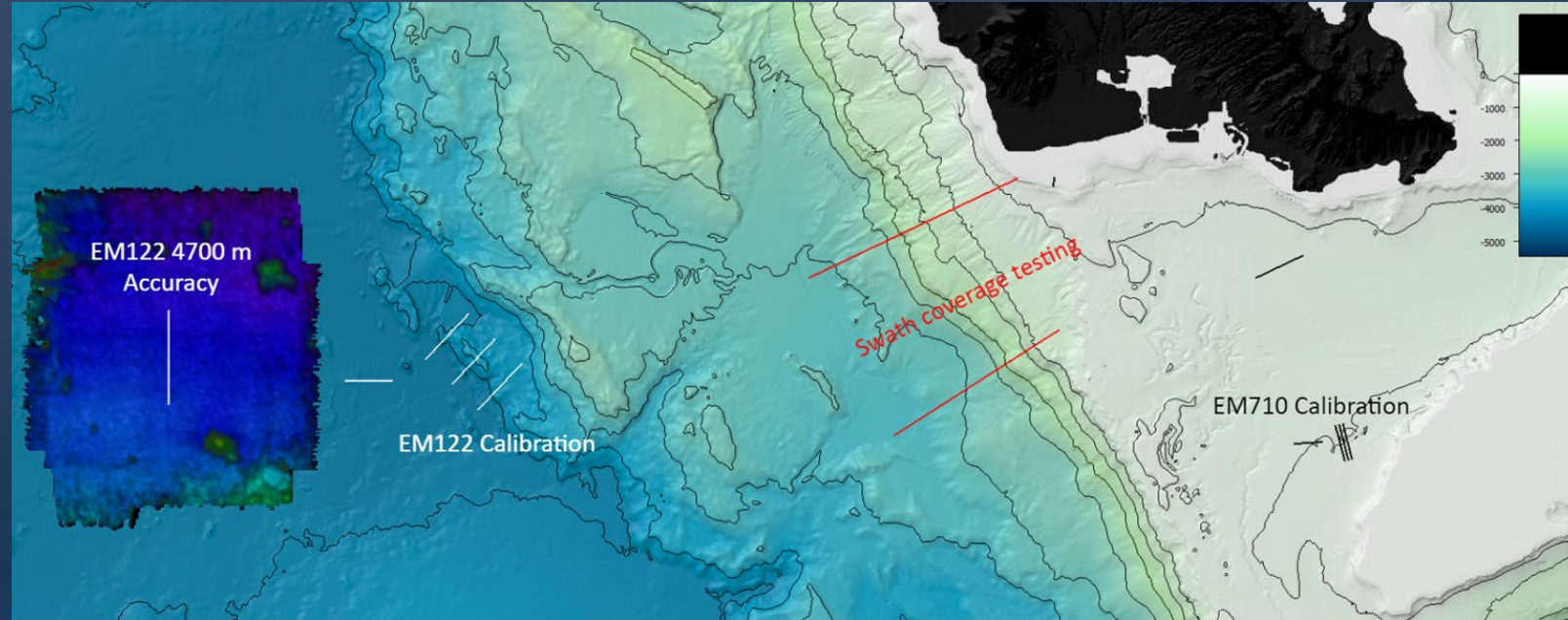
# Recent MAC and Related Activities

## MAC field support in last year

- 8 of 10 EM-equipped ships

## MAC-related projects

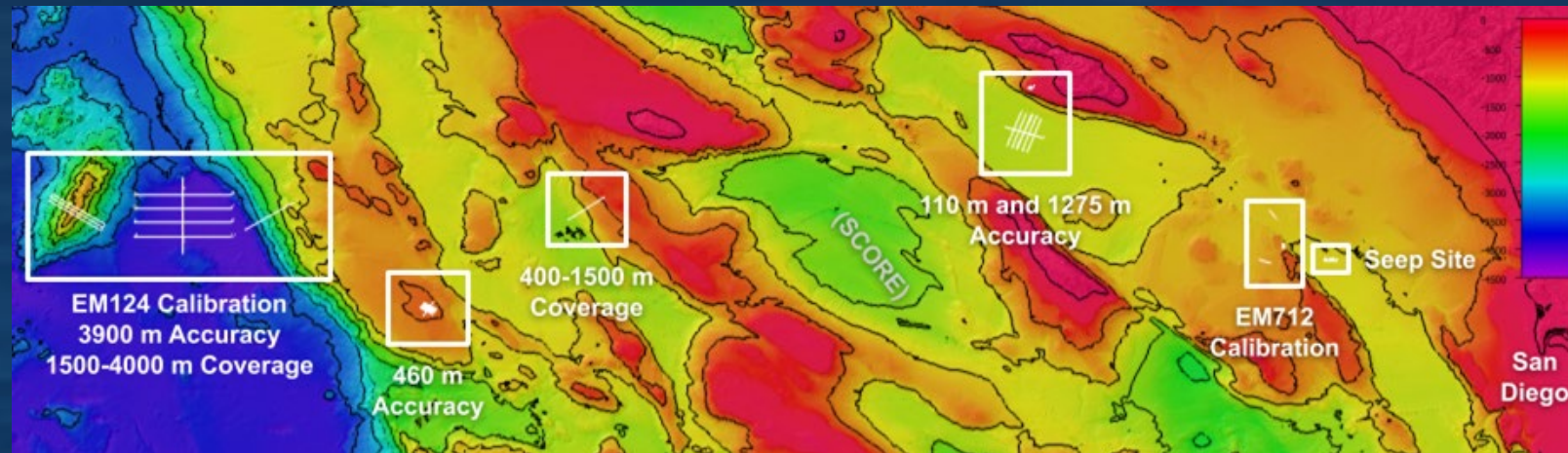
- Sound Speed Manager
- MAC Assessment Tools
- SAT/QAT site database
- GMRT tiling package



## Non-MAC testing / field work

- *Nautilus* (QAT)
- *Falkor (too)* (SAT)
- *OceanXplorer* (QAT)
- *Okeanos Explorer* (various)
- *Saildrone Surveyor* (various)
- *iXBlue DriX* (NA142, EM712 SAT)

**THANK YOU to technicians and managers  
for making remote support possible!**



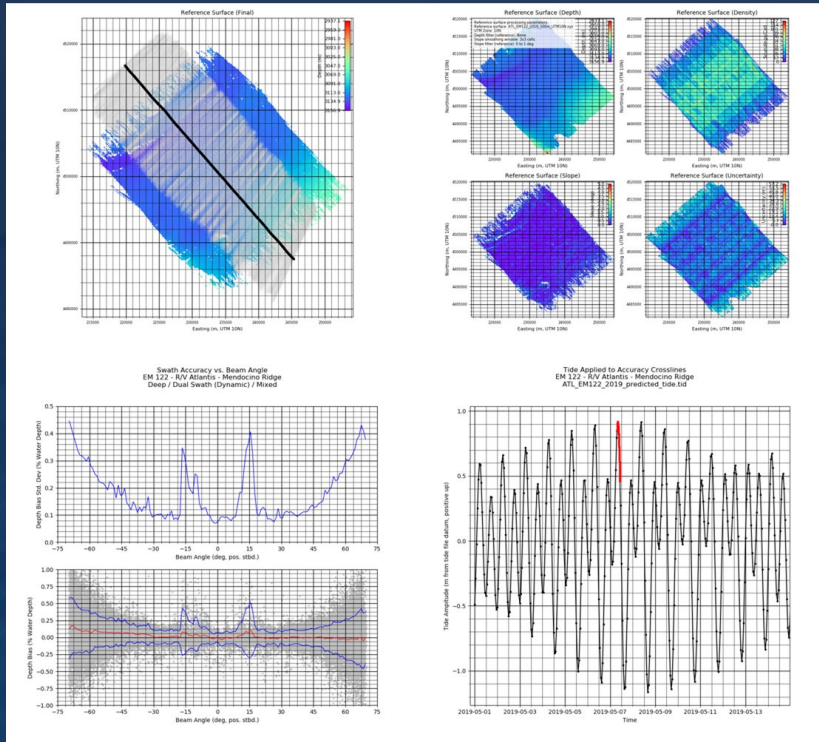
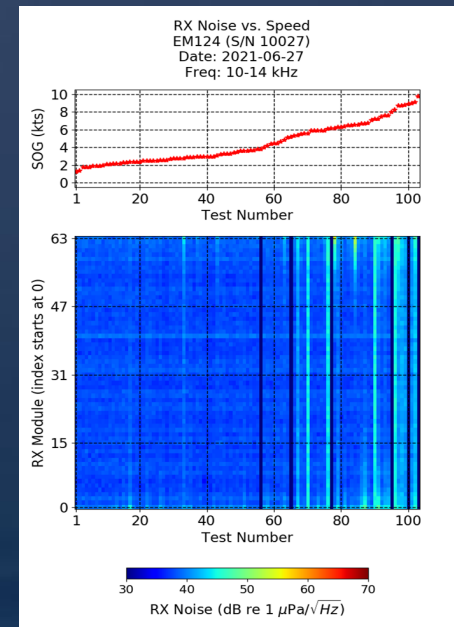
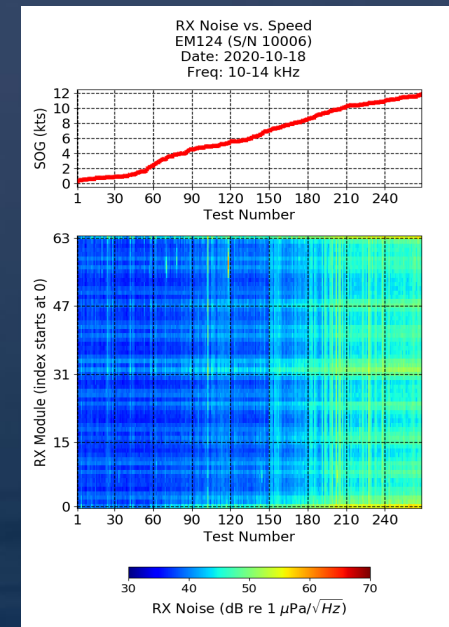
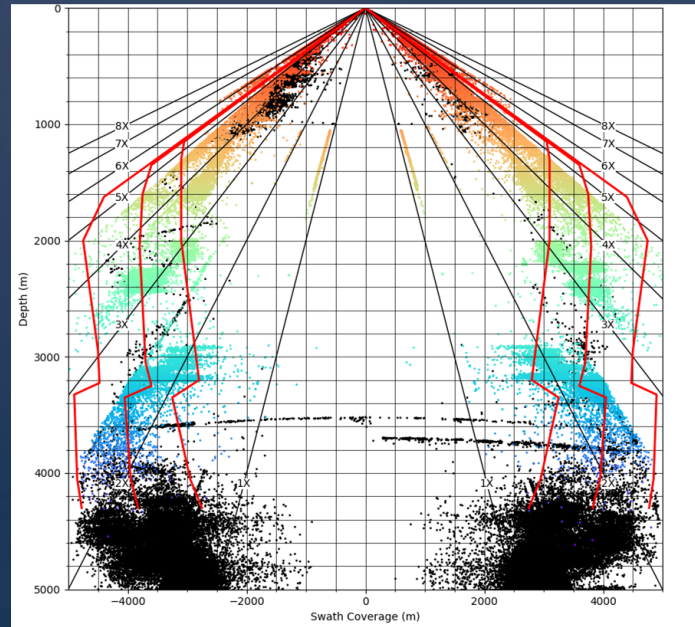
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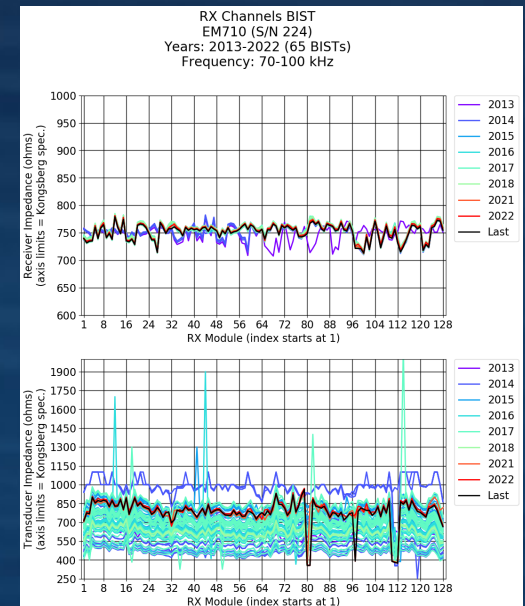
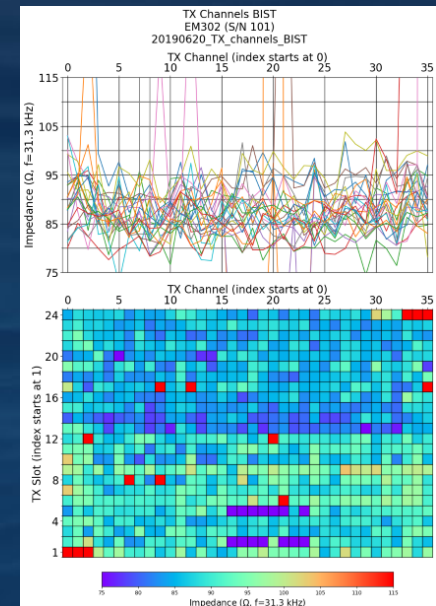
# Assessment Tools

[github.com/oceanmapping/community/wiki/Assessment-Tools](https://github.com/oceanmapping/community/wiki/Assessment-Tools)

1. File Trimmer
2. BIST Plotter
3. Swath Coverage Plotter
4. Swath Accuracy Plotter
5. ECDIS Converter



File Trimmer v.0.1.3 software interface. It shows a list of sources, a processing path, file control options, and an activity log. The activity log shows file trimming operations with file size reductions.

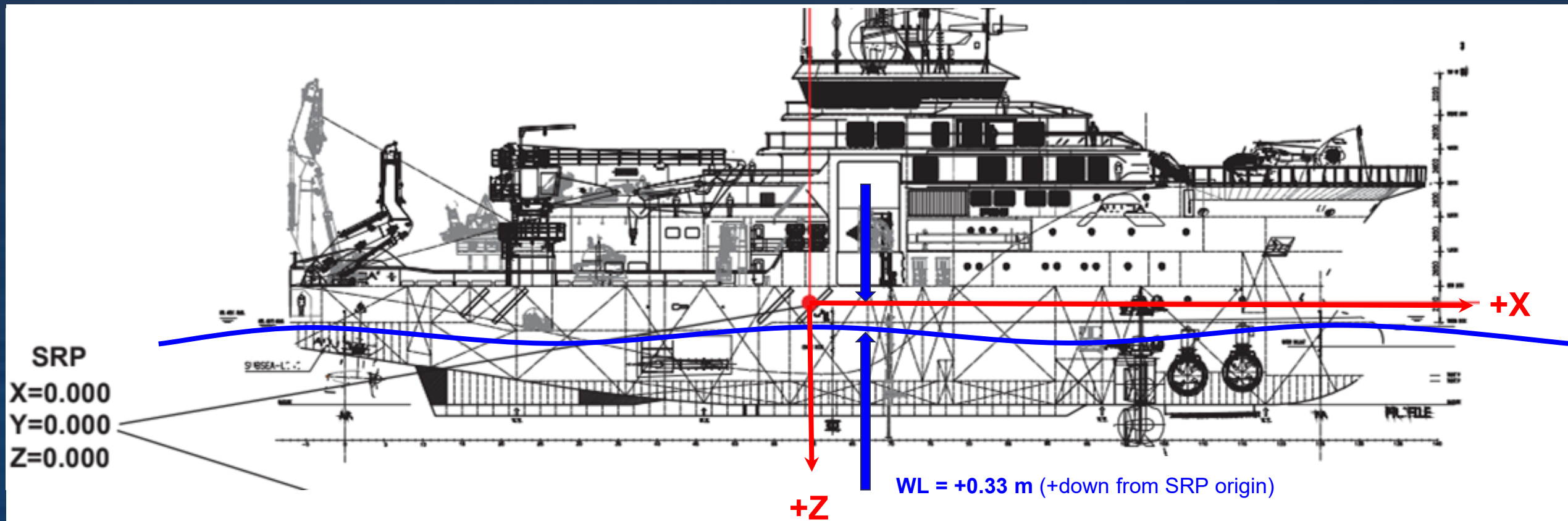


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# Examples from the Field: System Geometry

- Even the **best** survey reports can still be **interpreted incorrectly**
- **Waterline** remains a window of opportunity for large and persistent errors
- Affects 'starting point' in sound speed profile and final Z adjustment to surface





# Vessel Offset Survey Reports

## Recommendations for Reporting Vessel Geometry and Multibeam Echosounder System Offsets

Survey reports directly impact data quality for years  
Vessel and sensor offsets must be clearly documented  
Vessel / sensor offset survey reports **MUST** include:

1. **Origin** of survey reference frame
2. **Axes** of survey reference frame
3. **Sign conventions** of survey results
4. **Images** of surveyed points and sensors
5. **Sigma** / standard deviation or uncertainty
6. **Second review** before submission

1. Origin of the survey reference frame

2. Axes of the survey reference frame

3. Sign conventions of the survey reference frame

4. Images

5. Sigma / uncertainty of the survey results

6. Second review before submission

Example table of mapping sensor results

The ultimate purpose of the VSR is the confident and correct interpretation of the survey data for mapping system configuration. Building on criteria #1-6 presented above, this is best addressed with a simplified table of results for the relevant sensors using the chosen MBES manufacturer's reference frame and sign conventions. This table may be presented at the beginning or end of the report and only summarizes, rather than replaces, the more detailed survey data throughout.

Table 1. Example mapping sensor offsets from a chosen origin using consistent axis and sign conventions. This table summarizes the more detailed survey results presented elsewhere in the report. While these final numbers may be used directly for configuration, the reader must still carefully consider how the offsets will be applied among the sensor software packages to avoid doubling or cancelling the offsets. The items in the left column are examples only, and the final offsets required for configuration may differ by system; this should be clarified by the client. For example, manufacturers of higher-frequency echosounders may require a transducer bracket 'reference point' instead of the center of each array face; the client and surveyor must identify these items in planning the survey. Installations on adjustable rams or drop keels should include separate results for each standard positions used for mapping (e.g., recessed and extended, plus any intermittent standard positions)

R/V VESSEL	X	Y	Z	ROLL	PITCH	HEADING	Notes
Sign convention	Positive forward	Positive to starboard	Positive down	Positive with starboard side down	Positive with forward side up	Positive with forward side to starboard	
Units	meters	meters	meters	degrees	degrees	degrees	
Origin (chosen feature)	0.000	0.000	0.000	N/A	N/A	N/A	
TX array (center of array face)							
RX array (center of array face)							
GNSS antenna 1 (phase center)							Phase center height is _____m above the survey point (source: _____)
GNSS antenna 2 (phase center)							
Motion sensor (survey target on sensor housing)							
Additional sensors							

[github.com/oceanmapping/community/wiki/Dimensional-Control](https://github.com/oceanmapping/community/wiki/Dimensional-Control)



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5. Sigma / uncertainty of the survey results

6. Second review before submission

Example table of mapping sensor results

	Y	Z	ROLL	PITCH	HEADING	Notes
TX array (center of array face)						
RX array (center of array face)						
GNSS antenna 1 (phase center)						Phase center height is _____m above the survey point (source: _____)
GNSS antenna 2 (phase center)						
Motion sensor (survey target on sensor housing)						
Additional sensors						

1. Origin of survey reference frame  
2.  
3.  
4.  
5.  
6.

**See Anand Hiroji's talk at 9:30**  
**A Step Towards Standardizing**  
**Hydrographic Vessel Offset Surveys**

[github.com/oceanmapping/community/wiki/Dimensional-Control](https://github.com/oceanmapping/community/wiki/Dimensional-Control)



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# Waterline Worksheet

## Multibeam Advisory Committee Kongsberg Waterline Worksheet



Working draft; please contact mac-help@unols.org with feedback

### Purpose / Warning

This worksheet (in development) is intended to help translate draft readings into the 'Waterline' parameter required by SIS.  
Waterline is the vertical offset from the mapping system reference frame to the sea surface in normal trim.  
The Waterline parameter is entered in **meters, positive DOWN** from the mapping system origin.  
If the sea surface is above the origin, then the Waterline parameter is negative.  
Errors in waterline directly affect reported depths as well as refraction correction (e.g., starting depth in sound speed profile)  
More information at <https://github.com/oceanmapping/community/wiki/Dimensional-Control#waterline>

### Instructions

All cells are protected, aside from those requiring input. Please contact mac-help@unols.org with any feedback.

**Green sections: enter ship information** Enter data based on your vessel / sensor offset survey and interpretation of the mapping system reference frame. Ensure correct units are applied.  
**Yellow cells: extra attention needed** Review your vessel survey and mapping system configuration carefully!  
**Blue cells: waterline for SIS config** Waterline value for SIS configuration (meters, positive DOWN from the mapping system origin)

### Step 1: Consider how draft readings are taken and the current mapping system reference frame. Select the locations for draft reference and mapping system origin.

Reference for vessel draft readings	Keel	This is the reference used for draft readings (e.g., typically the keel or other deepest part of the hull, but not always!)
Mapping system origin (where Z=0)	Motion sensor	This is the origin of the mapping system reference frame as configured (e.g., not necessarily the "vessel survey" reference frame)
Origin height different from draft ref.?	Yes. Review the mapping system ref. frame carefully. Enter the mapping system origin height ABOVE the draft ref. and add alongship position in Step 2.	

### Step 2: Enter the mapping system origin height above the draft reference (not waterline!) and alongship distance from stern.

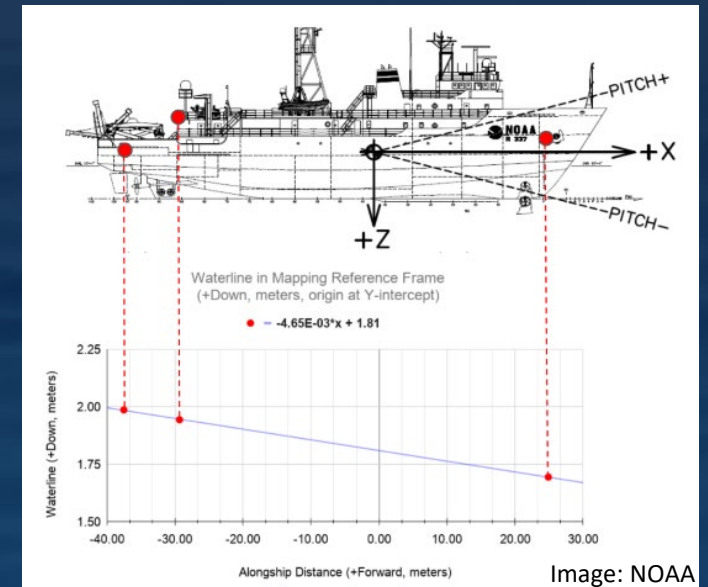
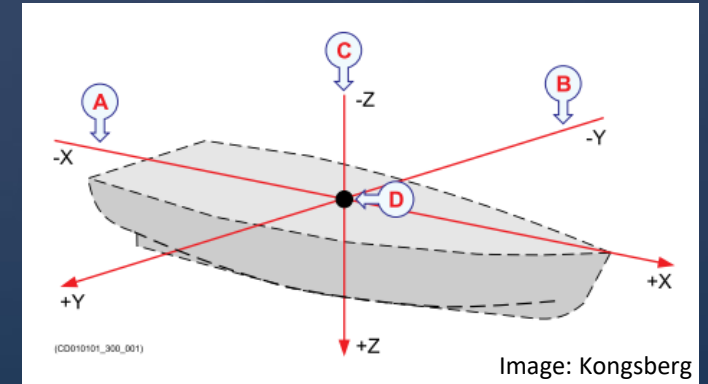
Mapping system origin offsets from draft ref.	Height above draft ref. (decimal feet or m)	Distance from stern (alongship feet or m)	Units (select 'none' if not applicable)	Scale factor to meters	X	Z
Mapping system origin	9.55	38.78	m	1	38.7800	9.5500

### Step 3: Enter draft readings and alongship distances from stern. Draft is estimated at mapping system origin.

Draft readings in normal trim (average Port/Stbd readings at each location to estimate draft at CL)	Draft reading (decimal feet or m)	Distance from stern (alongship feet or m)	Units (select 'none' if not applicable)	Scale factor to meters	X (m) +FWD from stern	Z (m) +UP from draft ref
BOW draft reading	5.10	62.38	m	1	62.3750	5.1000
STERN draft reading	6.00	0.00	m	1	0.0000	6.0000
ESTIMATED draft reading at origin	5.44	38.78	m	1	38.7800	5.4404

### Step 4: Calculate waterline at origin

Waterline in mapping system reference frame	Waterline (SIS)	X (m) +FWD from origin	Z (m) +DOWN from origin
BOW draft reading in mapping frame		23.60	4.45
STERN draft reading in mapping frame		-38.78	3.55
Waterline for SIS (m, +DOWN at origin)	4.11	0.00	4.11



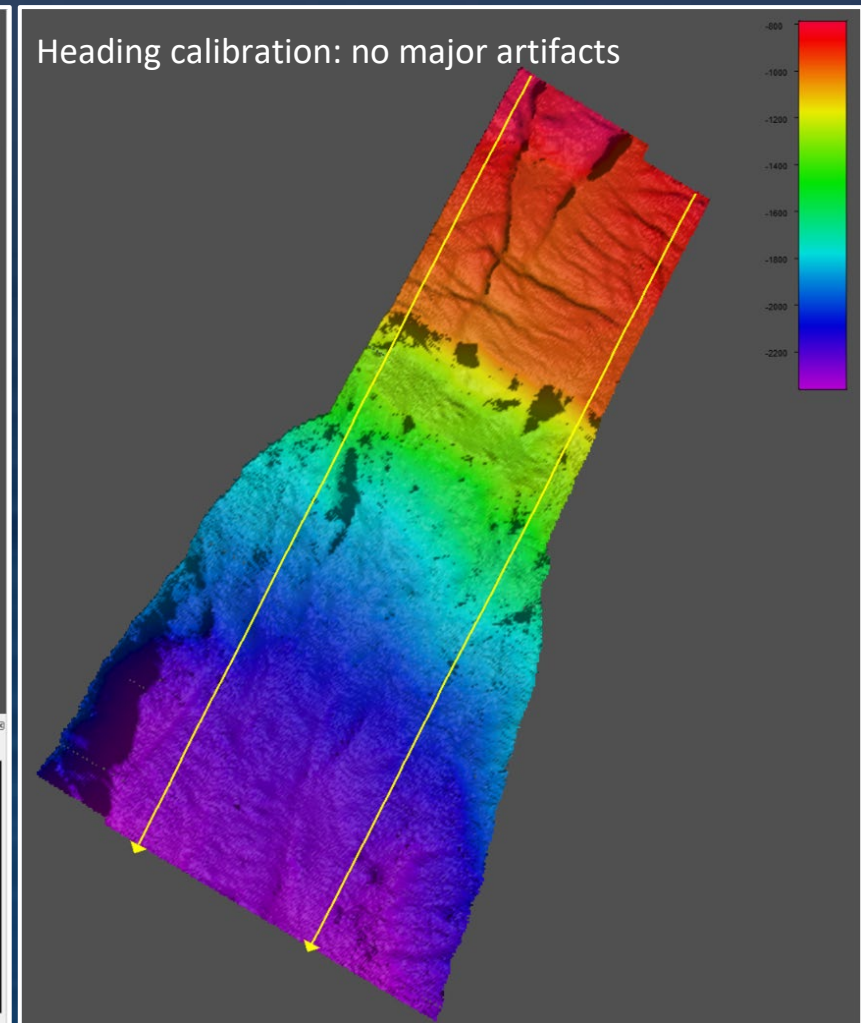
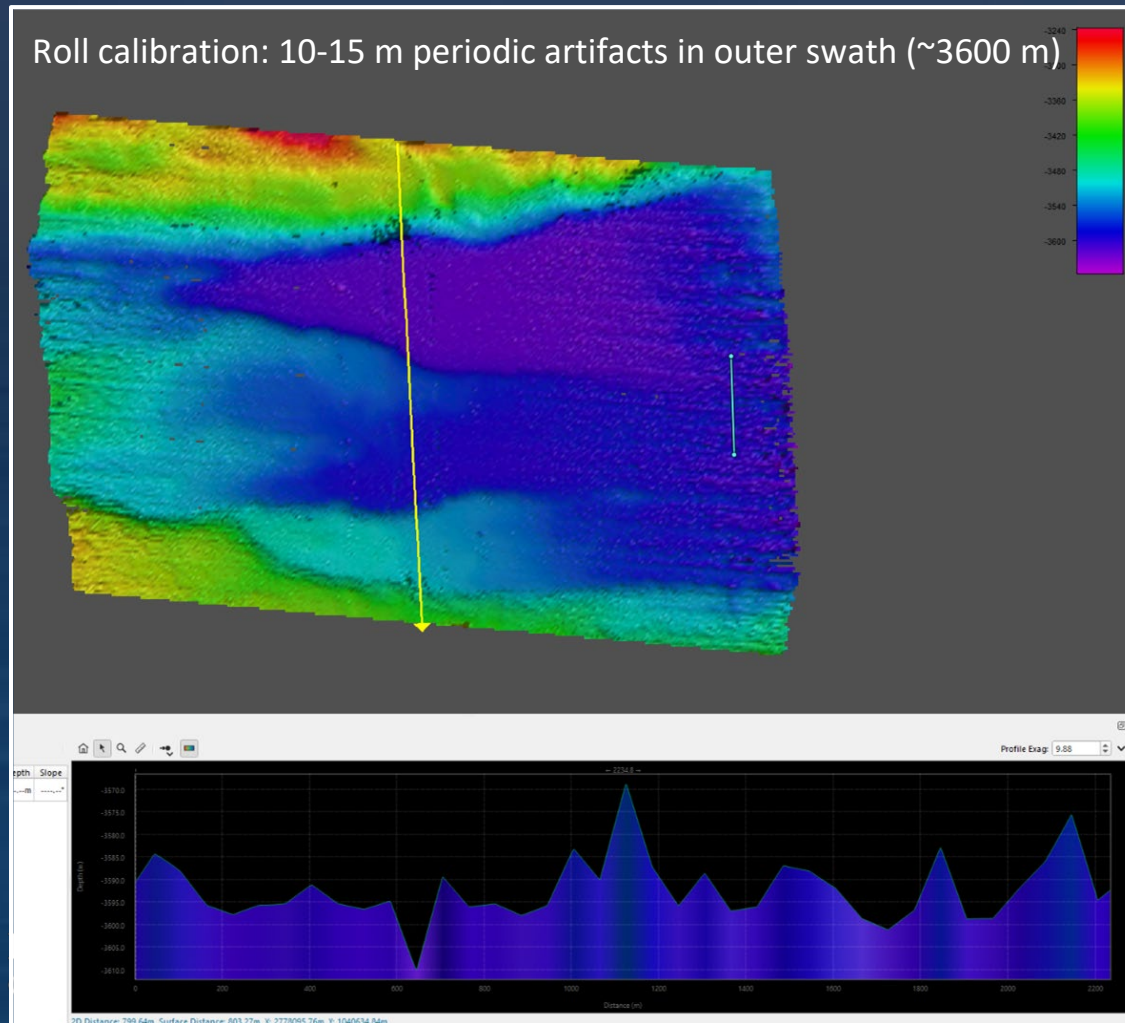
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# Examples from the Field: Swath Wobbles

1. Multibeam systems up to date with total geometry review, calibrations, noise testing
2. 'Wobbles' in some data (left) but not all (right) during calibration

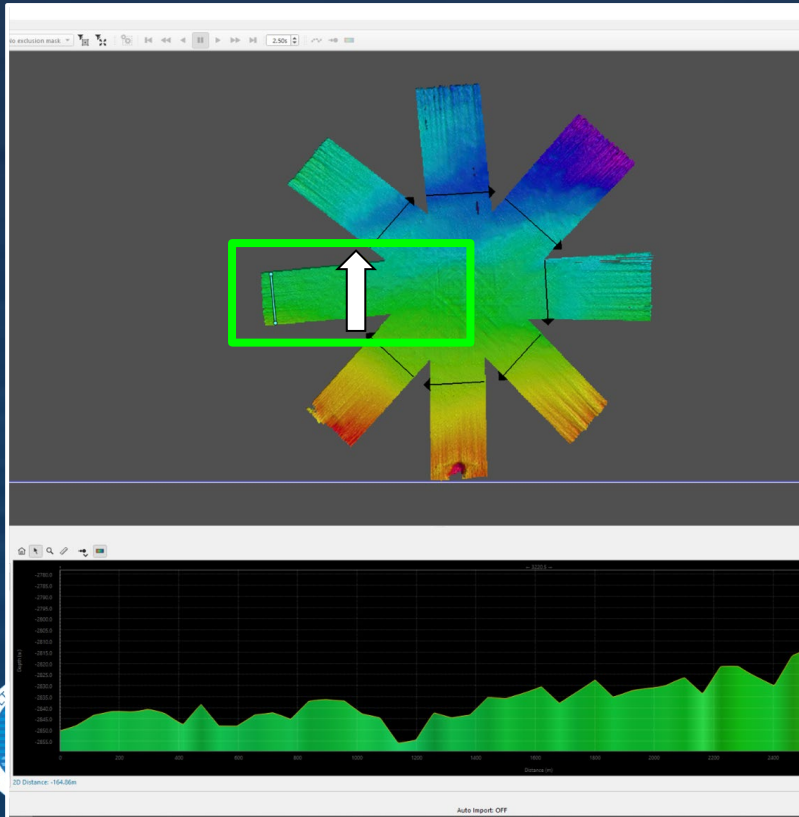




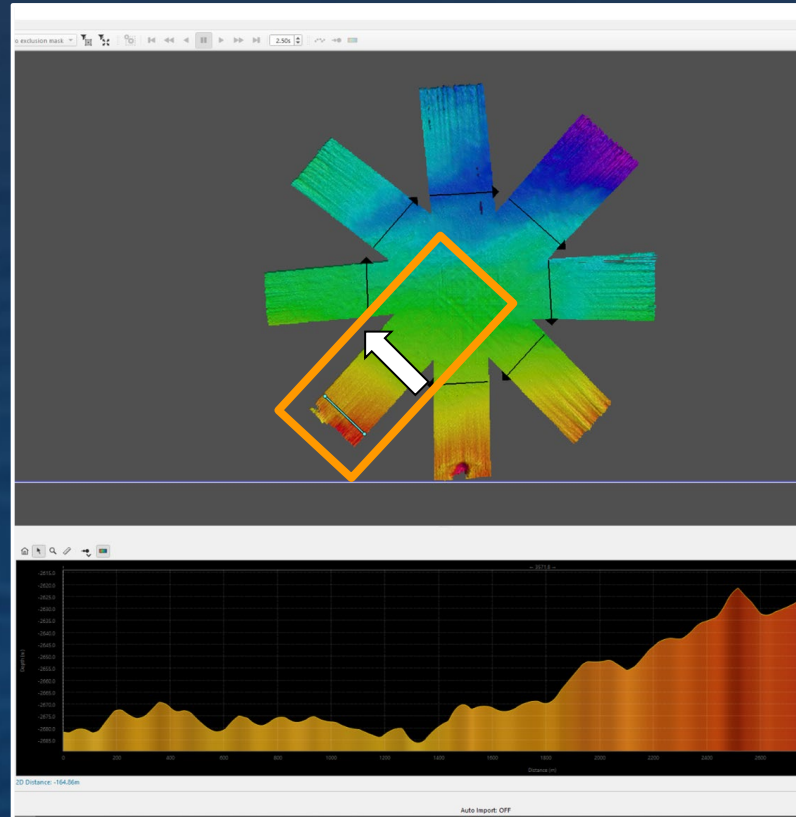
# Examples from the Field: Swath Wobbles

1. Mapping 'octagon' with 10-15 minutes on eight headings (2650-2850 m)
2. Changes in swath behavior with orientation to potential internal wave field
3. Consistent attitude (1-3° roll and pitch) and surface sound speed on all headings

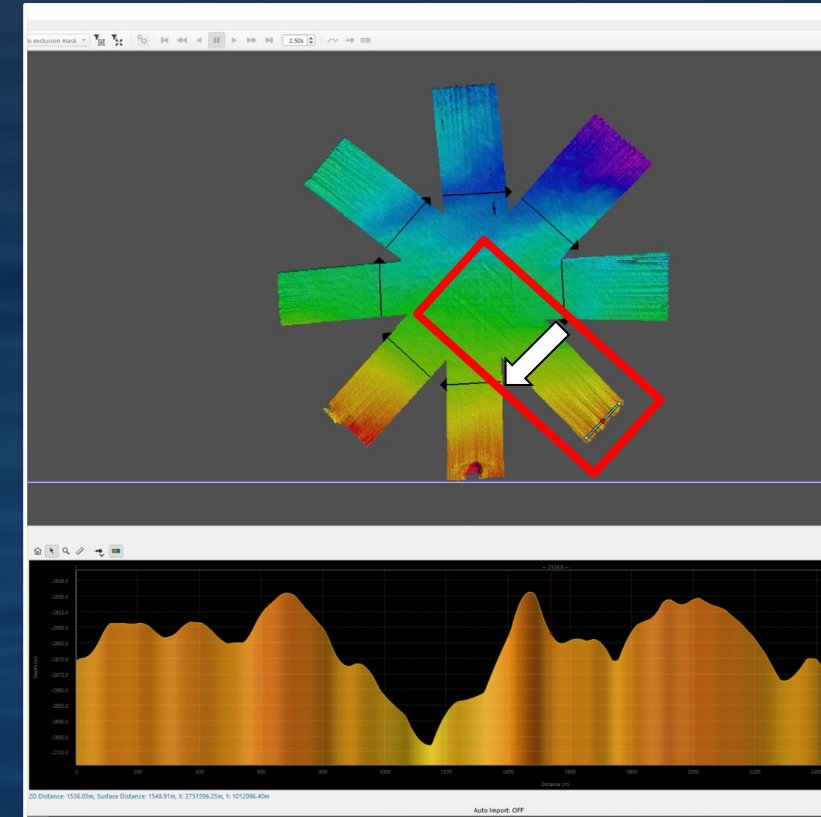
**'Best' case:**  
~5 m ripples (N)



**'Middle' case:**  
~20 m waves (NW)

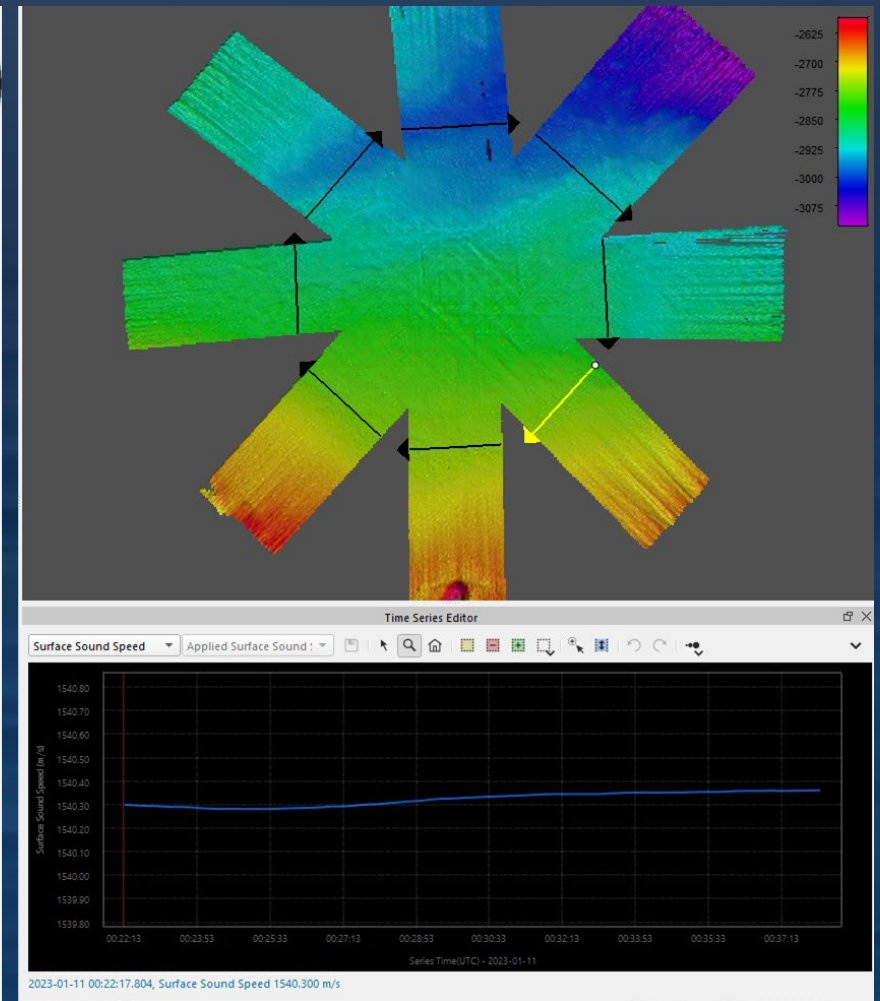
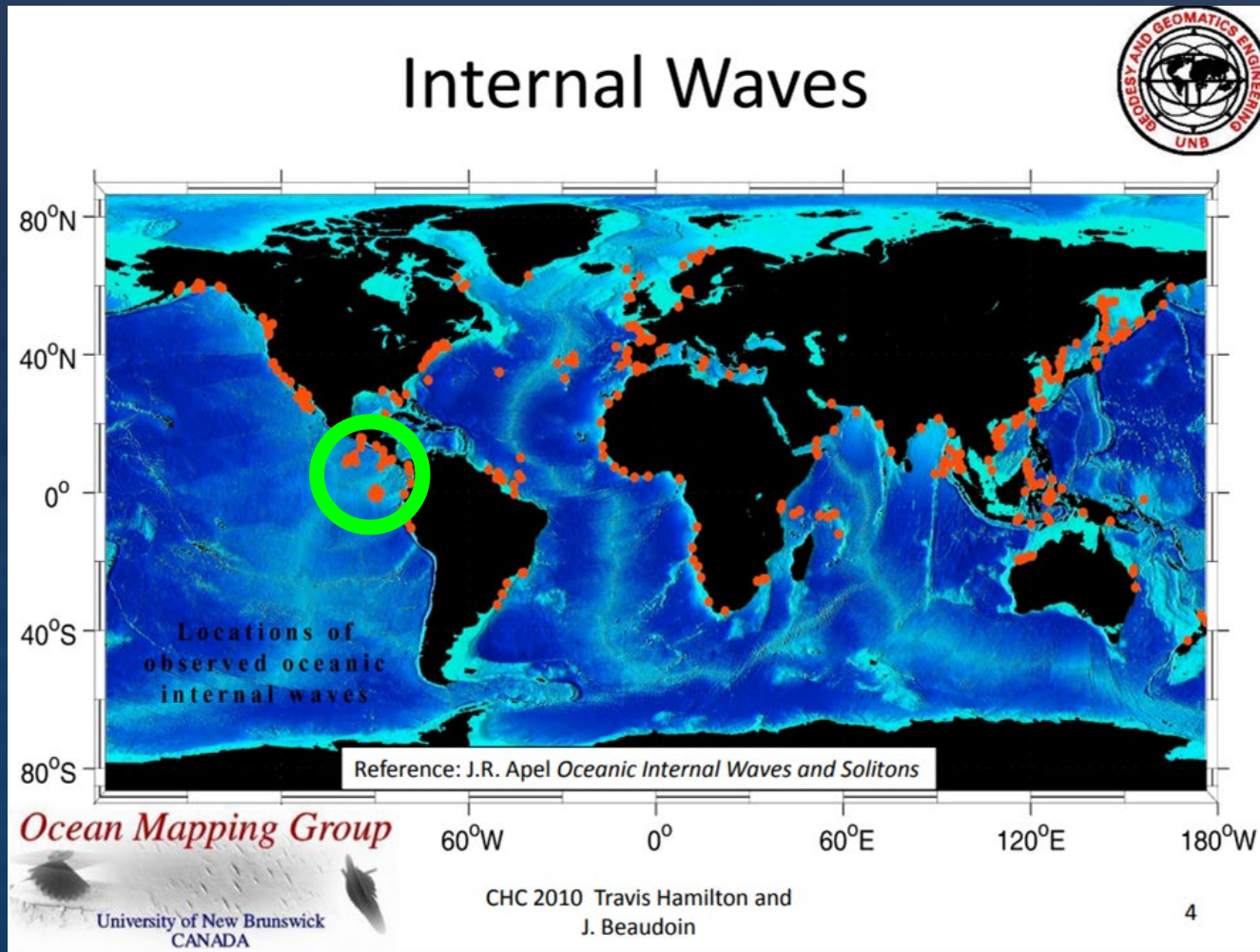


**'Worst' case:**  
~50 m wobbles (SW)



# Examples from the Field: Swath Wobbles

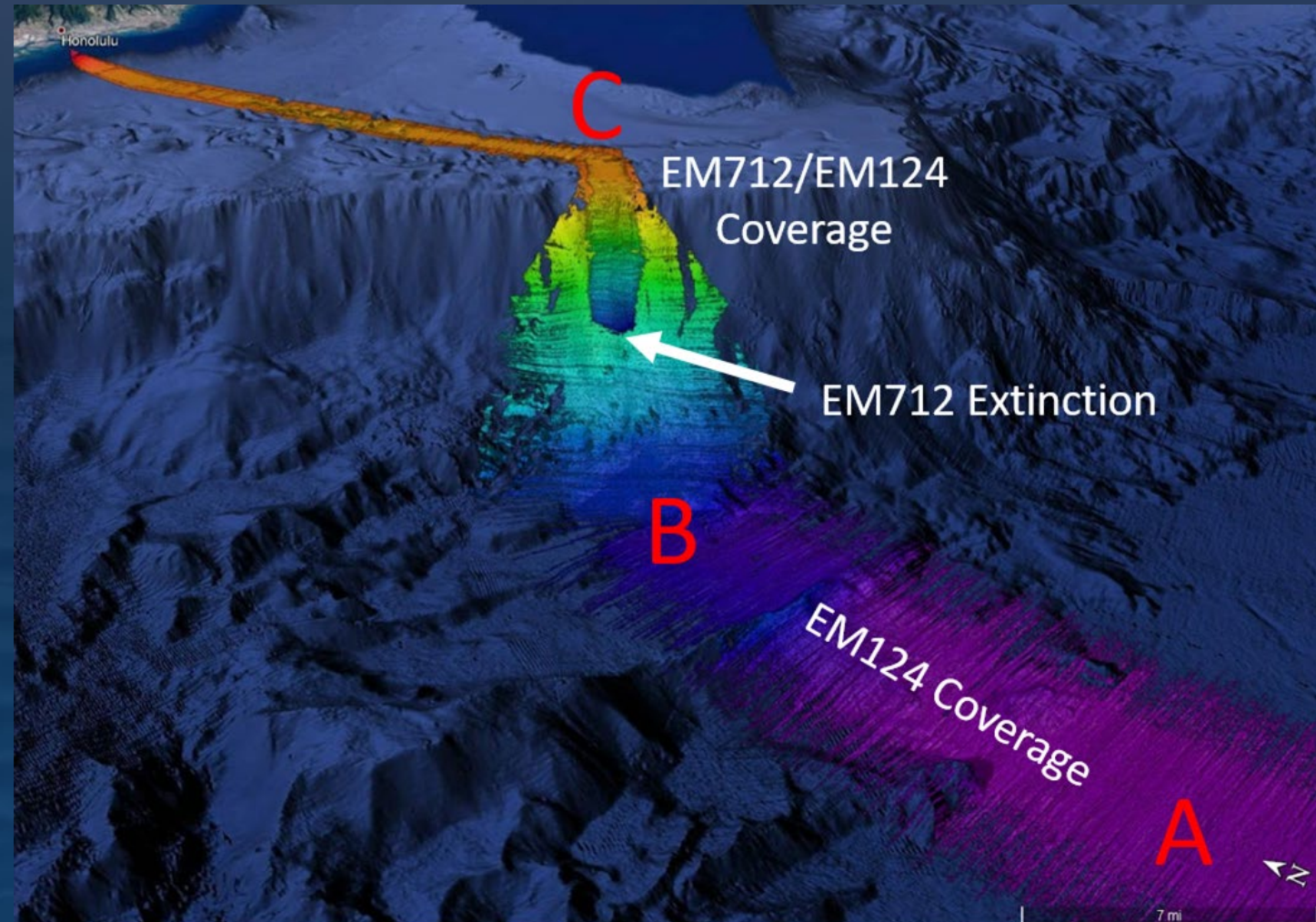
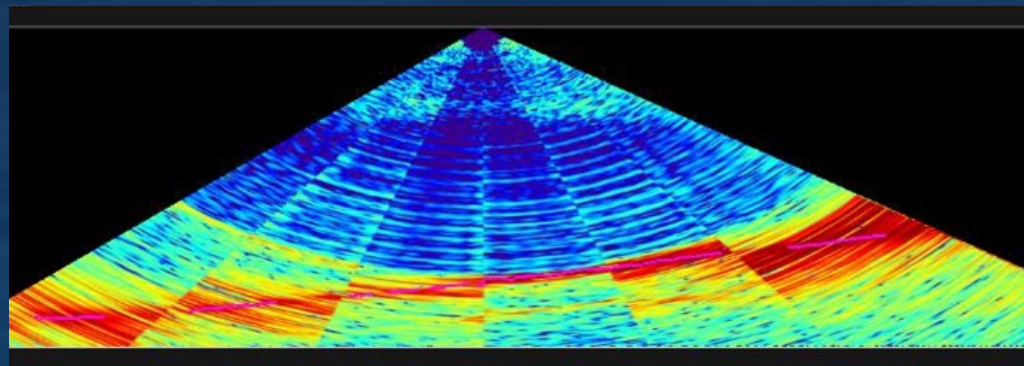
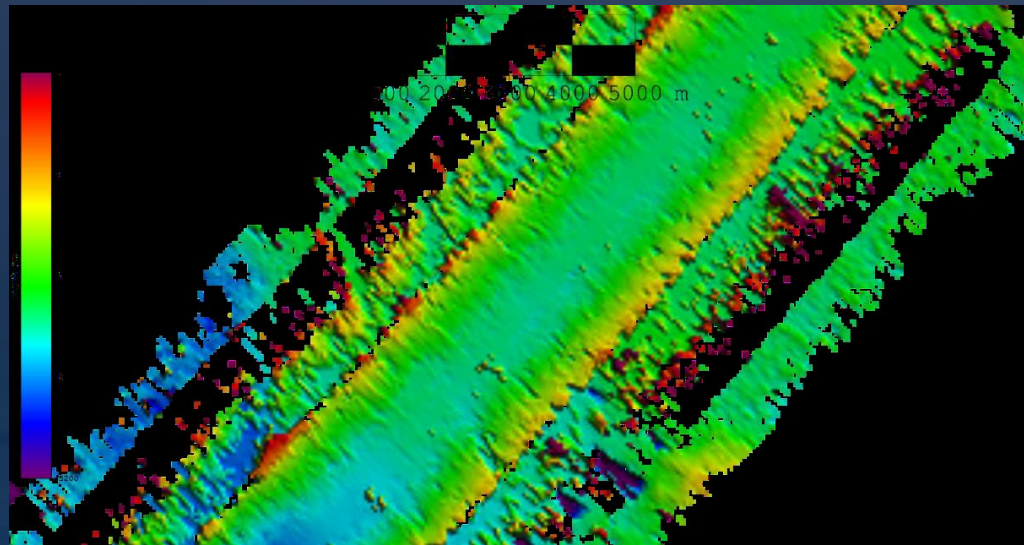
1. Oceanography: Internal waves?
2. Flow-through TSG: Intake depth? Temperature change? Lag time?





# Examples from the Field: Transit Mapping

System performance testing before 'real' mapping cruises

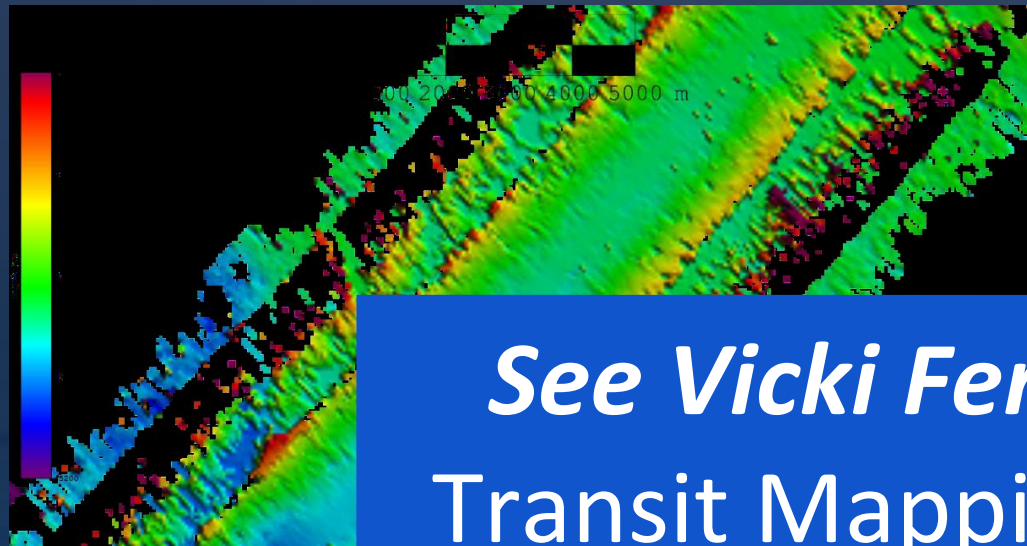


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# Examples from the Field: Transit Mapping

System performance testing before 'real' mapping cruises



*See Vicki Ferrini's talk at 10:00*  
Transit Mapping in Support of the  
Global Ocean Mapping Community

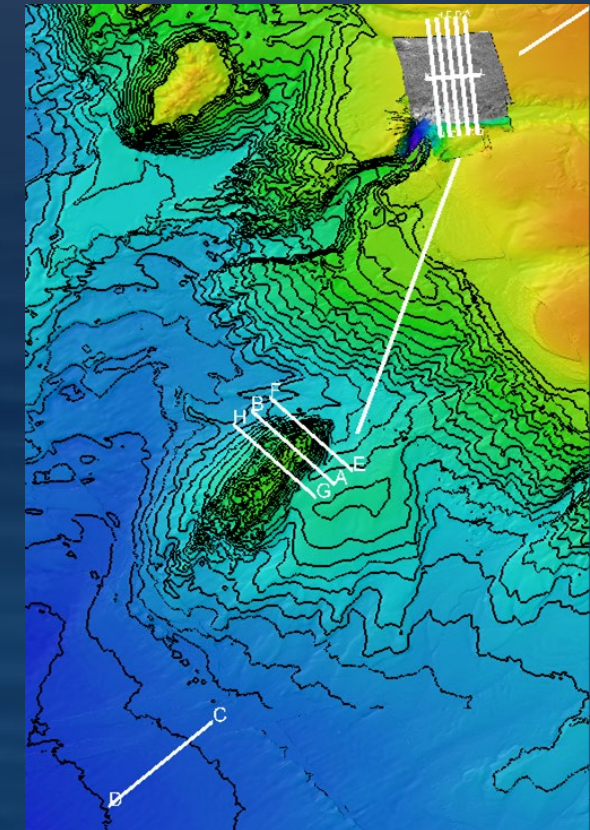
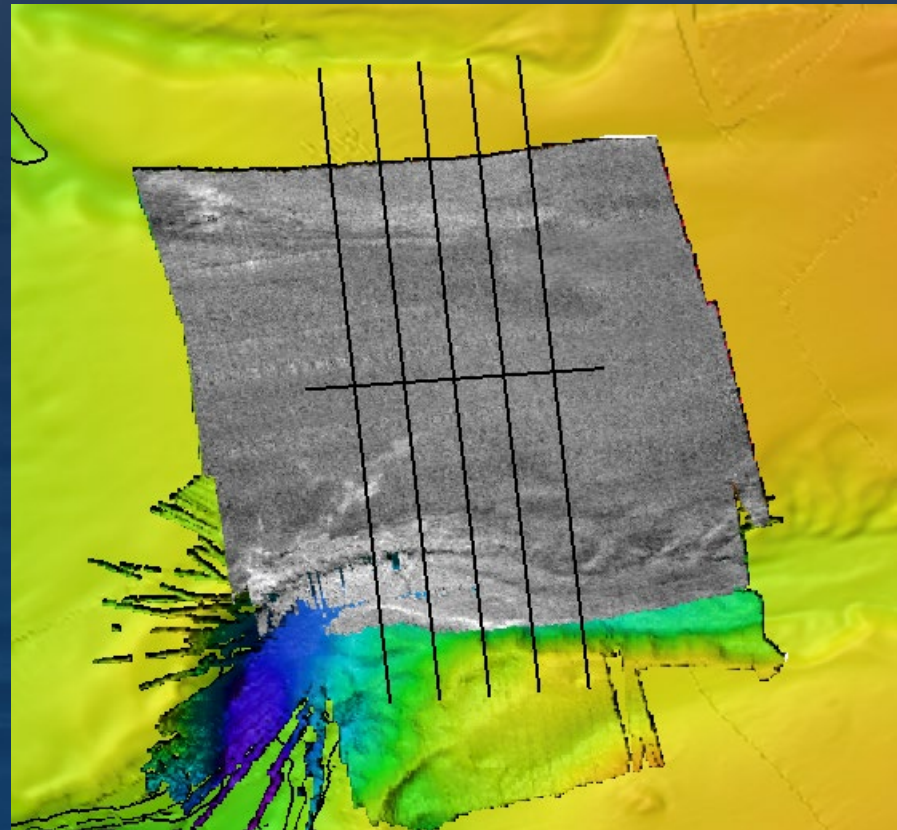
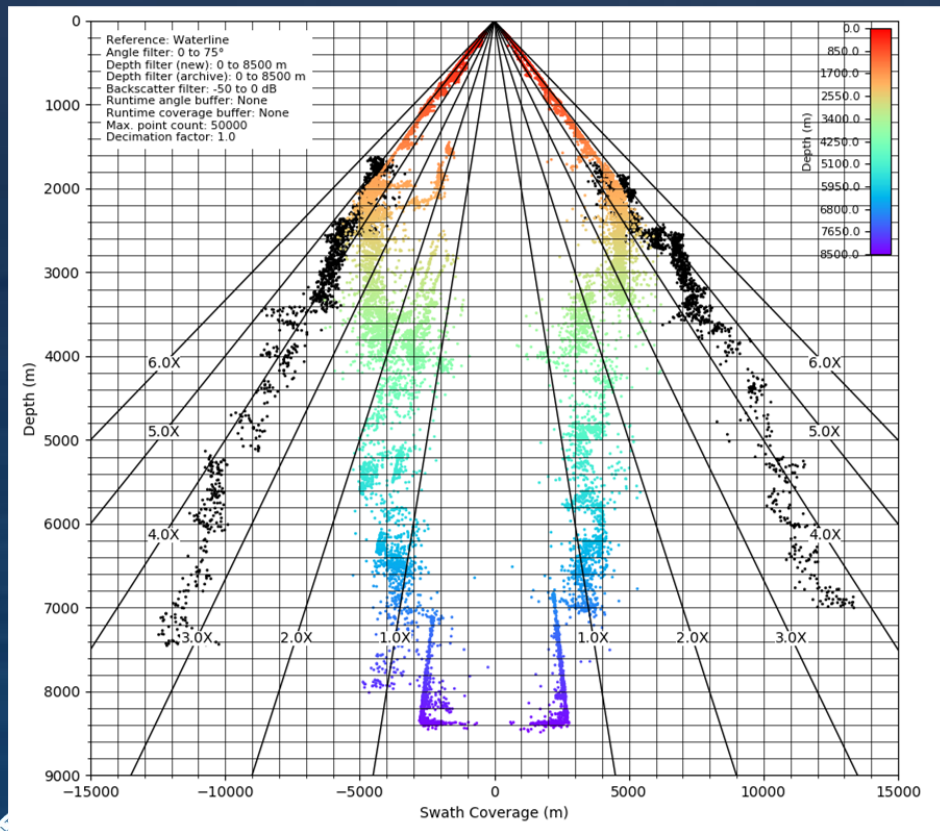


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# Examples from the Field: Reusing proven test sites

- Common test areas = routine assessments and meaningful comparisons
- SAT/QAT steps can be flexible (with limits) and worked around other activities
- **Advance planning with proven sites means efficient use of ship time and personnel**



# Multibeam Test Sites Database – Why is it needed?

Where can I run a test ?

- Depth, slope, seafloor type
- Proximity to other operations
- Exclusion zones / restrictions

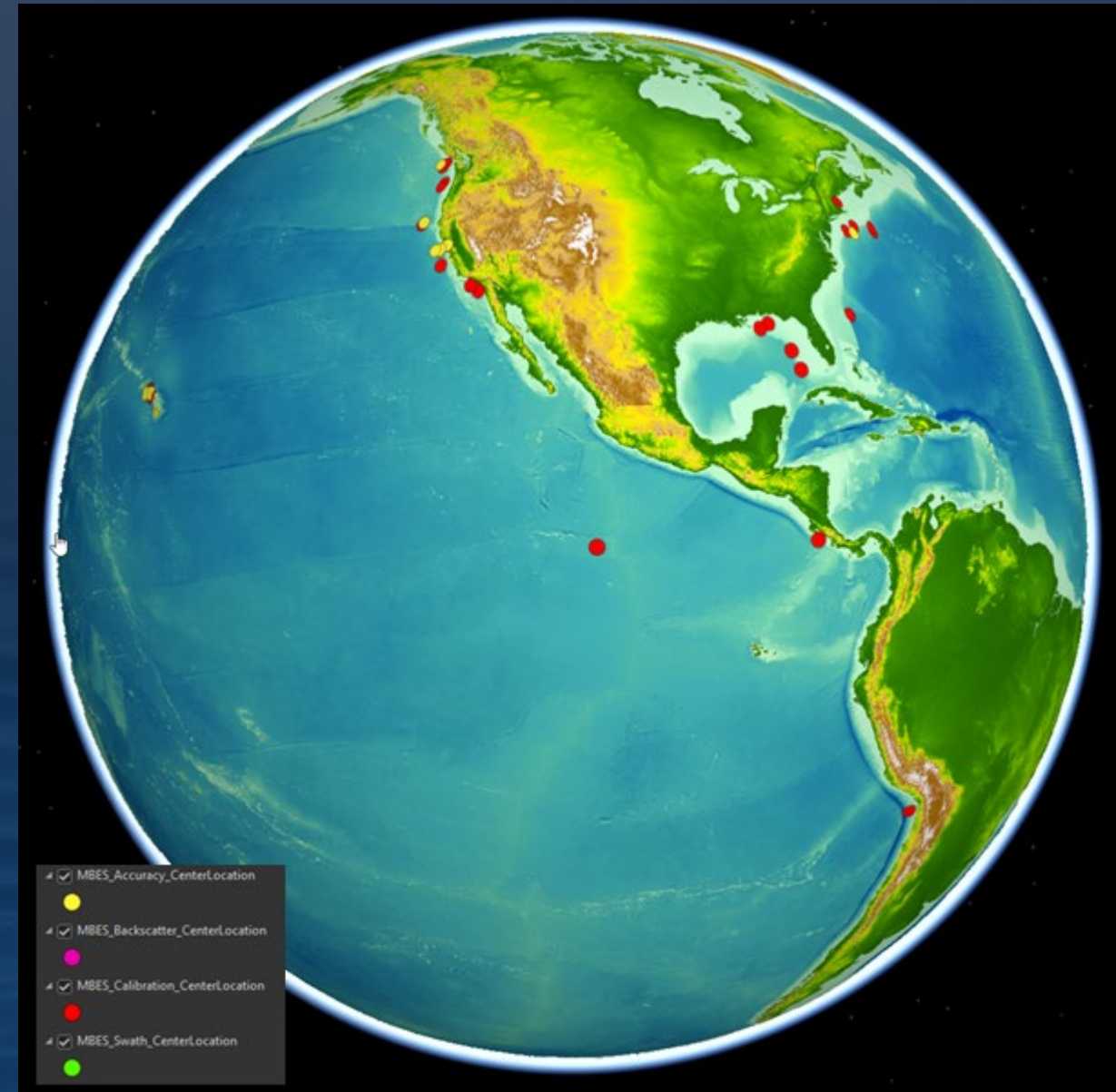
More appropriate sites and comparisons

- Ship to ship / system to system

Opportunistic testing on transits

Significant time savings (ref. surfaces)

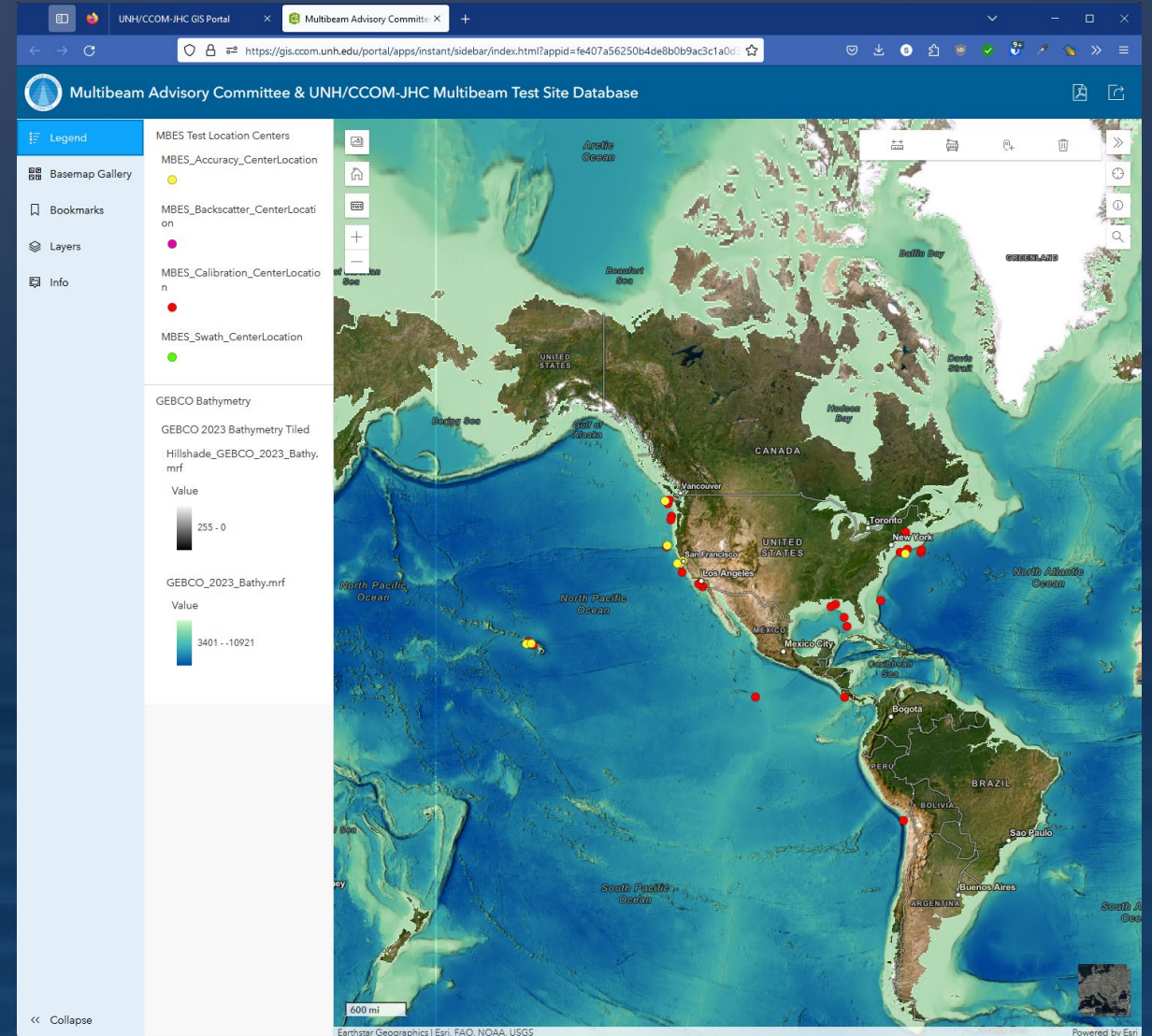
Regional planning data can be wrong





# Multibeam Test Sites Database – Prototype WebApp

<https://ccom.unh.edu/gis/maps/TestSites>



# Multibeam Test Sites Database – Site Info

## Types of MBES test sites:

- Calibration (Patch Test)
- Swath coverage
- Swath accuracy
- Backscatter normalization
- Water column evaluation

## Site info includes:

- Test type
- System type
- Location / line plans / settings
- Links to supporting files
- Quality / notes from users

The screenshot displays the ArcGIS Enterprise interface. The main map shows a bathymetric view of the ocean floor with several MBES test sites marked as colored lines and points. The sites are labeled with names like 'Honolulu', 'Kaiwi Channel', and 'Penguin Bank'. The interface includes a top toolbar with various tools, a left-hand 'Contents' pane showing the layer structure, and a right-hand 'Pop-up' pane displaying detailed information for a selected site.

Filename	Test Type	Report URL	Files URL	Line ID	Ship
EM122_Mytilus_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	1	R/V Neil
EM122_Mytilus_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	2	R/V Neil
EM122_Mytilus_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	3	R/V Neil
EM122_Mytilus_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	4	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	1	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	2	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	3	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystemr...	4	R/V Neil
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystemr...	1	NOAA St
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystemr...	2	NOAA St
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystemr...	3	NOAA St
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystemr...	4	NOAA St
EX1810_v4_calibration...	Calibration "Patch Test"	https://mac.unols.org/w...	https://universitysystemr...	1	NOAA St

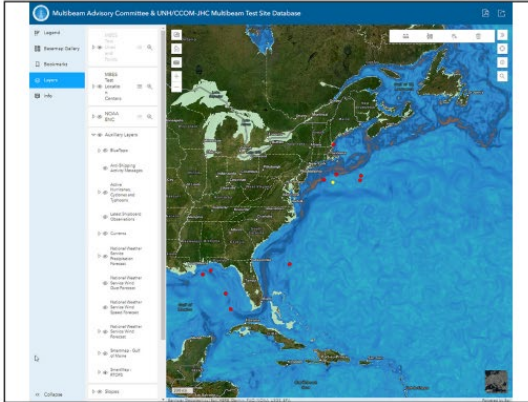


<https://gis.ccom.unh.edu>

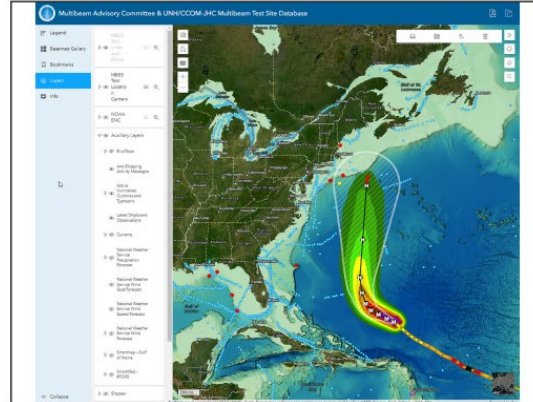


# Multibeam Test Sites Database – Planning Layers

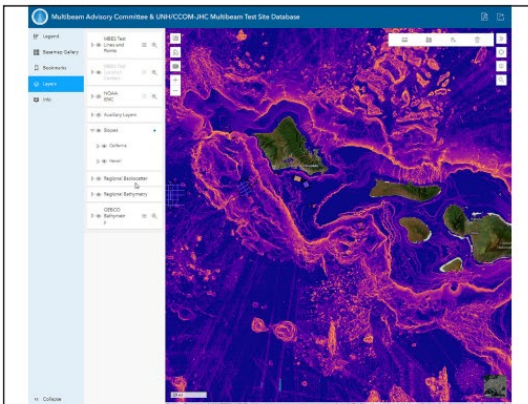
## Planning Information



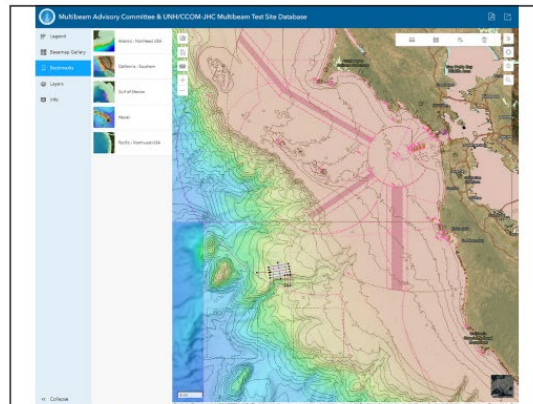
SmartMap Ocean Complexity



Ocean & Weather Conditions



Regional Bathymetry & Slope



Electronic Navigation Charts

The screenshot displays the ArcGIS Enterprise interface. The main map shows a coastal area with MBES Test Sites and MBES Test Location Centers. The Contents pane on the left shows the layer structure, including MBES Tests, MBES\_Test\_Points, and MBES\_Test\_Lines. The Data pane on the right shows a table of MBES\_Test\_Lines with the following data:

Filename	Test Type	Report URL	Files URL	Line ID	Ship
EM122_Mytilus_Seamo...	Calibration "Patch Test"	Planning Only	https://universitysystem...	1	R/V Neil
EM122_Mytilus_Seamo...	Calibration "Patch Test"	Planning Only	https://universitysystem...	2	R/V Neil
EM122_Mytilus_Seamo...	Calibration "Patch Test"	Planning Only	https://universitysystem...	3	R/V Neil
EM122_Mytilus_Seamo...	Calibration "Patch Test"	Planning Only	https://universitysystem...	4	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystem...	1	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystem...	2	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystem...	3	R/V Neil
EM122_Physalia_Seam...	Calibration "Patch Test"	Planning Only	https://universitysystem...	4	R/V Neil
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystem...	1	NOAA St
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystem...	2	NOAA St
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystem...	3	NOAA St
FH_2020_EM2040_cali...	Calibration "Patch Test"	Not Available	https://universitysystem...	4	NOAA St
EX1810_v4_calibration...	Calibration "Patch Test"	https://mac.unols.org/w	https://universitysystem...	1	NOAA St



<https://gis.ccom.unh.edu>



# Multibeam Test Sites Database – Recent Example

Hawaii 4700 m reference surface

- 2005 - R/V *Kilo Moana* EM120 (12 kHz)
- Very dense soundings for surface
- **36 hours needed for data collection**

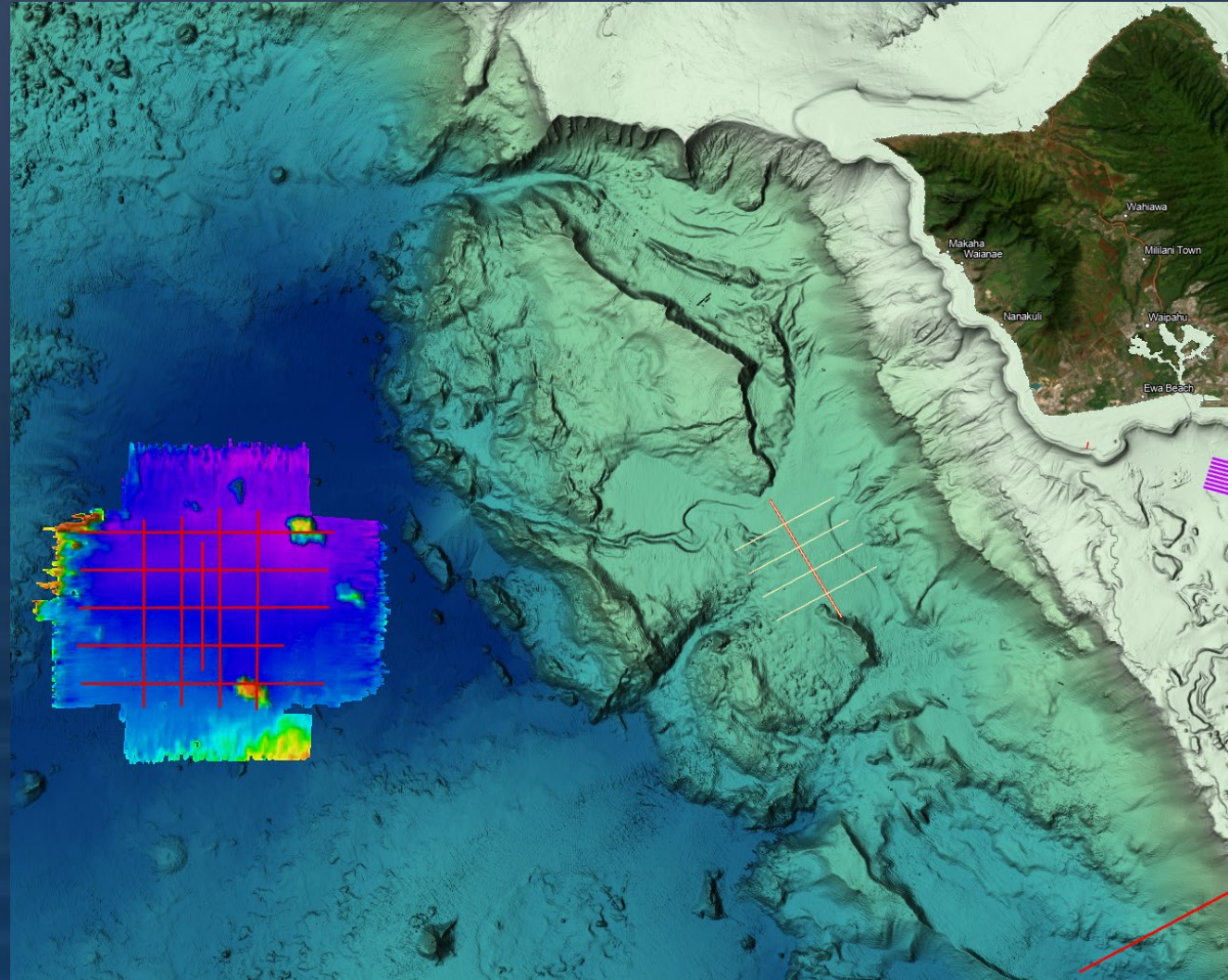
Ships collect accuracy cross lines only

- 2-3 hours per mode

Reused recently by four vessels

- System comparison across ships

*NOTE: suitable for stable areas*



<https://gis.ccom.unh.edu>



# Multibeam Test Sites Database – Future Work

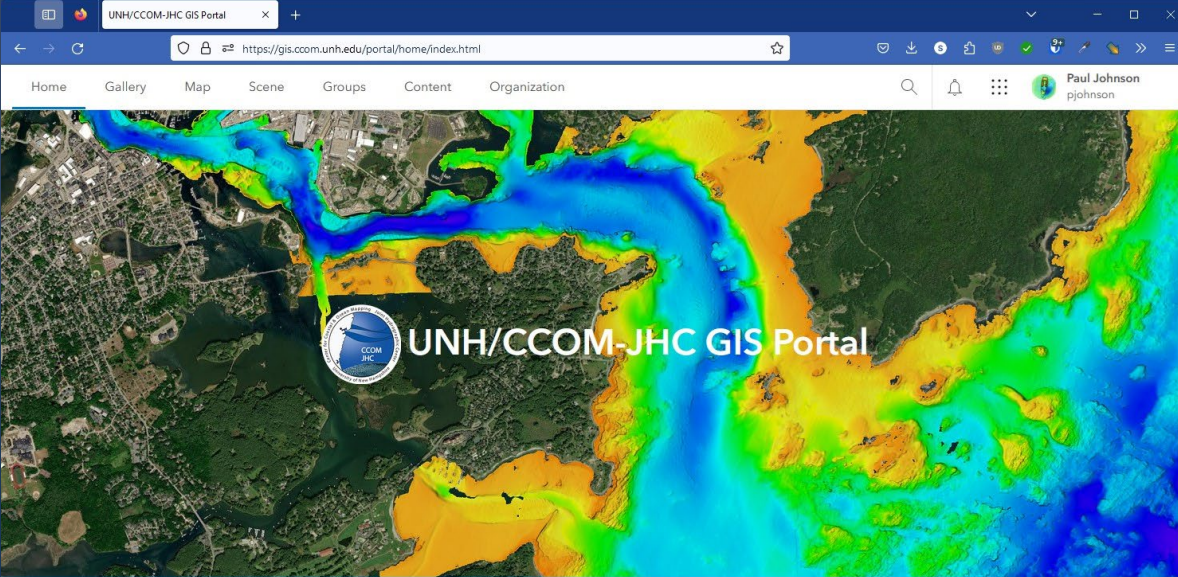
## Add new test sites

- NOAA, UNOLS and industry partners
- More sites from FEMME community!
- Reach out at mac-help@unols.org

## Standards for file submission

- Line files
- Bathymetry grids
- Operational parameters

## Speed up the WebApp



The screenshot shows the UNH/CCOM-JHC GIS Portal website. The main content area features a large bathymetry map of a coastal region, with a color scale ranging from blue (deep) to red (shallow). The map is overlaid on a satellite-style background. The text "UNH/CCOM-JHC GIS Portal" is prominently displayed over the map. Below the map, there is a blue banner with white text describing the center's mission: "The Center for Coastal and Ocean Mapping at the University of New Hampshire was founded with the objective of developing tools and offering training that would help NOAA and others to meet the challenges posed by the rapid transition from the sparse measurements of depth offered by traditional sounding techniques to the massive amounts of data collected by the new generation of multibeam echo sounders. The Center has since expanded its research objectives and now encompasses a broad range of ocean mapping technologies and applications, but at its roots, the Center continues to serve NOAA and the U.S. through the development of tools and approaches that support safe navigation, increase the efficiency of surveying, and offer a range of value-added ocean mapping products."

Below the banner, there is a section titled "Featured Maps and Apps" with the subtitle "Recently updated WebMaps and data layers available from the Center." This section contains four cards, each representing a different tool or data layer. The first card, "Instant App MBES Test Sites Database Web...", is highlighted with a red border. The other cards are "Instant App NHS Surficial Geology WebApp", "Instant App GEBCO 2023 Globe Bathymetry, elevation, TID, and Indirect Measurement mask with a 5x vertical exaggeration.", and "Web Experience WGoM, LI, SNE Bathymetry & B...".



<https://gis.ccom.unh.edu>



# Multibeam Test Sites Database

## Check out the poster and webapp!



### Where do I plan a multibeam echosounder shipboard acceptance test or quality assurance test?

Paul Johnson<sup>1</sup>, Kevin Jerram<sup>1</sup>, and Vicki Ferrini<sup>2</sup>

<sup>1</sup>: Center for Coastal and Ocean Mapping, University of New Hampshire

<sup>2</sup>: Lamont-Doherty Earth Observatory, Columbia University

#### Abstract

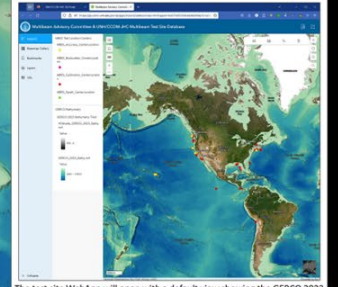
Throughout the life cycle of a multibeam echosounder system (MBES), testing for proper installation, configuration, and data quality is necessary. This starts with the initial Shipboard Acceptance Test (SAT) and is then followed by periodic Quality Assurance Tests (QAT) over the operational life of the MBES. For both SATs and QATs, seafloor with certain morphology is required to conduct the typical tests (e.g., calibration, swath coverage, swath accuracy, and backscatter normalization). However, planning these tests is often not very straightforward. Operators will need to quickly identify a test site that is located close to the port, has the right depths/slopes/bottom type for the tests, and will need to make a clear plan on how to run the tests. This is a high bar to clear as the operators must know where to find regional planning data, properly layout the tests, configure the MBES for acquisition of the test data, know how to interpret the test results, and know what other datasets are available for comparison. To at least partially fill the information void in MBES testing, the Multibeam Advisory Committee (MAC), a U.S. National Science Foundation-funded program, has compiled a publicly available database with a web application of MBES test sites that the MAC and other partner organizations have previously used. However, as the MAC conducts most MBES tests from U.S. ports, we are looking to the MBES community at large to contribute worldwide sites for inclusion into the database for all operators to access.

#### How do I access the WebApp?



The prototype multibeam echosounder system (MBES) test site WebApp can be accessed through the University of New Hampshire's Center for Coastal and Ocean Mapping (CCOM) GIS Portal (<https://gis.ccom.unh.edu>).

#### Multibeam Test Site WebApp

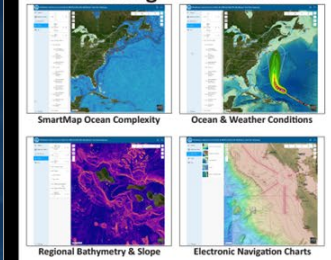


The test site WebApp will open with a default view showing the GEBCO 2023 bathymetry data overlaid with the center locations of all historic MBES test sites that have been contributed to the database. Users can pan and zoom, enable different auxiliary layers and basemaps, and query the layers shown.

Where should I plan my MBES test?

Please contribute your test sites to:  
[mac-help@unh.edu](mailto:mac-help@unh.edu)

#### Planning Information



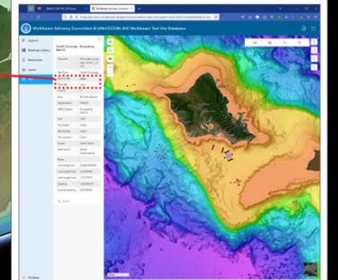
Users can easily interact with the many different types of auxiliary planning layers including: regional bathymetry, slopes, & backscatter data, ocean & weather conditions, and navigational charts. This list is easily expandable by simply adding any publicly available web service to app. Currently under development are bathymetry "image services" which will allow users to interact and query the depths for potential sites.

#### Reports & Planning Files



Users are provided easy access to test site reports and/or planning files (line files, acquisition parameters, time estimates, etc.).

#### Historic Test Sites



As a user "zooms in", higher resolution bathymetry layers will become visible and the test site center locations will transition to show the historic MBES test plan lines. Clicking on a line file will then show all available metadata for the test and will have links to download additional information.



Check out the WebApp at:  
<https://ccom.unh.edu/gis/maps/TestSites>  
- or - <https://gis.ccom.unh.edu>



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# Ocean Mapping Community Wiki

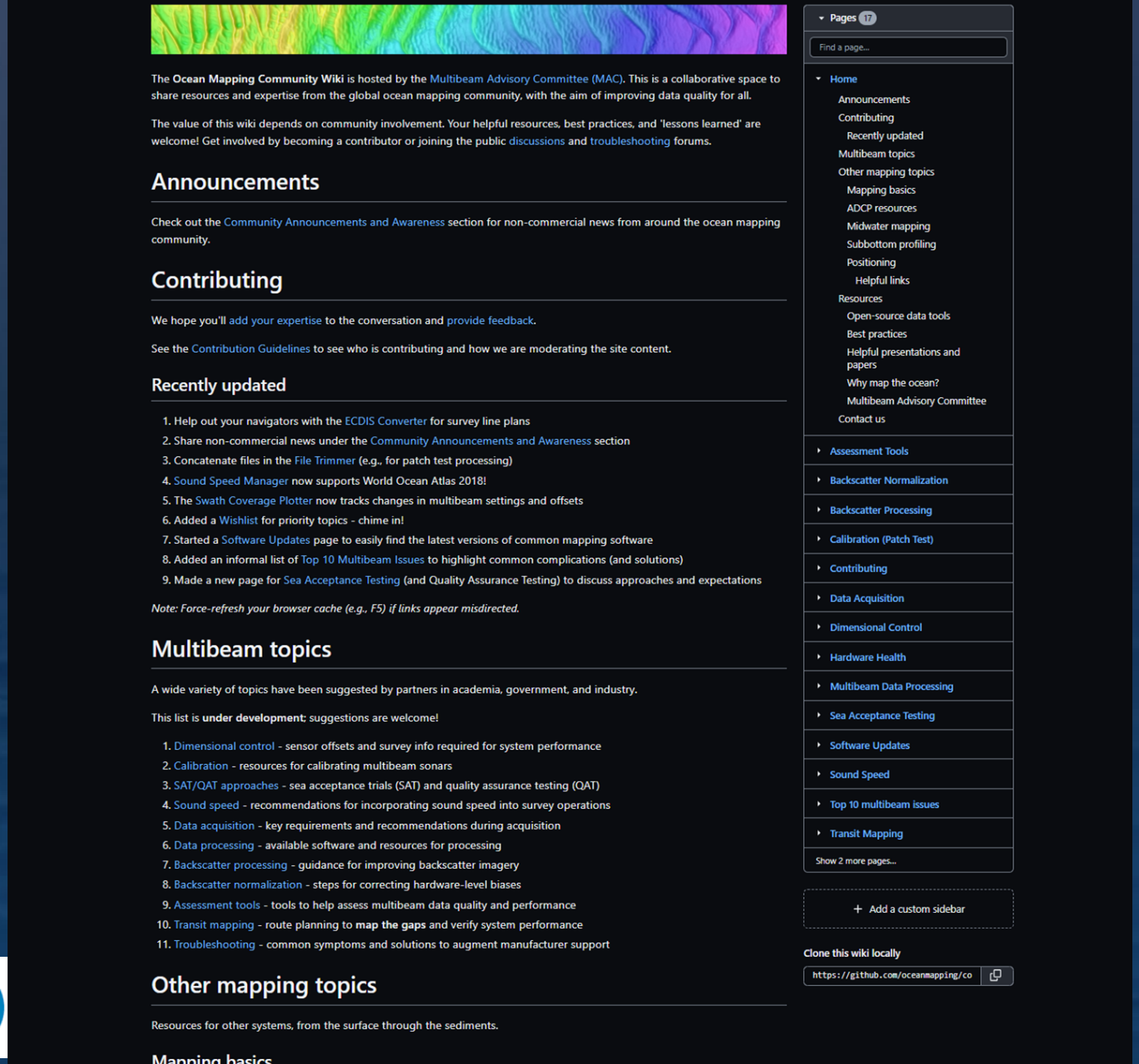
[github.com/oceanmapping/community/wiki](https://github.com/oceanmapping/community/wiki)

## What it aims to be:

1. Public resource with context and references
2. Easily updated and expanded
3. Platform for discussion / troubleshooting
4. Welcoming, accessible, and respectful
  - a. Admins from MAC, NOAA, and industry

## What it will not be:

1. SOP repository (see **Ocean Best Practices!**)
2. Replacement for manufacturer guidance
3. Promotional, preferential, or judgemental



The screenshot shows the homepage of the Ocean Mapping Community Wiki. At the top, there is a colorful bathymetric map. Below it, a paragraph explains that the wiki is hosted by the Multibeam Advisory Committee (MAC) and is a collaborative space for sharing resources and expertise. A second paragraph states that the value of the wiki depends on community involvement and that users are welcome to get involved by becoming contributors or joining discussions and forums.

### Announcements

Check out the [Community Announcements and Awareness](#) section for non-commercial news from around the ocean mapping community.

### Contributing

We hope you'll add your expertise to the conversation and provide feedback.

See the [Contribution Guidelines](#) to see who is contributing and how we are moderating the site content.

### Recently updated

1. Help out your navigators with the [ECDIS Converter](#) for survey line plans
2. Share non-commercial news under the [Community Announcements and Awareness](#) section
3. Concatenate files in the [File Trimmer](#) (e.g., for patch test processing)
4. [Sound Speed Manager](#) now supports World Ocean Atlas 2018!
5. The [Swath Coverage Plotter](#) now tracks changes in multibeam settings and offsets
6. Added a [Wishlist](#) for priority topics - chime in!
7. Started a [Software Updates](#) page to easily find the latest versions of common mapping software
8. Added an informal list of [Top 10 Multibeam Issues](#) to highlight common complications (and solutions)
9. Made a new page for [Sea Acceptance Testing](#) (and Quality Assurance Testing) to discuss approaches and expectations

*Note: Force-refresh your browser cache (e.g., F5) if links appear misdirected.*

### Multibeam topics

A wide variety of topics have been suggested by partners in academia, government, and industry.

This list is **under development**; suggestions are welcome!

1. [Dimensional control](#) - sensor offsets and survey info required for system performance
2. [Calibration](#) - resources for calibrating multibeam sonars
3. [SAT/QAT approaches](#) - sea acceptance trials (SAT) and quality assurance testing (QAT)
4. [Sound speed](#) - recommendations for incorporating sound speed into survey operations
5. [Data acquisition](#) - key requirements and recommendations during acquisition
6. [Data processing](#) - available software and resources for processing
7. [Backscatter processing](#) - guidance for improving backscatter imagery
8. [Backscatter normalization](#) - steps for correcting hardware-level biases
9. [Assessment tools](#) - tools to help assess multibeam data quality and performance
10. [Transit mapping](#) - route planning to map the gaps and verify system performance
11. [Troubleshooting](#) - common symptoms and solutions to augment manufacturer support

### Other mapping topics

Resources for other systems, from the surface through the sediments.

### Mapping basics

Pages 17

Find a page...

- Home
  - Announcements
  - Contributing
    - Recently updated
  - Multibeam topics
  - Other mapping topics
  - Mapping basics
  - ADCP resources
  - Midwater mapping
  - Subbottom profiling
  - Positioning
    - Helpful links
  - Resources
    - Open-source data tools
    - Best practices
    - Helpful presentations and papers
    - Why map the ocean?
    - Multibeam Advisory Committee
    - Contact us
- Assessment Tools
- Backscatter Normalization
- Backscatter Processing
- Calibration (Patch Test)
- Contributing
- Data Acquisition
- Dimensional Control
- Hardware Health
- Multibeam Data Processing
- Sea Acceptance Testing
- Software Updates
- Sound Speed
- Top 10 multibeam issues
- Transit Mapping

Show 2 more pages...

+ Add a custom sidebar

Clone this wiki locally

<https://github.com/oceanmapping/co>



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# Ocean Mapping Community Wiki

[github.com/oceanmapping/community/wiki](https://github.com/oceanmapping/community/wiki)

[omcadmin@ccom.unh.edu](mailto:omcadmin@ccom.unh.edu) or [mac-help@unols.org](mailto:mac-help@unols.org)

## All mappers and managers are invited to contribute

oceanmapping / community

Type to search

Code Issues 8 Pull requests Discussions Actions Projects Wiki Security Insights

Filters is:issue is:open Labels 45 Milestones 0 New issue

8 Open 21 Closed

Issue	Author	Label	Projects	Milestones	Assignee	Sort
<input type="checkbox"/> <b>CBMF 1: Timed out waiting for samples</b> #45 opened 3 weeks ago by kvonkrusenstiernOX						1
<input type="checkbox"/> <b>Real-time coverage grid stops updating in Kongsberg SIS</b> #39 opened on Jun 13 by ejheffron		gridding kongsberg sis4 sis5				3
<input type="checkbox"/> <b>Inmarsat C interference with POS MV GNSS antennas</b> #38 opened on May 25 by kjerram		applanix dropout gnss hardware inmarsat pos mv				1
<input type="checkbox"/> <b>GSF issues/limitations</b> #37 opened on Apr 12 by ejheffron		data processing em304 gsf qimera				5
<input type="checkbox"/> <b>Helmsman Tool does not work in UTM Projection</b> #36 opened on Apr 6 by shoy-NOAA						
<input type="checkbox"/> <b>ALL USERS: Become a collaborator on GitHub for Issue tagging and notification options</b> #32 opened on Mar 27 by kjerram						
<input type="checkbox"/> <b>Qimera distances are always grid distances</b> #31 opened on Mar 24 by lindsaymbc		bug data processing qimera				
<input type="checkbox"/> <b>ALL USERS: Clear the search bar to see ALL ISSUES!</b> #21 opened on Oct 19, 2022 by kjerram		doh! wontfix				

### Welcome

Welcome to the Ocean Mapping Community Wiki!

Thank you for contributing your expertise and experience.

As with the rest of the wiki, these Contribution Guidelines are in development to help establish a high degree of relevance and ease-of-use.

In all cases, we seek to follow the Code of Conduct and GitHub Community Guidelines

### Scope

It is important to consider the scope of the wiki so its content is relevant and easily maintained. Suggested topics for multibeam and other systems have been added by the first contributors, highlighting some areas of common interest.

The intent is to point users, new and expert, toward the most helpful and up-to-date resources so they can make informed decisions about installation, operation, and processing. It is not meant to be prescriptive for any particular system or insist on any 'one size fits all' approach.

Content should:

1. Apply broadly for mapping operations
2. Highlight examples of successful use cases
  - i. Show us how you did it!
3. Discuss limitations or caveats of an approach
4. Protect IT security and sensitive information
5. Respect the expertise of others and differences among programs

Troubleshooting steps are also of interest for solving common issues.

### Adding and editing content

#### Through GitHub

Please contact us to be added as a GitHub collaborator.

1. Review the existing topics to see where your content fits.
2. Whenever possible, expand on existing topics and add sub-topics to existing pages.
  - i. As the site grows, we will reorganize as necessary to improve clarity or context.
3. Add or edit content directly with the GitHub wiki editing features
  - i. Check out GitHub's quick guides for adding or editing wiki pages and basic syntax to get started
4. Images require URLs; upload images from your computer to the wiki repository (Code --> Add file) to generate a URL
5. Wherever possible, link to resources (e.g., SOPs) hosted by others rather than uploading separate copies to the repository
  - i. This will simplify updates as new versions of these documents are released

Remember this is new for many of us and we are excited for your contributions!

#### Contact us

You don't have join GitHub to contribute. Please reach out to any of the wiki managers with the content or updates you'd like to see.

### Support

Helpful resources from GitHub and others:

1. Writing on GitHub
2. Using wikis
3. Markdown cheatsheet
4. Using GitHub Issues for troubleshooting
5. Resizing images in articles
6. Add other resources you like!

### Home

Contributing

Contribution Guidelines

Multibeam topics

Other mapping topics

Mapping basics

ADCP resources

Midwater mapping

Subbottom profiling

Positioning

Helpful links

Resources

Open-source data tools

Best practices

Helpful presentations

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Contact us

Assessment Tools

Backscatter Normalization

Backscatter Processing

Calibration (Patch Test)

Contributing

Data Acquisition

Dimensional Control

Multibeam Data Processing

Sound Speed

Transit Mapping

Troubleshooting

Water Column Mapping



# Ocean Mapping Community Wiki

[github.com/oceanmapping/community/wiki](https://github.com/oceanmapping/community/wiki)

[omcadmin@ccom.unh.edu](mailto:omcadmin@ccom.unh.edu) or [mac-help@unols.org](mailto:mac-help@unols.org)

## Assessment Tools

kjerram edited this page on Apr 6 · 40 revisions

## Overview

Multibeam assessment tools described here include:

1. Swath Coverage Plotter v0.2.3
2. Swath Accuracy Plotter v0.1.0
3. BIST Plotter v0.2.2
4. File Trimmer v0.1.5
5. ECDIS Converter v0.0.3

## Distribution

The standalone Python apps are available through several avenues for different users:

1. **Typical users:** each app is packaged with all libraries and zipped for easy download on [Google Drive](#) (with [version notes](#)).
  - i. Just download, unzip, and run the .exe (similar to Sound Speed Manager).
  - ii. The zipped packages are not available through GitHub due to file size limits.
2. **GitHub users:** apps and libraries are packaged in the [multibeam\\_tools\\_distribution](#) repository.
  - i. Due to GitHub's file size limits, these are not zipped and may be more cumbersome to download for normal use.
3. **Python folks:** source code is available in the [multibeam\\_tools](#) repository.

## Using the tools

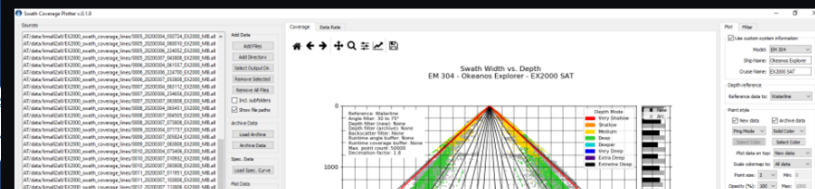
These tools are intended to give users the same plotting and reporting functions used by the MAC for routine performance testing (e.g., sea acceptance trials and quality assurance testing). Currently, only Kongsberg data formats are supported.

**Hint: Most of the app features include tooltips; just hover over a button, list, or checkbox to get more information!**

Instructions for data acquisition and processing are presented in the following sections. Suggestions are welcome for improving the workflow in each application.

## Swath Coverage Plotter

The swath coverage plotter extracts the outermost soundings (flagged 'valid') and plots these with a variety of filtering and plotting options. Currently only .all and .kml are supported.



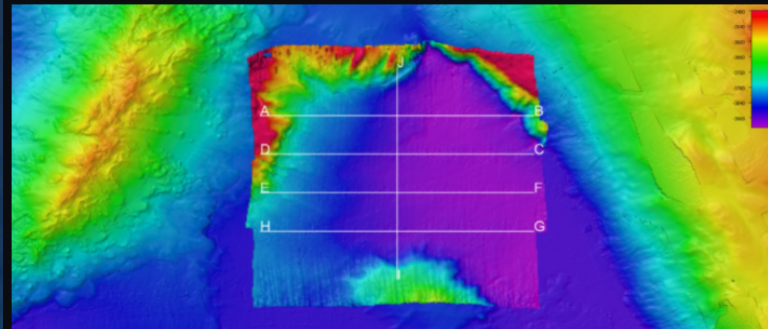
## Reference survey acquisition

The reference survey should be planned over relatively flat, benign, homogenous seafloor with slopes no greater than a few degrees. Because the selected depths will likely be used for testing several different modes, the area may also be suitable for backscatter normalization across those modes [wiki development: add link to BS normalization section when complete].

The reference survey lines are planned with a few key considerations:

1. Orientation orthogonal to the crossline (or as a 'grid' if time allows)
  - i. This reduces alignment of any swath biases in the reference grid with the crosslines
2. Narrow spacing (e.g., 1 WD) to achieve very high sounding density
3. Length sufficient to cover the full crossline swath width (e.g., 6-8 WD, with buffer for ship handling)
  - i. Typically 6-10 reference lines at 1 WD spacing, depending on depth, to yield several hundred crossline pings
4. Number of reference lines to accommodate desired crossline length

Small regions of steeper slopes may be filtered during processing, if present (e.g., the 3900 m reference site off San Diego, below). Likewise, the number of lines may be adjusted to fit the terrain and the schedule.

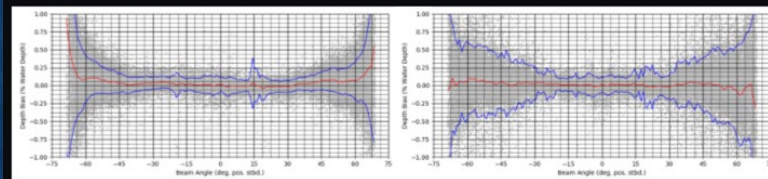


## Crossline data acquisition

The primary crossline setting of interest should be the same used for the reference survey; ideally, this is a setting that would be selected automatically by the multibeam system for this depth. This provides a consistent comparison between the 'trusted' bathymetry created from a dense survey and the single-pass crossline(s) for the mode that is intended for this terrain.

As discussed in the [planning constraints](#), there may be several modes of interest that have been grouped for this reference surface depth. Additional crosslines are added as needed and allowed by the ship schedule.

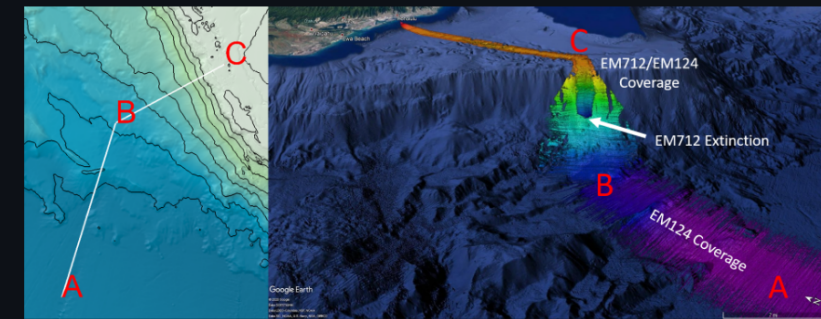
Crosslines are typically run in 'pairs' on opposite headings for each mode to assess any heading-dependent impacts, such as sea state (example below shows accuracy heading with seas and into seas shown on top and bottom, respectively). When seas are calm, this approach also supports deep roll verification using pairs of lines with the same mode and settings on opposite headings over the flat terrain.



## Data collection

Ideally, swath coverage test data is collected under vessel operating parameters (e.g., speed, engine lineup, active sensors) that reflects 'typical' mapping configurations. For example, transit data collected at 12 kts with additional engines or generators online may not reflect the flow and machinery noise environment present at a typical mapping speed of 8 kts. Additional acoustic sensors (e.g., a bridge Doppler speed log) may cause interference and outliers in the coverage data that do not represent the standard mapping configuration with those sensors secured. Likewise, highly elevated sea state may not represent suitable mapping conditions.

The MAC recommends acquiring coverage test data at typical mapping speeds (e.g., 8-10 kts) and crossing contours at perpendicular angles wherever possible. Maintaining the ship heading directly up and down the slope is important for reducing coverage biases on either side of the swath that may result from the slope facing toward or away from the system. A coverage test line off HI for the R/V *Roger Revelle* EM124 / EM712 SAT is shown as an example of transiting 'up' and 'down' the major seafloor slopes in order to reduce port / starboard coverage biases across a wide depth range (~100-4000 m). In this example, the transit from waypoint A toward port was routed through waypoints B and C to cross contours more perpendicularly; this small amount of additional transit time produced much more useful data for coverage assessment.



## Runtime parameters

The purpose of testing is to let the multibeam system achieve its maximum coverage under the mode it selects automatically for the given depth.

The following settings are generally recommended for Kongsberg EM systems to best illustrate 'automatic' system performance. Vessels that use different parameters during routine mapping should apply those settings where appropriate, aside from the maximum angle, coverage, and depth gates that may inadvertently limit the coverage test data.

Parameter	Recommended	Notes
Depth mode	Automatic	
Dual swath	Dynamic	
FM Transmission	Enabled	Read checkbox carefully <sup>1</sup>
Max angles	75°/75°	70°/70° for some systems
Max coverage	Maximum	Varies by model
Depth limits	As needed	Adjust as needed <sup>2</sup>
TX power	Maximum	0 dB

# Ocean Mapping Community Wiki

[github.com/oceanmapping/community/wiki](https://github.com/oceanmapping/community/wiki)

[omcadmin@ccom.unh.edu](mailto:omcadmin@ccom.unh.edu) or [mac-help@unols.org](mailto:mac-help@unols.org)

## Sensors

Manufacturers define sensor reference points that must be interpreted correctly when configuring that sensor's software.

As with axis and sign conventions, misinterpretation of these definitions will cause data quality issues that cannot always be addressed in post-processing.

Reference points are presented below for several common sensors (alphabetical order). All units are meters unless otherwise noted.

TABLE IN DEVELOPMENT; GitHub-flavored Markdown experts welcome!

It is always recommended to confirm these conventions with the most recent manufacturer documentation. Sources are linked if publicly available; otherwise, please consult the manufacturer.

Transducer	Reference Point	Source
Kongsberg TX/RX arrays	Center of array face <sup>1</sup>	Kongsberg manual
Kongsberg EM2040 portable	[Pending review] <sup>2</sup>	Kongsberg manual
Norbit		
Reson T20/T50	Sonar ref. point (see manual) <sup>3</sup>	Reson T-Series manual
Reson 7125		
Reson 7160	Sonar ref. point (see manual) <sup>3</sup>	Reson 7160 manual
R2Sonic	Acoustic centers of TX (horiz.) / RX (vert.)	R2Sonic knowledgebase
Simrad EK80	Center of array face	Simrad manual (?)
Motion Sensor	Reference Point	Source
Applanix IMU	Target on housing	Applanix manual <sup>4</sup>
iXBlue PHINS IMU	Sensing center	
Seapath MRU 5+	Target on housing	Seapath manual <sup>5</sup>
Antenna	Reference Point	Source
AeroAntenna	Notch 1.90 inch above base	Antenna 'notch' specification
Trimble (AeroAntenna) AT1675-540-TS	Phase center 57.75 mm above base	Antenna specification
Trimble GA830	Phase center 88.8 mm above base	Antenna specification
NovAtel GNSS-850	Phase center 51.7 mm above base	Antenna diagram <sup>6</sup>
NovAtel GPS-702-GG	Phase center 66.0 mm (L1) above base	NovAtel GPS-702/701 User Guide
NovAtel GPS-702-GGG	Phase center 65.0 mm above base	
NovAtel GPS-713-GGG-N	Phase center 61.5 mm (L1) above base	Antenna specification
Waterline	Reference Point	Source
Kongsberg	WL from origin meters positive down	Kongsberg manual
PPS Output	Edge Configuration	Source
Applanix POS MV	Falling edge	Applanix manual
Seapath	Rising edge	Seapath 320 manual

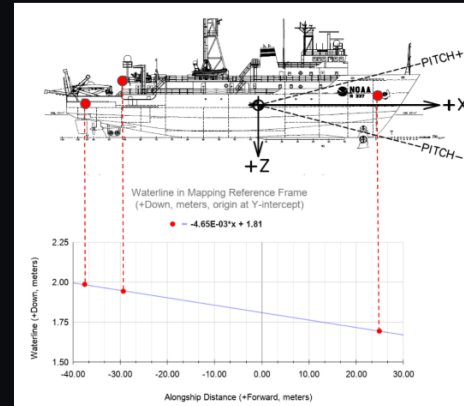
1. For all EM models, including most EM2040 (narrow beamwidths / large arrays); need to verify for arrays with ice protection
2. Need to verify whether all EM2040 models use separate array offsets or if some use a bracket location

## Waterline

If survey data are to be referenced to the water level (regardless of later tide correction), then the waterline on the vessel must be measured and configured appropriately in the mapping system reference frame.

The conventions for measuring and configuring waterline vary, and waterline naturally changes with loading and location around the hull. For many applications, it is sufficient to estimate waterline using draft marks or sight tubes and converting these into a 'best-fit' water level around the vessel; this yields the waterline offset at the location required by the mapping system.

For instance, Kongsberg requires the Waterline parameter in meters, positive down from the origin. The example shows a best-fit line through water level measurements taken from surveyed benchmarks around the hull, yielding the waterline offset of +1.80 m at the mapping system origin.



The approach outlined above, translating water levels measured from benchmarks into the mapping system frame, is typically sufficient for deepwater mapping referenced to the water level. However, shallow water configurations may require more detailed waterline estimates with consideration for dynamic draft (if not referenced to the ellipsoid).

## Survey reports

It is common for a single survey report to be referenced routinely for the entire service life of a multibeam mapping system. When sensors are moved or replaced, the original survey is used to re-establish the vessel frame and tie in new equipment.

Keeping this in mind, the costs of a high-quality initial survey and clear report are relatively small compared to the ship (and human) time spent acquiring and processing reduced-quality data. In some cases, the vessel must be dry-docked to repeat the survey for proper mapping system configuration.

## Recommendations

The MAC developed a set of recommendations for mapping vessel survey reports based on a wide array of experiences interpreting these documents. This guide is intended to help the surveyor ensure that their final report can be easily and correctly interpreted by the vessel operator to reduce windows of opportunity for error in translation, as well as serve as a clear foundation for future vessel surveys in the years ahead.

The recommendations address a few common pitfalls:

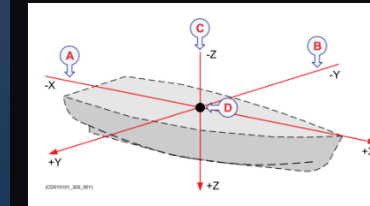
1. even 'good' survey results (meeting the manufacturer's requirements) are reported with ambiguous, inconsistent, or incorrect axis and sign conventions;
2. the mapping system reference frame and sensor reference points are not clearly identified;
3. the report lacks photos or diagrams of the measured locations, leading to errors in interpretation;
4. mapping systems are sometimes configured using 'draft' reports before errors are discovered (e.g., when a final report is not available before sea acceptance trials).

The MAC welcomes other user experiences and recommendations related to mapping system survey reports.

## Axis and Sign Conventions

Manufacturers define axis and sign conventions that *must be applied correctly* when interpreting survey reports and configuring software. Misinterpretation of these conventions will cause data quality issues that cannot always be addressed in post-processing.

For example, the Kongsberg reference frame convention is presented below.



Axis and sign conventions are presented below for several hardware manufacturers (alphabetical order). All units are meters and degrees unless otherwise noted.

It is always recommended to confirm these conventions with the most recent manufacturer documentation. Sources are linked if publicly available; otherwise, please consult the manufacturer.

System	+X	+Y	+Z	+Roll	+Pitch	+Heading	+Heave	+Waterline	Source
Applanix	FWD	STBD	DOWN	PORT UP	BOW UP	COMPASS	DOWN	N/A	POS MV V5 Guide (Rev. 4) secs. 2-31, 5-8
iXBlue <sup>1</sup>	FWD	PORT	UP	PORT UP	BOW DOWN	COMPASS	N/A <sup>4</sup>	N/A	PHINS Manual (Rev. Q) pp. 42-45
Kongsberg	FWD	STBD	DOWN	PORT UP	BOW UP	COMPASS	N/A <sup>4</sup>	DOWN <sup>5</sup>	EM Installation Manual p. 140
Reson <sup>2</sup>	STBD	FWD	UP	PORT UP	BOW UP	COMPASS	N/A <sup>4</sup>	UP <sup>6</sup>	Teledyne PDS p. 117, Calibration p. 20
Seapath	FWD	STBD	DOWN	PORT UP	BOW UP	COMPASS	DOWN	N/A	MRU 5+ Installation Manual (Rev. 8) pp. 33, 146
Simrad <sup>3</sup>	FWD	STBD	DOWN	PORT UP	BOW UP	COMPASS	N/A <sup>4</sup>	DOWN <sup>7</sup>	EK80 Manual, Transducer Installation
Software	+X	+Y	+Z	+Roll	+Pitch	+Heading	+Heave	+Waterline	Source
Caris HIPS/SIPS	STBD	FWD	DOWN	PORT UP	BOW UP	COMPASS	(needed)	(needed)	Caris HIPS/SIPS v8.1 manual
QPS Qimera	FWD	STBD	UP	PORT UP	BOW UP	COMPASS	DOWN	Draft and HADR <sup>8</sup>	Qimera v2.5 manual

1. iXBlue alongship (X), athwartship (Y), and vertical (Z) axes are named '1', '2', and '3', respectively.
2. Reson conventions may differ between models and documents (e.g., T50 dual-head drawings are +X forward, +Y starboard, Z+ down)
3. Simrad rotations are assumed to follow the right-hand rule (as do Seapath and other Kongsberg products)





# Ocean Mapping Community Wiki

[github.com/oceanmapping/community/wiki](https://github.com/oceanmapping/community/wiki)

[omcadmin@ccom.unh.edu](mailto:omcadmin@ccom.unh.edu) or [mac-help@unols.org](mailto:mac-help@unols.org)

## Discussions

The screenshot shows the 'Discussions' page of the Ocean Mapping Community Wiki. At the top, there is a navigation bar with options like 'Code', 'Issues', 'Pull requests', 'Discussions', 'Projects', 'Wiki', 'Security', 'Insights', and 'Settings'. Below this is a purple banner with the text 'Community Announcements and Awareness Welcome to community Discussions!' and a notification bell icon. A search bar is present with the text 'Search all discussions'. On the left, there is a 'Categories' sidebar with options like 'View all discussions', 'Community Announcements and Awareness', 'General', 'Ideas', 'MBCourse', 'Polls', 'Q&A', 'Show and tell', 'SIS 5', and 'Troubleshooting'. The main content area is titled 'Discussions' and lists several discussion topics, each with a title, author, and date. The topics include 'Recordings of TSCOM GEBCO Listening Sessions (Feb 27 - March 1)', 'Standard Ocean Mapping Protocol (SOMP) DRAFT is open for public comment', 'Multibeam Course: Outreach and Follow-up', 'SIS 5 v5.9.3', 'Requests for Wiki Content', 'New Tools', 'TESTING DISCUSSION WORKFLOW: Erik's Horns (Railroad Tracks)', and 'Welcome to community Discussions!'.

## Troubleshooting

The screenshot shows the 'Issues' page of the Ocean Mapping Community Wiki. At the top, there is a navigation bar with options like 'Code', 'Issues', 'Pull requests', 'Discussions', 'Projects', 'Wiki', 'Security', 'Insights', and 'Settings'. Below this is a banner with the text 'Label issues and pull requests for new contributors' and 'Now, GitHub will help potential first-time contributors discover issues labeled with good first issue'. A 'Go to Labels' button is visible. A search bar is present with the text 'Search all issues'. Below the search bar, there is a table of issues. The table has columns for 'Filters', 'Search all issues', 'Labels (32)', 'Milestones (0)', and 'New issue'. The table lists several issues, each with a title, author, and date. The issues include 'EM304 mistracking up and down slopes', 'No pings', 'EM304 ping dropouts related to ship satellite network interruptions', 'ALL USERS: Clear the search bar to see ALL ISSUES!', 'EM122 soundings rejected for outer region of second swath', 'EM2040 RX Unit BIST / power supply failure', 'EM Processing Unit (PU) powers up but does not boot', 'SIS Bugs (5.9.3 and 5.10.1)', 'EM124 TXU periodically losing connection to PU', 'Excessive BPDU packets on EM multibeam network', 'Valeport surface sound speed format for SIS 5.7.0+', and 'Parameters windows (and other menus) not showing in SIS 5.9.3'.

## Contributing

The screenshot shows the 'Contributing' page of the Ocean Mapping Community Wiki. At the top, there is a navigation bar with options like 'Code', 'Issues', 'Pull requests', 'Discussions', 'Projects', 'Wiki', 'Security', 'Insights', and 'Settings'. Below this is a banner with the text 'Contributing' and 'Hayley Drennon edited this page 3 weeks ago · 7 revisions'. A 'New page' button is visible. The main content area is titled 'Contributing' and contains a 'Welcome' section, 'Contribution Guidelines', and a 'Wish list'. The 'Welcome' section says 'The Ocean Mapping Community Wiki is a public resource that will serve students, technicians, and scientists on ships all over the globe - and benefit from their contributions. It is intended to augment other platforms for sharing best practices across the ocean science community. To ensure the accuracy and utility of content, contributors must be first verified by the Admins prior to adding content. We encourage community members with relevant experience and expertise to become Contributors. The Admins will also monitor new content for accuracy.' The 'Contribution Guidelines' section says 'The Contribution Guidelines provide details on how to add and edit content. [These sections may be restored as wiki articles, pending discussion / user feedback]'. The 'Wish list' section says 'The topics below are high priority for development; some may have placeholders or suggestions for content. Sections can start small and snowball, so reach out if you'd like to contribute!'. The 'Wish list' contains a list of items: 1. Recommendations for backscatter processing: tips, tricks, workflows, processing guides... 2. Bathymetry processing - what's on your mind? i. Guidelines for gridding approaches / expectations for data quality ii. When to worry about IHO compliance / relevance iii. Approaches for 'fixing' 'bad data' 3. Expanding the GitHub Issues base with troubleshooting examples from more users 4. Multibeam data acquisition recommendations i. Synchronization - when is it needed? a. Grid chart of system combinations, color-coded by interference (present / not present / uncertain) 5. Water column mapping resources i. Target strength (sphere) calibration guides a. When, why, and how to do these? b. Table of spheres required for each frequency range 6. Amazing data examples! i. Every page --> highlight exciting data examples / new and unexpected uses for mapping systems 7. Recommendations on how to improve the wiki workflow



# Ocean Mapping Community Wiki

[github.com/oceanmapping/community/wiki](https://github.com/oceanmapping/community/wiki)

[omcadmin@ccom.unh.edu](mailto:omcadmin@ccom.unh.edu) or [mac-help@unols.org](mailto:mac-help@unols.org)

## Discussions

## Troubleshooting

## Contributing

oceanmapping / community Public

Community Announcements and Awareness  
Welcome to community Discussions!

Search all discussions

Categories

- View all discussions
- Community Announcements and Awareness
- General
- Ideas
- MBCourse
- Polls
- Q&A
- Show and tell
- SIS 5
- Troubleshooting

Most helpful

- TESTING DISCUSSION WORKFLOW: Erik's Horns (Railroad Tracks)
- Welcome to community Discussions!

oceanmapping / community Public

Label issues and pull requests for new contributors

Filters

Issues

- EM Processing Unit (PU) powers up but does not boot
- SIS Bugs (5.9.3 and 5.10.1)
- EM124 TXU periodically losing connection to PU
- Excessive BPDU packets on EM multibeam network
- Valeport surface sound speed format for SIS 5.7.0+
- Parameters windows (and other menus) not showing in SIS 5.9.3

oceanmapping / community Public

Contributing

Welcome

The Ocean Mapping Community Wiki is a public resource that will serve students, technicians, and scientists on ships all over the globe - and benefit from their contributions. It is intended to augment other platforms for sharing best practices across the ocean science community.

To ensure the accuracy and utility of content, contributors must be first verified by the Admins prior to adding content. We

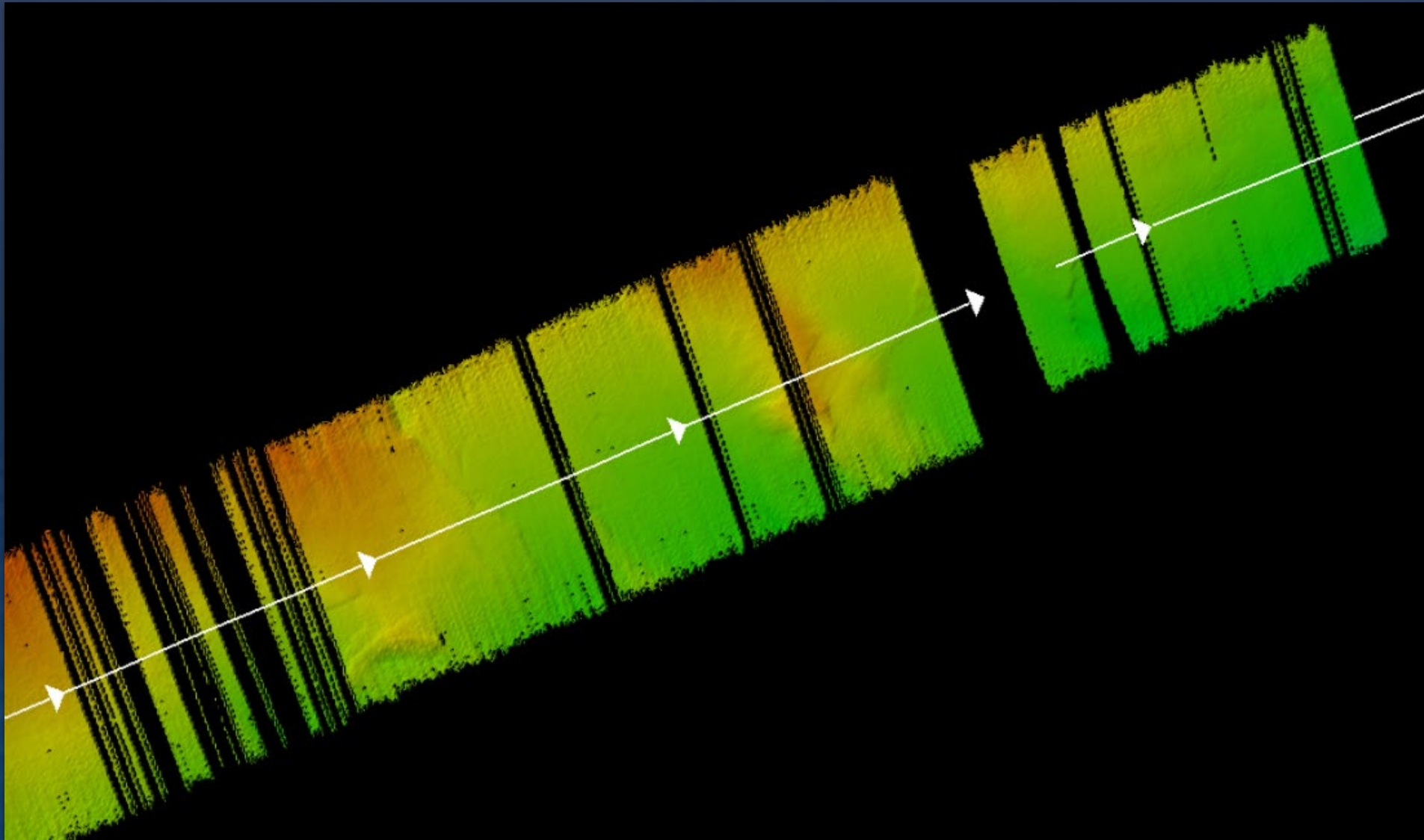
- Guidelines for granting approvals / expectations for user query
- When to worry about IHO compliance / relevance
- Approaches for fixing 'bad data'
- Expanding the GitHub Issues base with troubleshooting examples from more users
- Multibeam data acquisition recommendations
  - Synchronization - when is it needed?
    - Grid chart of system combinations, color-coded by interference (present / not present / uncertain)
  - Water column mapping resources
    - Target strength (sphere) calibration guides
      - When, why, and how to do these?
      - Table of spheres required for each frequency range
- Amazing data examples!
  - Every page --> highlight exciting data examples / new and unexpected uses for mapping systems
- Recommendations on how to improve the wiki workflow

*What is ONE mapping resource or answer you found (or wish you had) in the last year?*

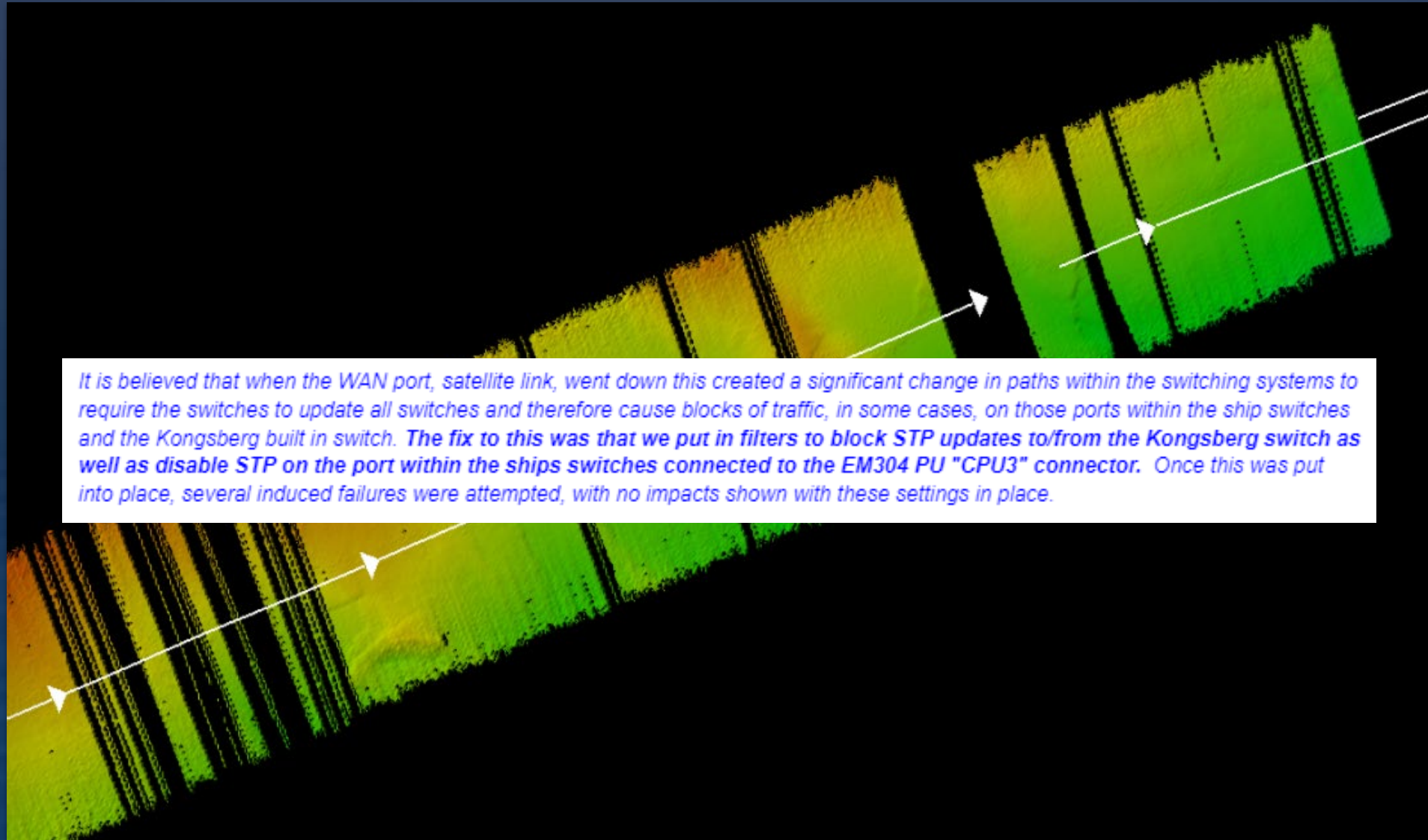




# Example from the Wiki: EM304 Dropouts



# Example from the Wiki: EM304 Dropouts





# Example from the Wiki: EM304 Dropouts

oceanmapping / community Public

Edit Pins Unwatch 10 Fork 1

<> Code Issues 1 Pull requests Discussions Projects Wiki Security Insights Settings

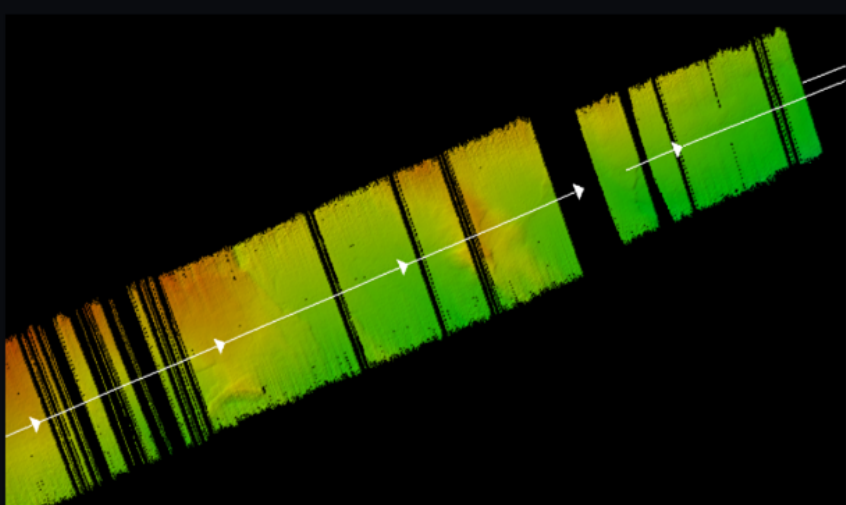
## EM304 ping dropouts related to ship satellite network interruptions #22

Closed kjerram opened this issue 6 minutes ago · 0 comments

kjerram commented 6 minutes ago · edited Member

**Context:**  
NOAA Ship Okeanos Explorer with EM304 MKII and POS MV/Seapath navigation inputs.

**Symptoms:**  
The EM304 intermittently and unpredictably stops pinging / tracking seafloor, leaving large data gaps of variable duration. Logging continues as normal (no file increment).



**Troubleshooting:**  
Extensive troubleshooting was conducted by the EX team on board in communication with Kongsberg support in Norway. Multiple software and firmware updates were applied with no improvement.

The PU ethernet switch firmware was updated to v1.40 to address an issue with excessive BPDUs (#15)

EM dropouts were found to correlate with brief VSAT satellite internet outages, suggesting a broader ship network interruption impacting the EM network.

**Solution:**  
The relationship between VSAT interruptions and EM network dropouts was traced to the on-board network's spanning tree protocol (STP).

Assignees: kjerram

Labels: data quality em304 hardware kongsberg ship network sis5

Projects: None yet

Milestone: No milestone

Development: Create a branch for this issue or link a pull request.

Notifications: Unsubscribe

1 participant: kjerram

Lock conversation Pin Comment Transfer issue Convert to discussion Delete issue

## Excessive BPDUs on EM multibeam network #15

Closed kjerram opened this issue on Jul 5, 2022 · 1 comment

kjerram commented on Jul 5, 2022 Member

Information provided by Mary Huey (SIO).

**Context / symptoms:**

- The ship's networks experienced excessive traffic of BPDUs originating from the CPU3 port on the PU (EM124 on Sally Ride).

kjerram added bug kongsberg sis5 ship network labels on Jul 5, 2022

kjerram self-assigned this on Jul 5, 2022

kjerram commented on Jul 5, 2022 Member Author

Solution provided by Mary Huey (SIO) after discussion with Kongsberg technical support.

- Make sure EM switches have latest firmware (v1Wss-1.40). Earlier versions may have a bug that allows settings to be wiped.
- Go to C:\Program Files\Kongsberg Maritime\EMSystem\K-Controller\PU\EM124\Update\Support\Vada\_Tech and follow the setup guide for CP219.

Kongsberg technical support can provide a PDF of how switches should be set up.

kjerram closed this as completed on Jul 5, 2022

kjerram mentioned this issue on Nov 3, 2022

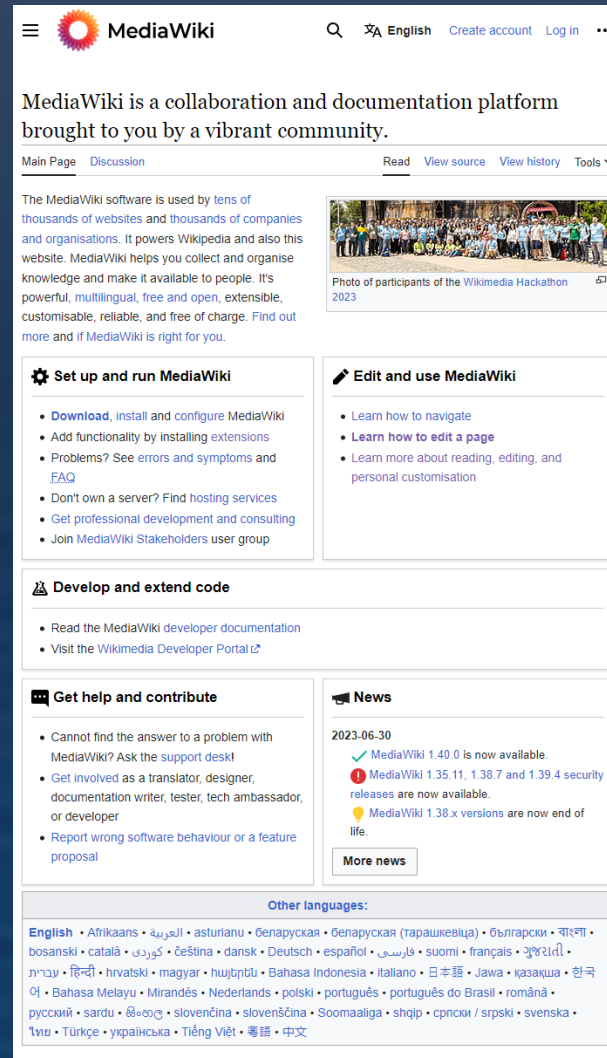
EM304 ping dropouts related to ship satellite network interruptions #22 Closed

# Ocean Mapping Community Wiki

**COMING SOON... a better wiki framework!**

## Testing MediaWiki with new URL

1. Widely adopted (e.g., Wikipedia)
2. Free and open-source
3. Designed for broad user base
4. Easy transfer of GitHub content



## Main Page

From Ocean Mapping Community Wiki

**NOTE: This is a TEST SITE** for consideration of WikiForge as a platform, migrating content from the existing wiki on GitHub (adapting from markdown to wikitext). Many links still connect to GitHub for now as we test importing additional content and explore the options for hosting Issues, Discussions, and other features currently available on the GitHub-based wiki.



### Welcome

The Ocean Mapping Community Wiki is hosted by the [Multibeam Advisory Committee \(MAC\)](#). This is a collaborative space to share resources and expertise from the global ocean mapping community, with the aim of improving data quality for all.

The value of this wiki depends on community involvement. Your helpful resources, best practices, and 'lessons learned' are welcome! Get involved by becoming a contributor or joining the [public discussions](#) and [troubleshooting](#) forums.

### Announcements

Check out the [Community Announcements and Awareness](#) section for non-commercial news from around the ocean mapping community.

### Contributing

We hope you'll [add your expertise](#) to the conversation and [reach out](#) with any questions or suggestions.

See the [Contribution Guidelines](#) to see who is contributing and how we are moderating the site content.

### Recently updated

1. Stay tuned for an official move to [www.oceanmapping.wiki!](#)
2. We're currently seeking feedback on more robust wiki frameworks, such as this test site with MediaWiki
3. Help out your navigators with the [ECDIS Converter](#) for survey line plans
4. Share non-commercial news under the [Community Announcements and Awareness](#) section
5. Concatenate files in the [File Trimmer](#) (e.g., for patch test processing)
6. [Sound Speed Manager](#) now supports World Ocean Atlas 2018!
7. The [Swath Coverage Plotter](#) now tracks changes in multibeam settings and offsets
8. Added a [Wish list](#) for priority topics - chime in!
9. Started a [Software Updates](#) page to easily find the latest versions of common mapping software
10. Added an informal list of [Top 10 multibeam issues](#) to highlight common complications (and solutions)
11. Made a new page for [Sea Acceptance Testing](#) (and Quality Assurance Testing) to discuss approaches and expectations

Contents

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Open-source data tools

Best practices

Helpful presentations and papers

Why map the ocean?

Multibeam Advisory Committee

Contact us



Lamont-Doherty Earth Observatory  
COLUMBIA UNIVERSITY | EARTH INSTITUTE

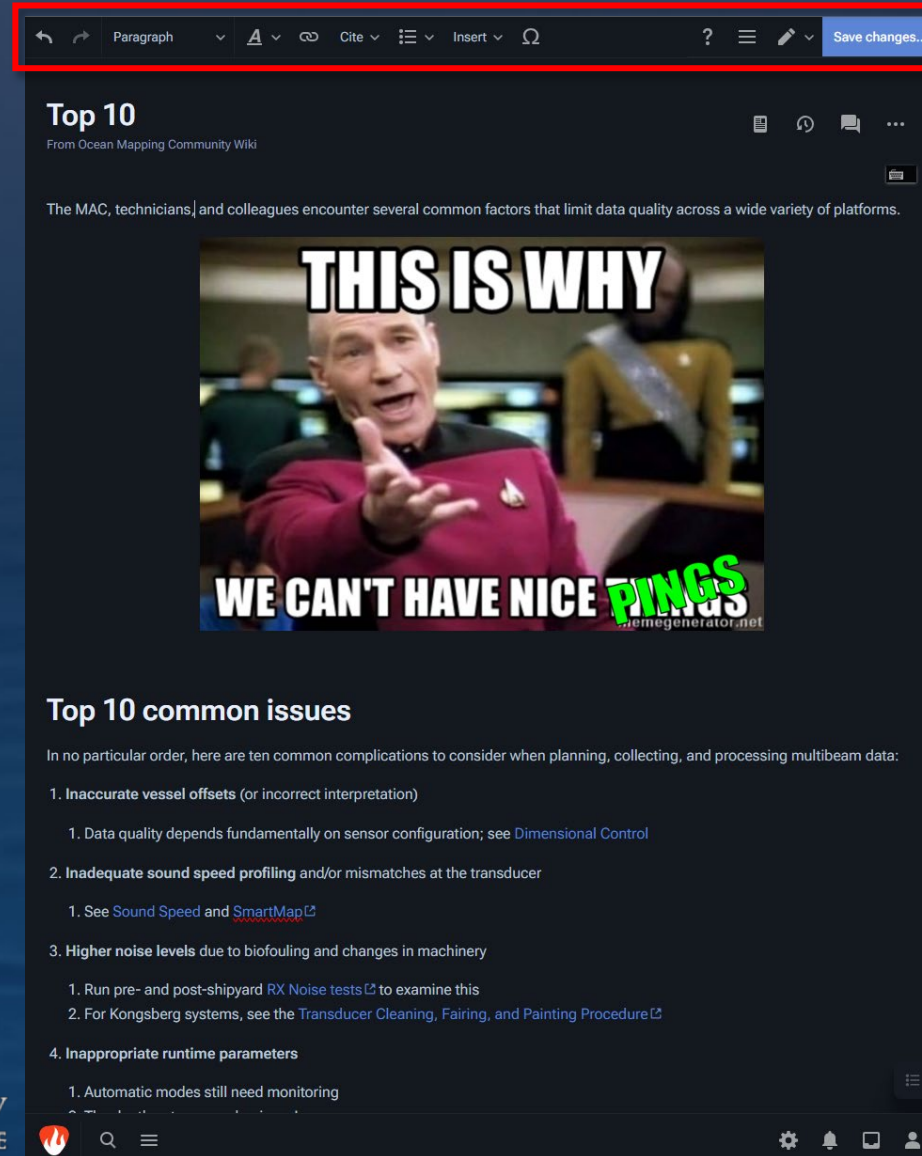


# Ocean Mapping Community Wiki

## Testing MediaWiki and Wiki Forge platforms

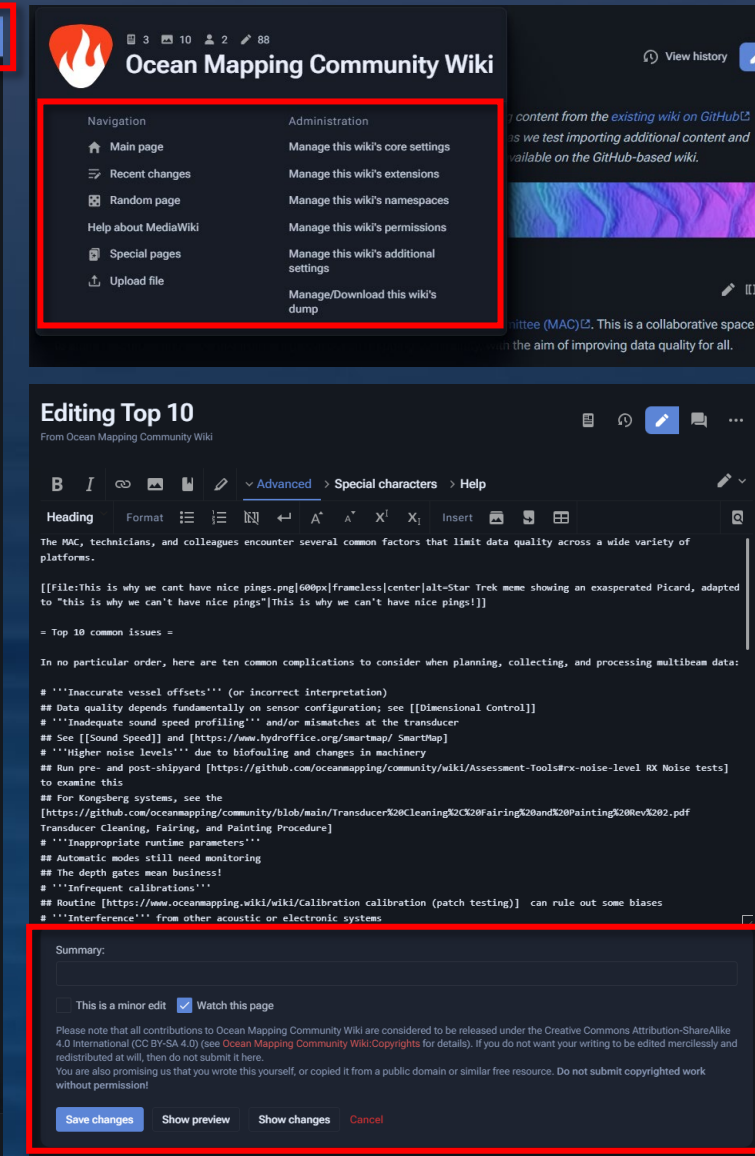
### Major advantages so far...

1. Easy login and attribution
2. Intuitive editors and previews
  - a. Visual and wikitext
3. Broad admin settings / options
4. Multi-user editing support
5. Avoids GitHub 'barrier to entry'



The screenshot shows the 'Top 10' page on the Ocean Mapping Community Wiki. The page content includes a Star Trek meme with the text 'THIS IS WHY WE CAN'T HAVE NICE PINGS' and a list of 'Top 10 common issues'. The issues listed are:

1. Inaccurate vessel offsets (or incorrect interpretation)
  1. Data quality depends fundamentally on sensor configuration; see [Dimensional Control](#)
2. Inadequate sound speed profiling and/or mismatches at the transducer
  1. See [Sound Speed and SmartMap](#)
3. Higher noise levels due to biofouling and changes in machinery
  1. Run pre- and post-shipyard [RX Noise tests](#) to examine this
  2. For Kongsberg systems, see the [Transducer Cleaning, Fairing, and Painting Procedure](#)
4. Inappropriate runtime parameters
  1. Automatic modes still need monitoring



The screenshot shows the 'Administration' settings page for the Ocean Mapping Community Wiki. The page is divided into two columns of settings:

Navigation	Administration
<a href="#">Main page</a>	<a href="#">Manage this wiki's core settings</a>
<a href="#">Recent changes</a>	<a href="#">Manage this wiki's extensions</a>
<a href="#">Random page</a>	<a href="#">Manage this wiki's namespaces</a>
<a href="#">Help about MediaWiki</a>	<a href="#">Manage this wiki's permissions</a>
<a href="#">Special pages</a>	<a href="#">Manage this wiki's additional settings</a>
<a href="#">Upload file</a>	<a href="#">Manage/Download this wiki's dump</a>

Below the settings, there is a section for 'Editing Top 10' which shows the wikitext editor interface. The editor contains the following text:

```
[[File:This is why we cant have nice pings.png|600px|frameless|center|alt-Star Trek meme showing an exasperated Picard, adapted to "this is why we can't have nice pings"|this is why we can't have nice pings!]]
```

The editor also shows a 'Summary' field and a 'Watch this page' checkbox.

### Next steps...

1. Issue tracking setup
2. Converting content from GitHub
3. Announcing new web address



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# Questions? Answers? Reach out!

Ocean Mapping Community Wiki

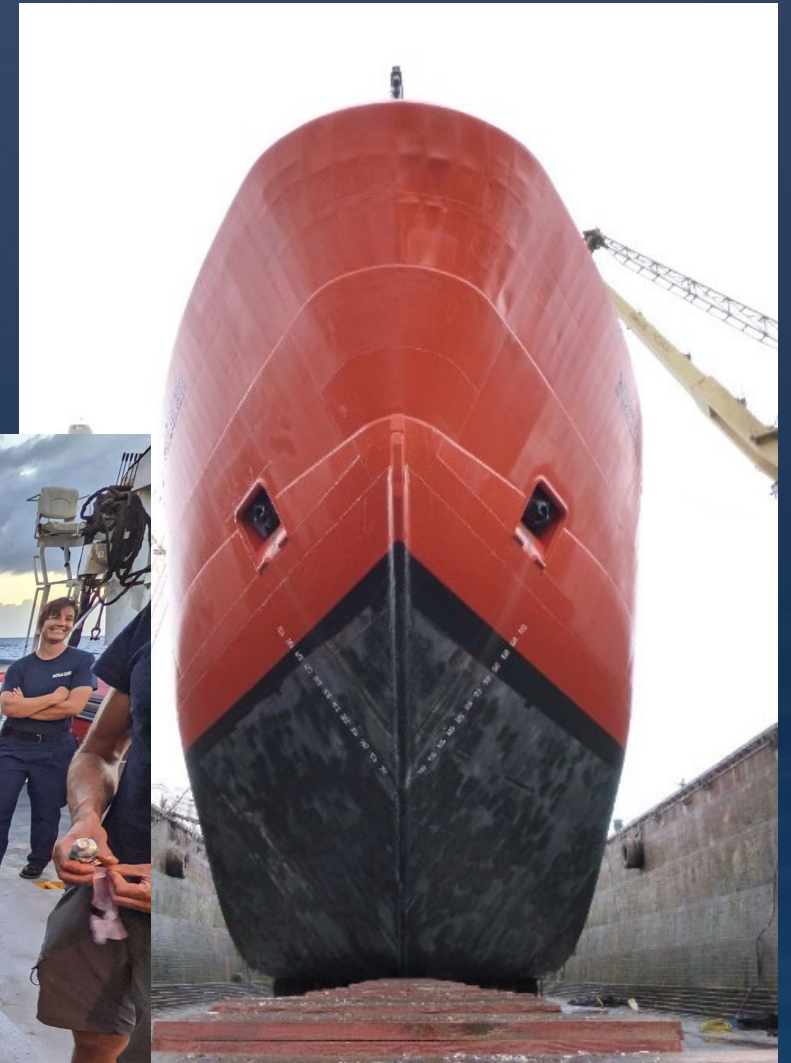
[github.com/oceanmapping/community](https://github.com/oceanmapping/community)

[omcadmin@ccom.unh.edu](mailto:omcadmin@ccom.unh.edu)

Multibeam Advisory Committee

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