# Multibeam Advisory Committee Updates

*RVTEC - Honolulu, HI*

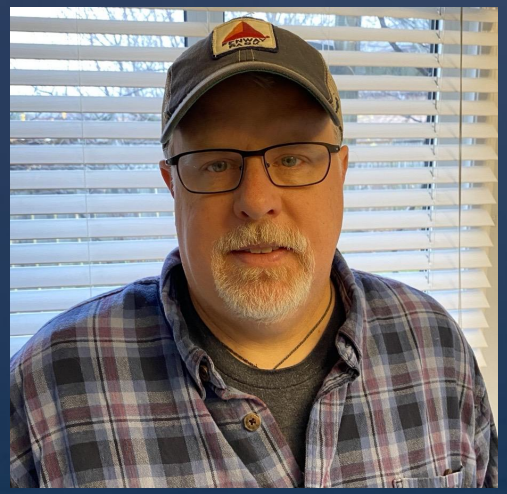
*24 October 2023*

*Kevin Jerram*
*Paul Johnson*
*Vicki Ferrini*
*Hayley Drennon*

*MAC supported under NSF grant 1933720*

https://mac.unols.org

mac-help@unols.org



## Paul Johnson

*Data Manager*
*UNH*

*Extended Continental Shelf, GEBCO, Seabed 2030*

## Vicki Ferrini

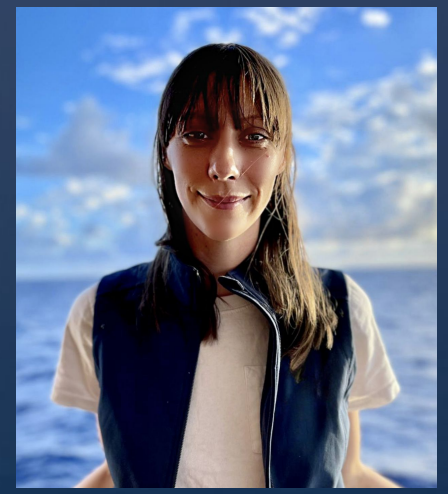
*Sr. Research Sci. and Assoc. Dir. DEI (LDEO)*
*Affiliate Assoc. Prof. (UNH)*

*GMRT, MGDS, Seabed 2030, GEBCO, Explorers Club*


## Kevin Jerram

*Mapping Specialist*
*UNH*

*CCOM research, MAC field support*



## Hayley Drennon

*Sr. Research Assistant*
*LDEO*

*GMRT, MGDS, GEBCO Seabed 2030*

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

# The Multibeam Advisory Committee (MAC)

- Established in 2011 with funding from NSF to ensure the consistent collection of high-quality multibeam data across the U.S. Academic Research Fleet (USARF)
  - ***On-board and remote support*** *for ships*
  - ***Standardize*** *system performance testing*
  - ***Publish*** *performance and share best practices*

- Technical Reports & Resources
  - Sea Acceptance / Quality Assurance / RX Noise
  - Host Non-USARF reports for reference
  - Assessment tools, survey guidance

Website: mac.unols.org

Help desk: mac-help@unols.org

Wiki: github.com/oceanmapping/community/wiki


Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

# Thank you, Jim!

# 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











Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

# System Performance Testing

## SAT and QAT checklist

1. Hardware / software health
2. Sensor offset / 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)

Post-SAT / Pre-SVC Review (Discussion)

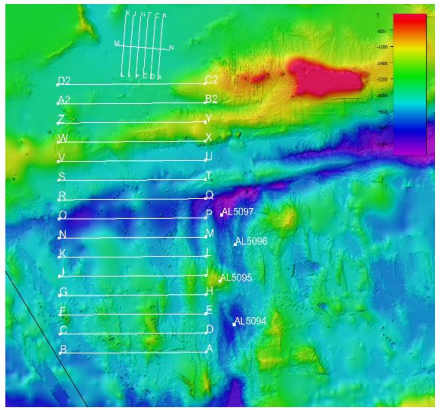
These topics help to ensure an up-to-date understanding of the mapping system and adequate/complete plan for testing, taking into consideration any changes since the SAT or last QAT.

1. What has changed since the last MAC visit o
   a. Any sensors replaced, removed, and/
   b. Any damage or repairs?
   c. Any upgrades to hardware or software
2. Is there any new documentation?
   a. Updated survey of vessel and/or sens
   b. Updated guidance or service notes fr
   c. Any performance notes from normal o
3. Is there any recent data that can be provided
   a. Ideally, these data would be collected
      profiling; data covering a wide range
      depth as an early indicator of perform
   b. Any recent ‘problem’ datasets should
      as appropriate

Recommended/Prioritized Post-SAT

1. **EM124 updates**
   a. Kongsberg has released several softw
      issues; ***the EM124 should be updat***
      i. Download links and Kongsber
      https://github.com/oceanmapp
   b. Known issues with recent SIS version
      i. https://github.com/oceanmapp
   c. Related: Update to Sound Speed Mar
      i. https://www.hydroffice.org/sou
2. **Dockside testing and review**
   a. Prior to departure, the MAC is availab
      i. Seapath and EM124 configura
      ii. line plan review with operators
      iii. pre-cruise system testing (e.g.
3. **Antenna calibration**
   GNSS antenna baseline calibration according
   a. Seapath antenna calibration ***if any ac***
      i. Antenna calibration is perform
      at least two hours per iteration
      antenna baseline, applying the
      average baseline result in the
4. **DONE! Swath coverage testing**
   Swath coverage data are collected in fully au
   Additional time should be planned to survey
   perpendicular to contours for establishing bas

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.
   a. **Tested in 2021 (worthwhile to redo and compare to 2021 results)**
      i. **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)
      ii. This test should be repeated underway to ensure there have been no major changes to the vessel’s noise environment since the SAT
      iii. **See ‘Noise vs. Speed’ section under RX Noise Logging**
   b. **Untested:**
      i. **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)
      ii. 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
      iii. **See ‘Noise vs. Azimuth’ section under RX Noise Logging**
7. **PROPOSED: Overnight mapping / test survey in poorly mapped areas**




8. a. 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)




UNOLS — University-National Oceanographic Laboratory System

Multibeam Advisory Committee

Lamont-Doherty Earth Observatory
Columbia University | Earth Institute

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

| Ship | System(s) | Arrays | Life Cycle | MAC Visits (Recent) | 2024 Plans |
|---|---|---|---|---|---|
| *Atlantis* | **EM124 (g)** | 2021 | Early | SAT* (2021), QAT* (2022) | QAT |
| *Healy* | *EM122* | 2010 / 2023 RX | Late | ANT, QAT/SAT* (2022-23) | QAT |
| *Kilo Moana* | EM122 / EM710 | 2012 | Late | ANT, QAT* (2023) | QAT |
| *Marcus G. Langseth* | EM122 (g) | 2007 TX / 2010 RX | Late | ANT, QAT (2023) | QAT |
| *Nathaniel B. Palmer* | EM122 | 2015 | Mid | SAT, ANT, QAT (2015) | TBD |
| *Neil Armstrong* | *EM122 / EM710* | 2016 | Mid | SAT, QAT* (2020) | EM124 / 712 |
| *Roger Revelle* | EM124 / EM712 (g) | 2020 | Early | SAT*, QAT* (2023) | QAT |
| *Sikuliaq* | *EM302* / EM710 | 2014 | Mid | SAT, QAT* (2023) | EM304 MKII |
| *Sally Ride* | **EM124** / EM712 | 2016 | Mid | SAT (2021), QAT* (2023) | QAT |
| *Thomas G. Thompson* | *EM302* | 2018 | Mid | SAT, QAT* (2023) | TBD |
| *Hugh R. Sharp* | *EM2040* | 2024 | Early | QAT (Reson, 2016) | EM2040 |

(g) indicates gondola installation
*Indicates remote support
**Underline = recent install (2021)**

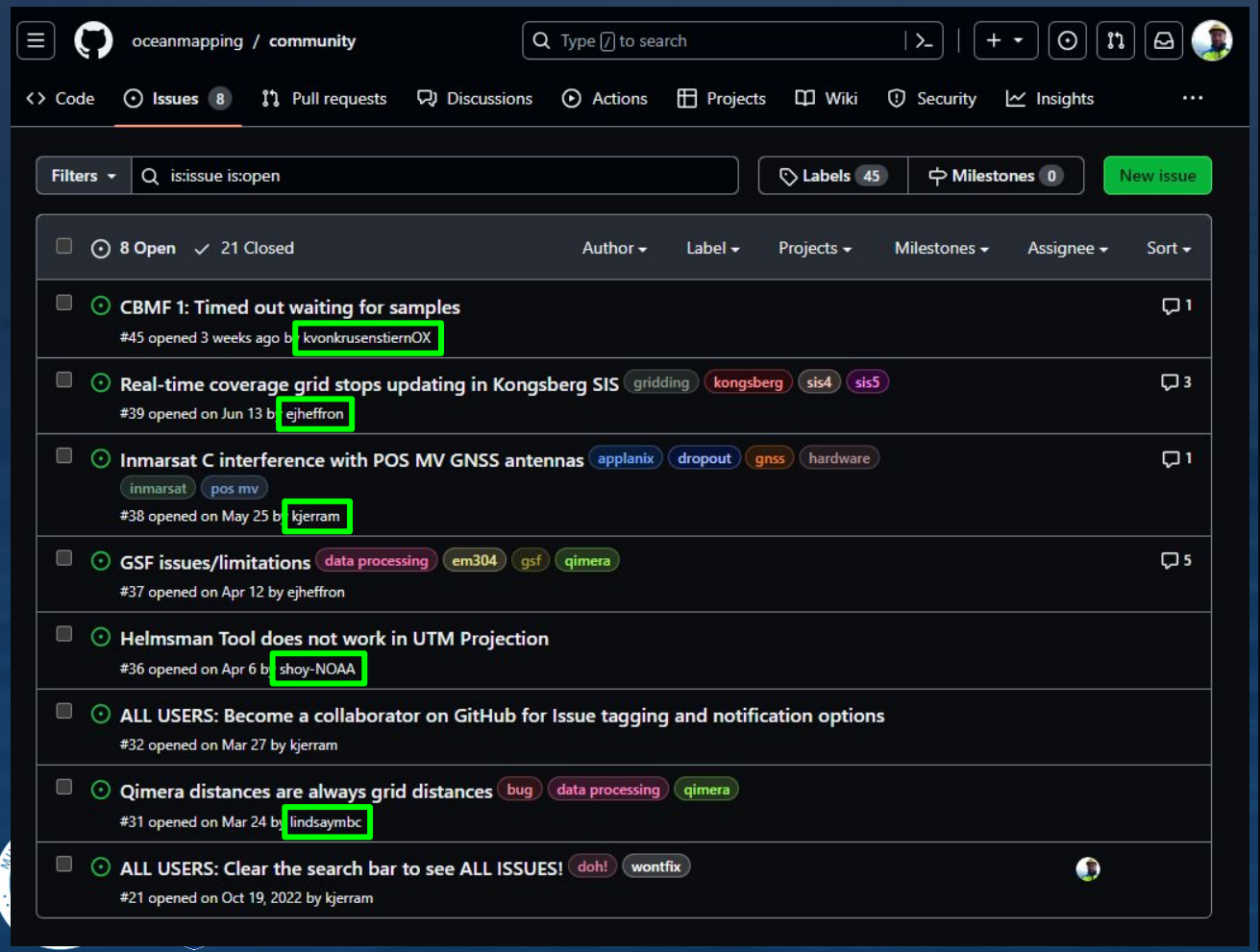
*Italic = pending replacement (2023+)*
Green = visited in last two years

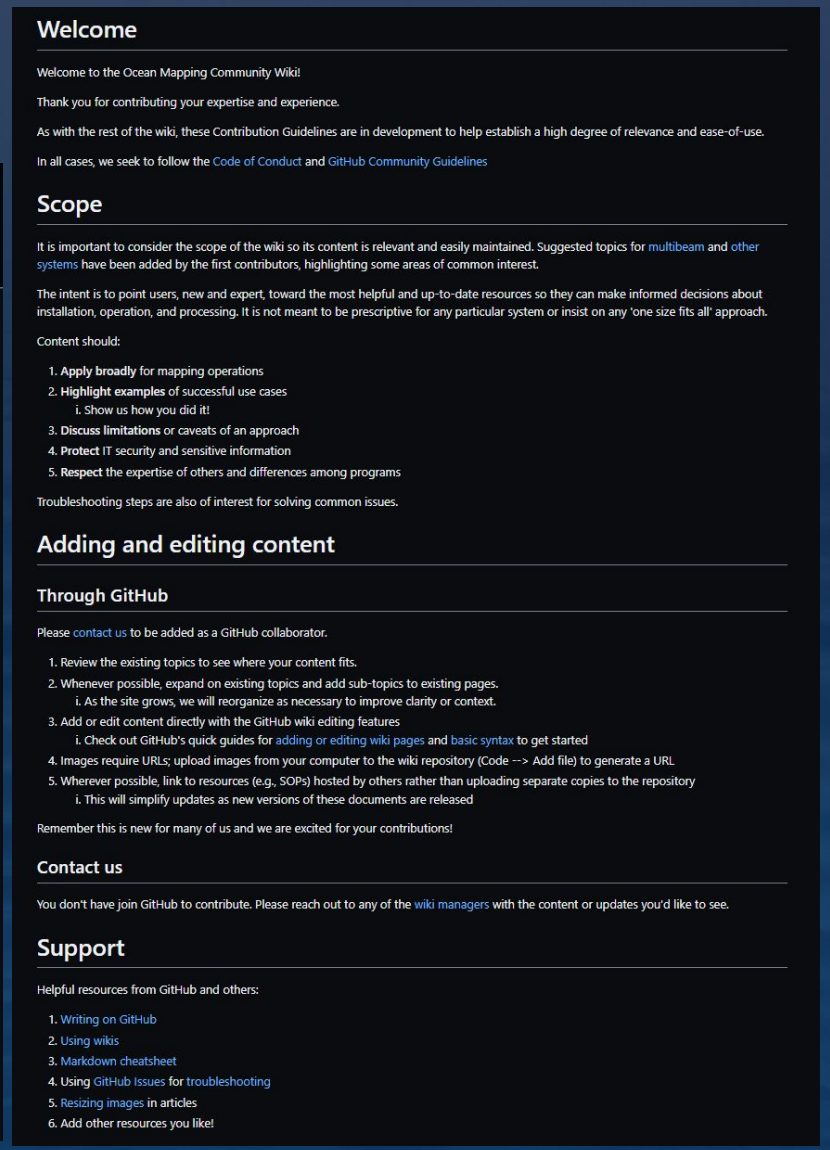
# Ocean Mapping Community Wiki

*github.com/oceanmapping/community/wiki*

*omcadmin@ccom.unh.edu or mac-help@unols.org*

**All mappers and managers are invited to contribute**



## 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!

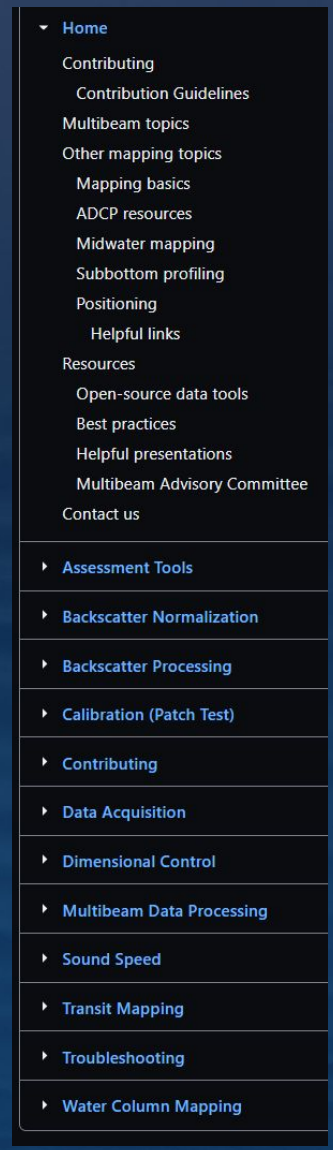
## Contact us

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!



# Ocean Mapping Community Wiki

*github.com/oceanmapping/community/wiki*

*omcadmin@ccom.unh.edu or 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.*

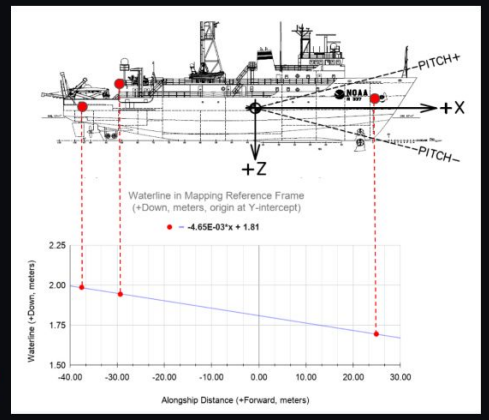
| Transducer | Reference Point | Source |
|---|---|---|
| Kongsberg TX/RX arrays | Center of array face[1] | Kongsberg manual |
| Kongsberg EM2040 portable | [Pending review][2] | Kongsberg manual |
| Norbit | | |
| Reson T20/T50 | Sonar ref. point (see manual)[3] | Reson T-Series manual |
| Reson 7125 | | |
| Reson 7160 | Sonar ref. point (see manual)[3] | 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[4] |
| iXBlue PHINS IMU | Sensing center | |
| Seapath MRU 5+ | Target on housing | Seapath manual[5] |
| | | |
| **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[6] |
| 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:

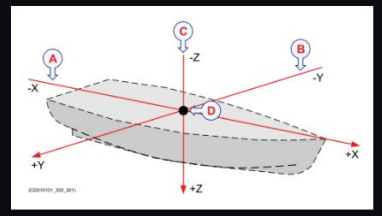
1. even 'good' survey results (meeting the manufacturer's requirements) are reported with ambiguous, inconsistent, or incorrect axis and sign conventions;
2. the mapping system reference frame and sensor reference points are not clearly identified;
3. the report lacks photos or diagrams of the measured 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[1] | FWD | PORT | UP | PORT UP | BOW DOWN | COMPASS | N/A[4] | N/A | PHINS Manual (Rev. Q) pp. 42-45 |
| Kongsberg | FWD | STBD | DOWN | PORT UP | BOW UP | COMPASS | N/A[4] | DOWN[5] | EM Installation Manual p. 140 |
| Reson[2] | STBD | FWD | UP | PORT UP | BOW UP | COMPASS | N/A[4] | UP[6] | 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[3] | FWD | STBD | DOWN | PORT UP | BOW UP | COMPASS | N/A[4] | DOWN[7] | 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[8] | Qimera v2.5 manual |

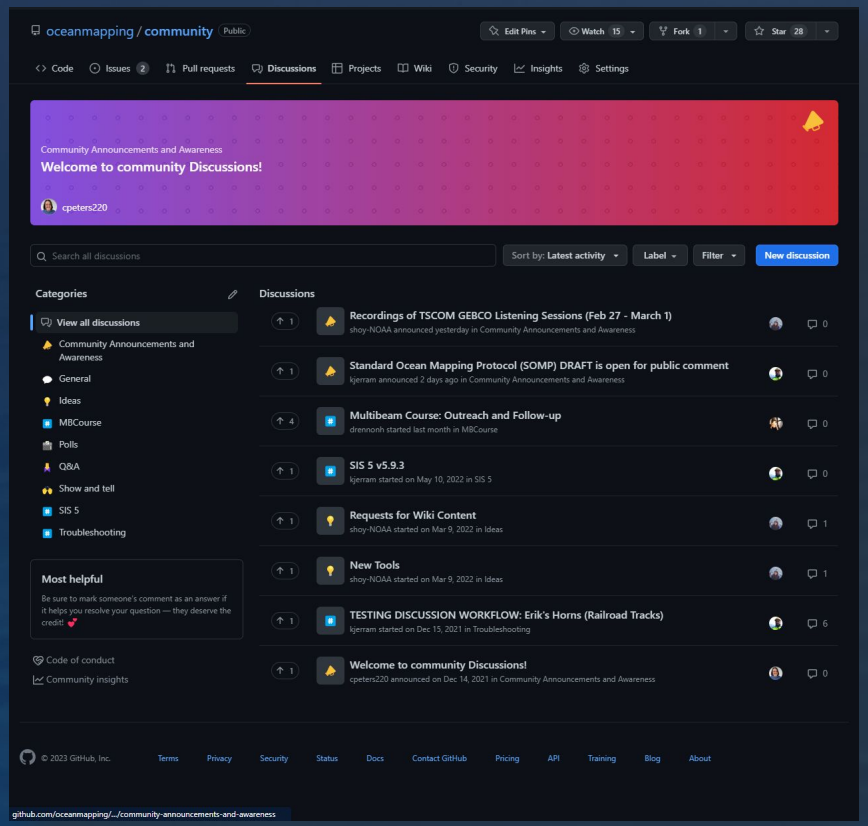
1. iXBlue alongship (X), athwartship (Y), and vertical (Z) axes are named '1', '2', and '3', respectively.
2. Reson conventions may differ between models and documents (e.g., T50 dual-head drawings are +X forward, +Y starboard, Z+ down)
3. Simrad rotations are assumed to follow the right-hand rule (as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

# Ocean Mapping Community Wiki

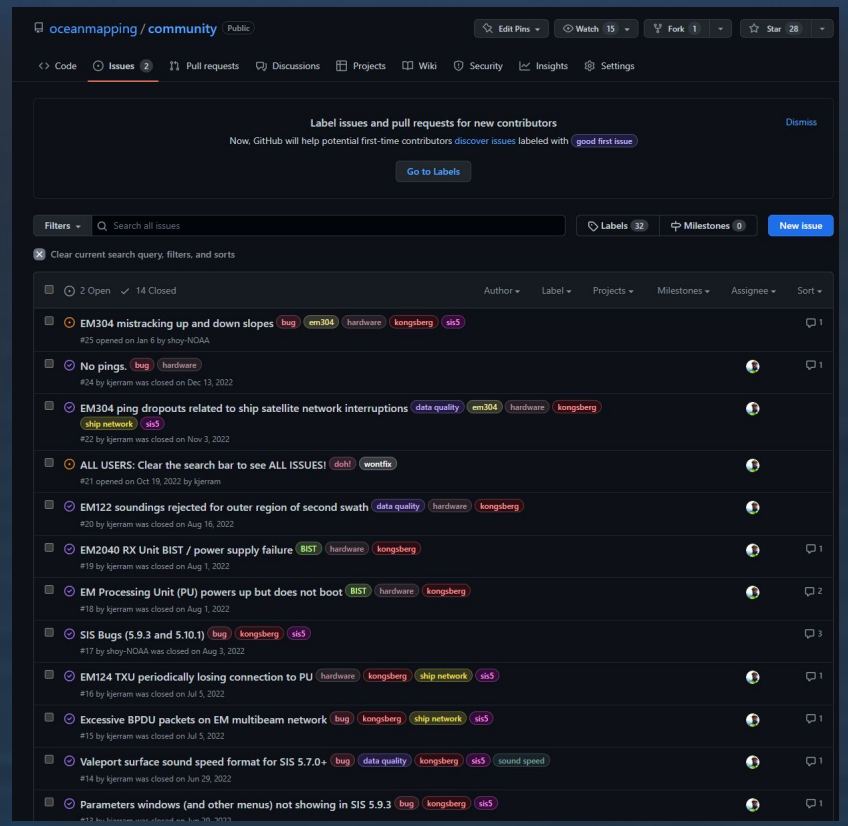
*github.com/oceanmapping/community/wiki*

*omcadmin@ccom.unh.edu or mac-help@unols.org*

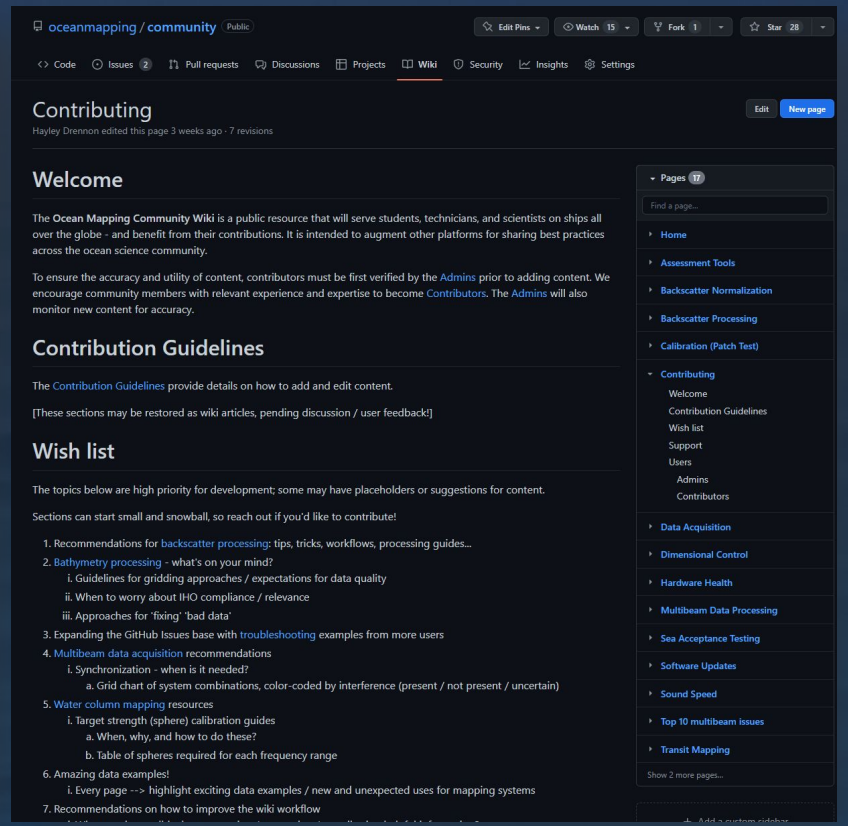
## Discussions




## Troubleshooting

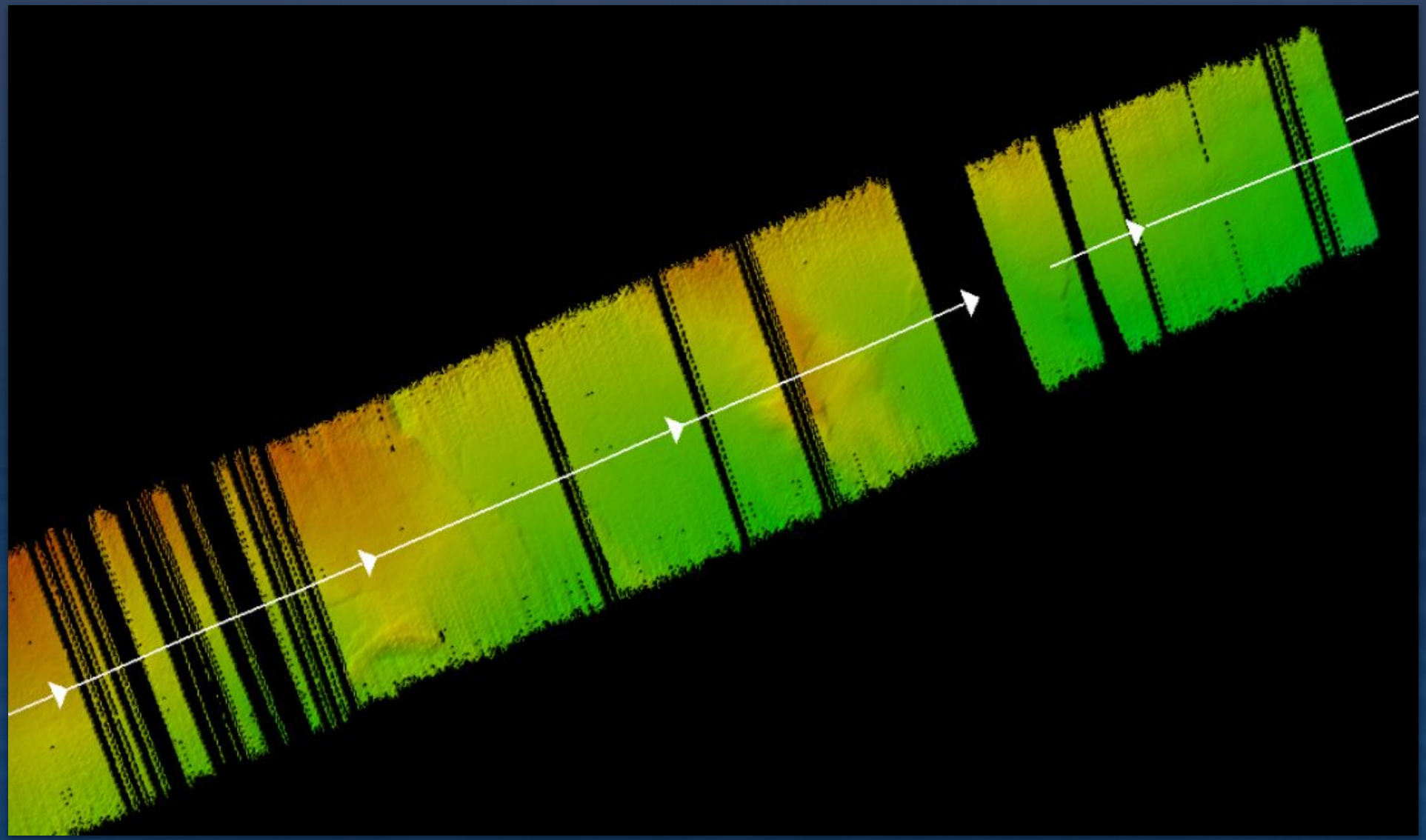



## Contributing

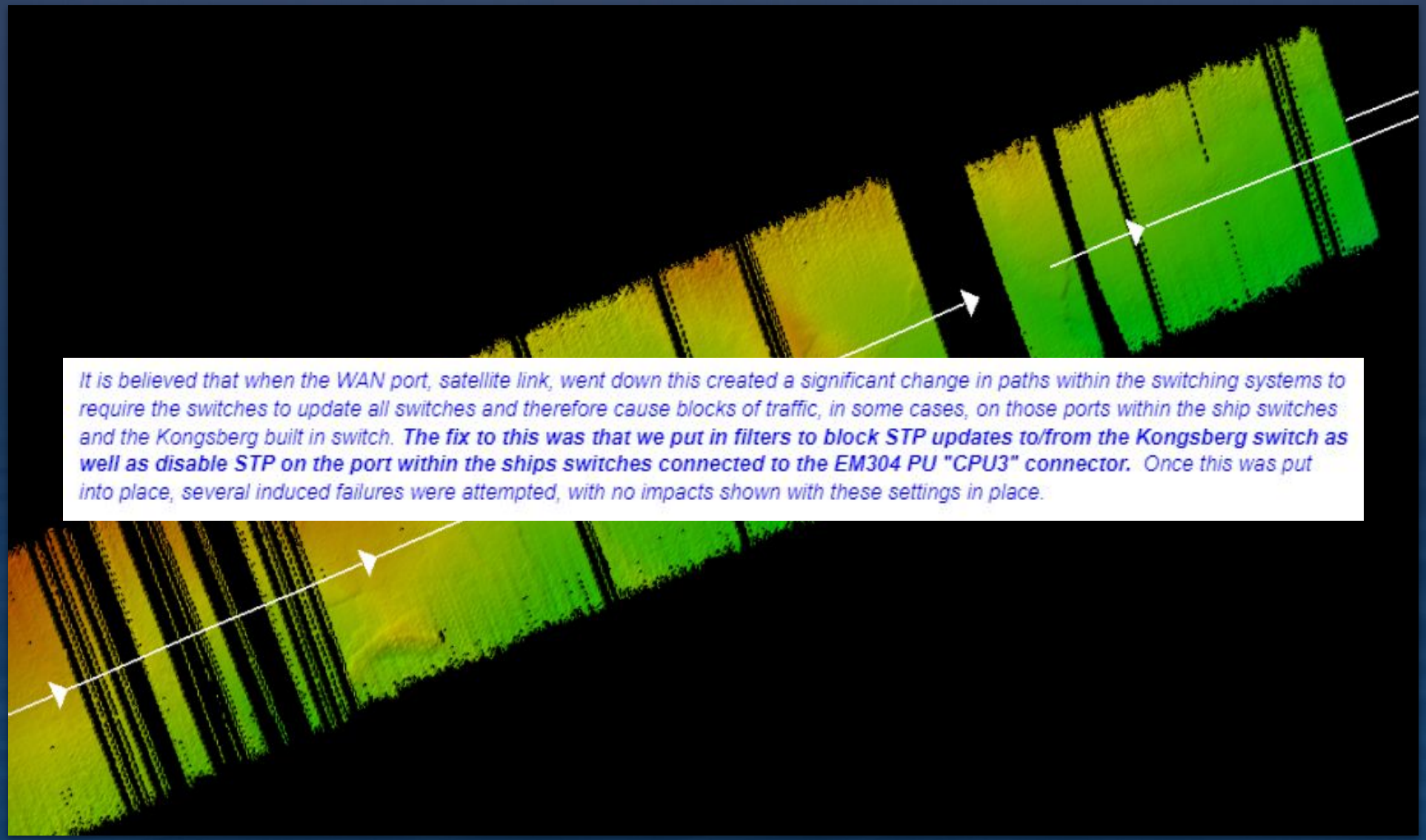



Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

# 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

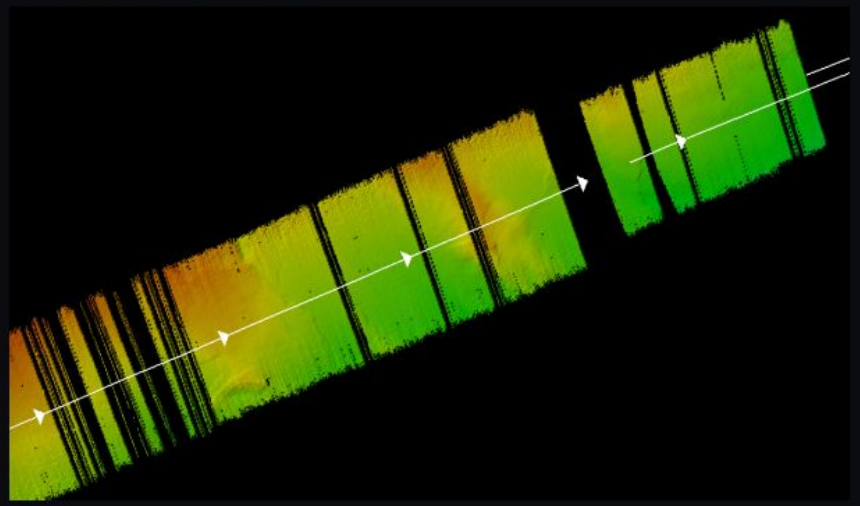
Edit | New issue

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 BPDU packets (#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

You're receiving notifications because you're watching this repository.

1 participant

Lock conversation | Pin issue | Transfer issue | Convert to discussion | Delete issue

## Excessive BPDU packets 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:

1. The ship's networks experienced excessive traffic of BPDU packets 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.

1. Make sure EM switches have latest firmware (vtWss-1.40). Earlier versions may have a bug that allows settings to be wiped.
2. 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

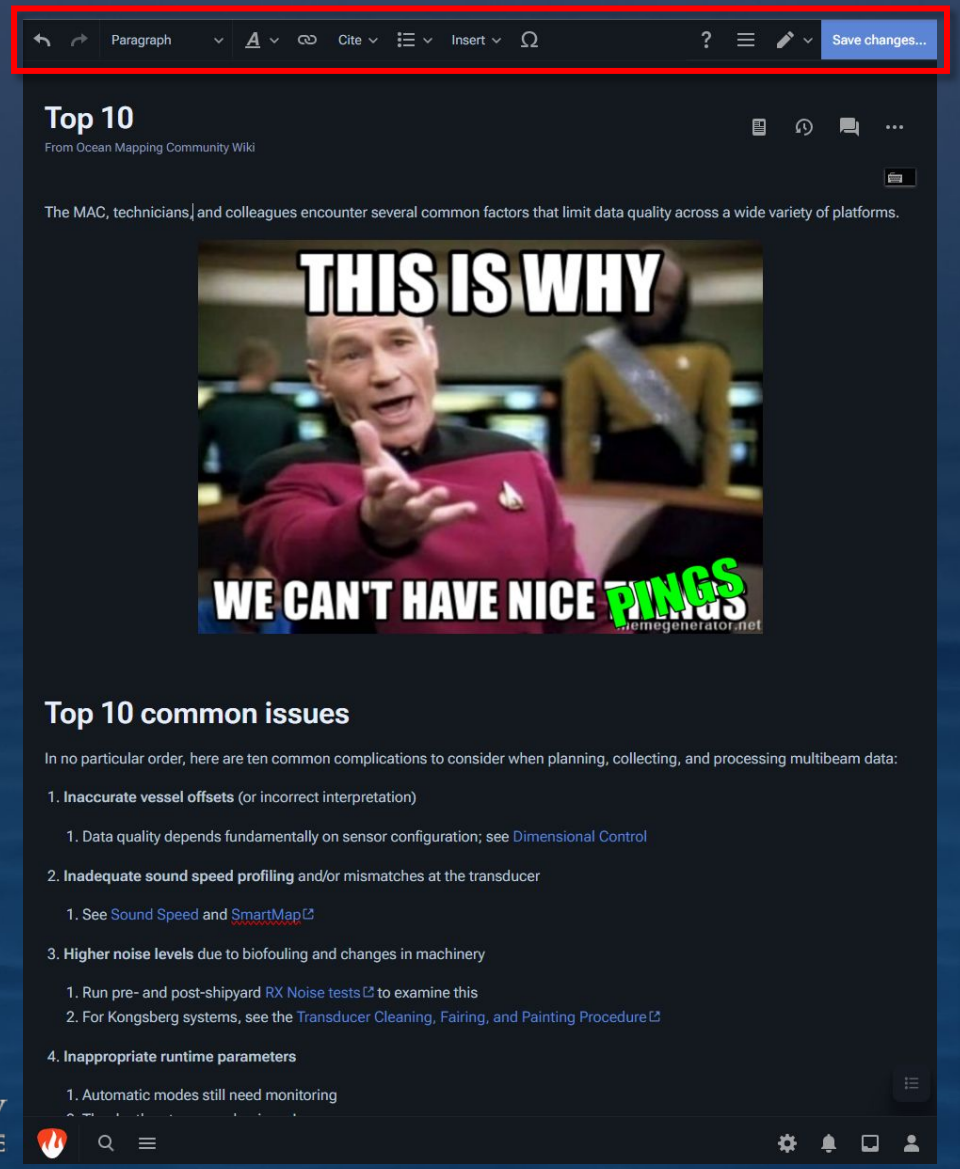
## COMING SOON: better interface and address!

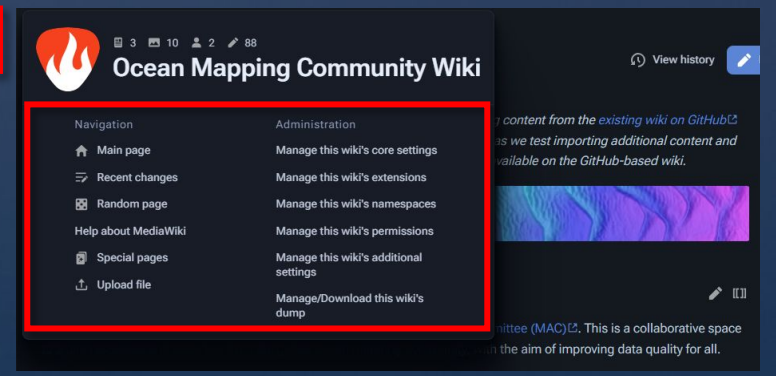
### Advantages in testing…

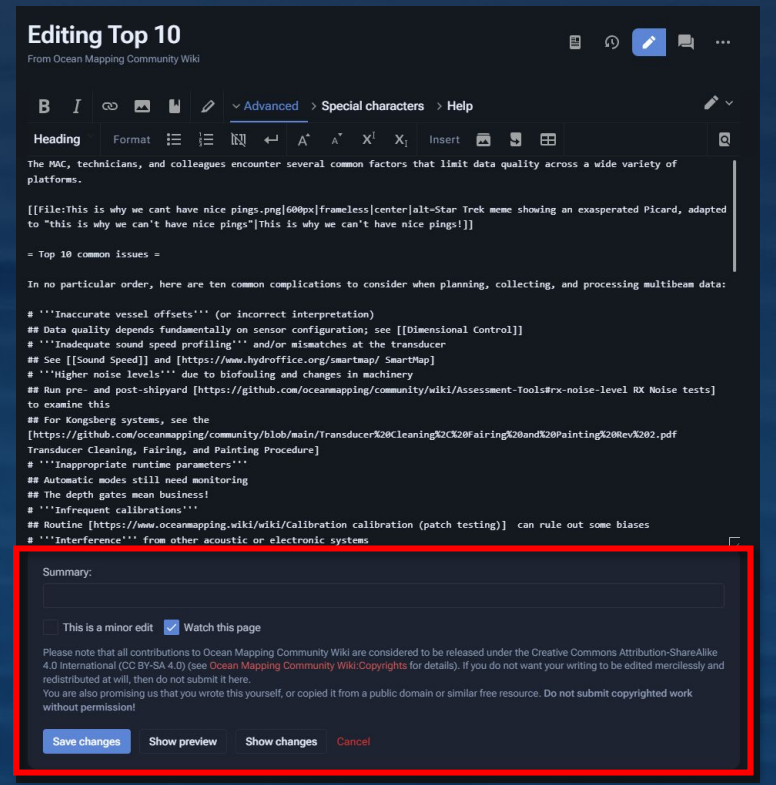
1. **Multi-user** editing
2. **Easy login** and attribution
3. **Intuitive editors** and previews
4. **Accessible** for broader user base

### Next steps…

1. Set up issue tracking
2. Move content from GitHub
3. Announce new web address
   a. It's pretty great…
4. **WIKI LOGO CONTEST**

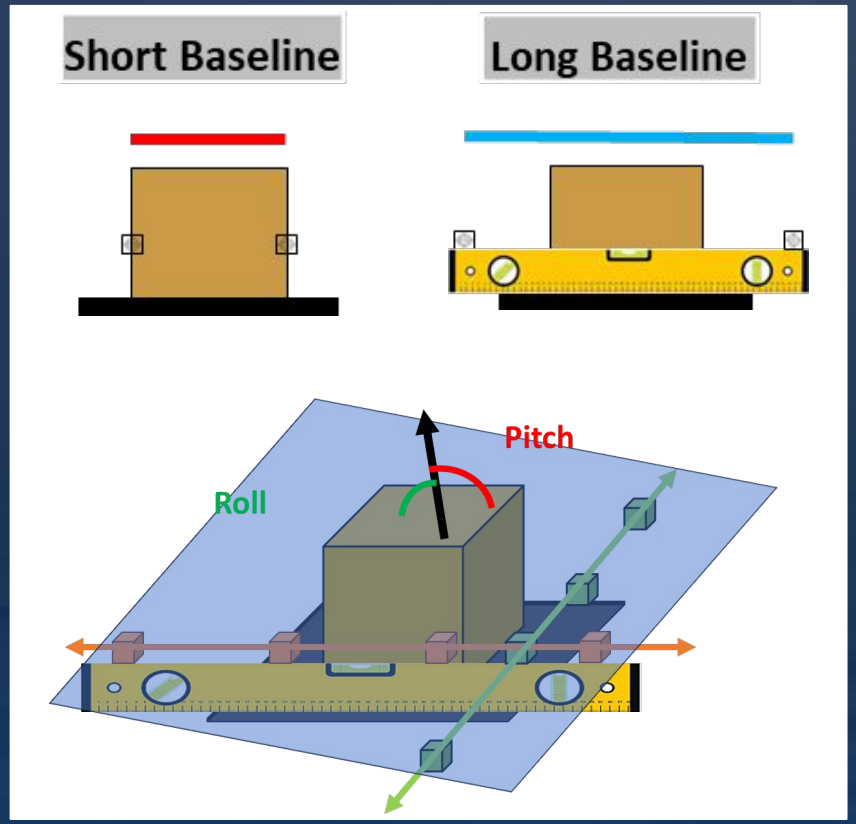


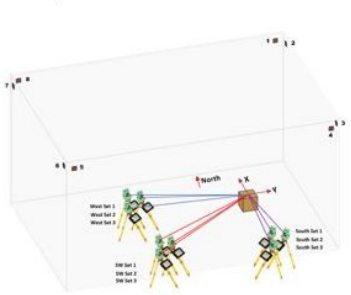



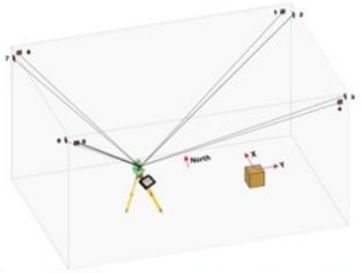

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

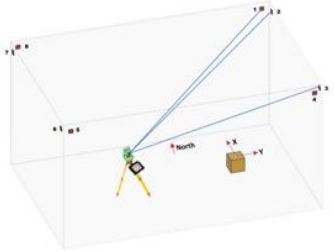
# Survey Accuracy Improvements by Anand Hiroji




## Experimental setup 1: Results

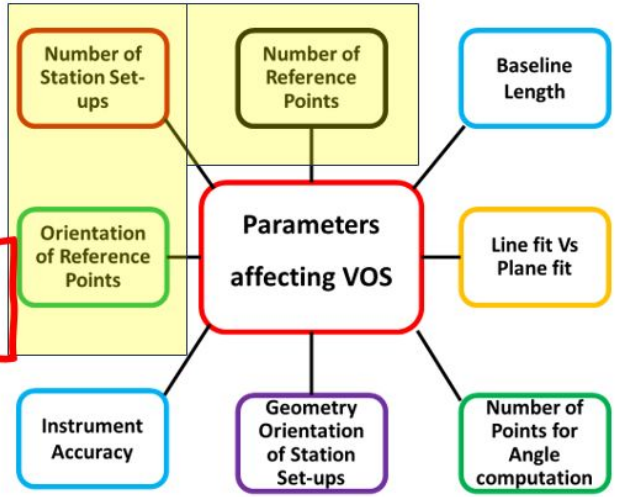






Angular difference of up to 0.19° between 9 setups!

Required accuracy 0.02°

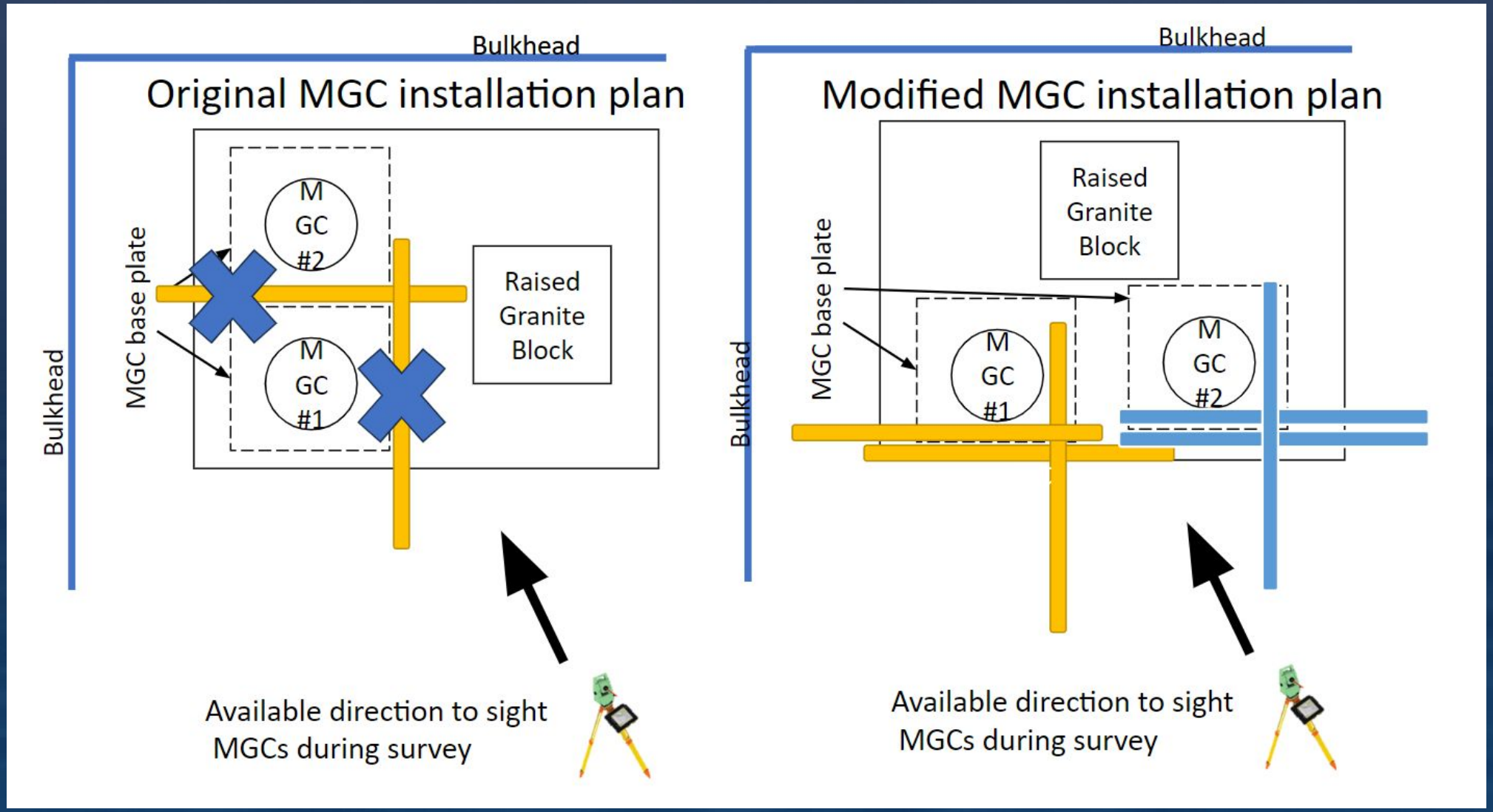



Having more reference points, number of station setups, and verity of orientations **provides redundancy and helps identify/minimize/reduce the absolute error.**

15

1. Longer baselines **reduces effect of random errors** on computed angles
2. Plane fitting **provides redundancy and helps to minimize the absolute error**
3. **Accuracy calculated** (not estimated) for QC and reporting

# Implementation: Seapath MGCs on RCRVs



# Offset Surveys and Reports V2

**Survey reports** directly impact data quality for years

Improve survey benchmarks, accuracy, and clarity

Recommendations for Multibeam Echosounder Mapping System Offset Surveys and Reports

Multibeam Advisory Committee

www.mac.unols.org | mac-help@unols.org

*Supported under NSF grant no. 1933720*


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


Recommendations for Multibeam Echosounder Mapping System Offset Surveys and Reports

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 report 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 canceling 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 position used for mapping (e.g., recessed and extended, plus any intermittent standard positions).**

| R/V _____ | 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 | A clear, accessible, and permanent fixture |
| TX array (center of array face) | | | | | | | |
| RX array (center of array face) | | | | | | | |
| GNSS antenna 1 (phase center) | | | | N/A | N/A | N/A | *Phase center height is ____ m above the survey point (source: _____)* |
| GNSS antenna 2 (phase center) | | | | N/A | N/A | N/A | |
| Motion sensor (survey target on sensor housing) | | | | | | | |
| Center of gravity (approx. loc. for heave filtering) | | | | | | | Required for POS MV configuration |
| Waterline | | | | | | | Waterline in normal trim |
| Additional sensors | | | | | | | |

13

*github.com/oceanmapping/community/wiki/Dimensional-Control*

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

# 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 |

*github.com/oceanmapping/community/wiki/Dimensional-Control*

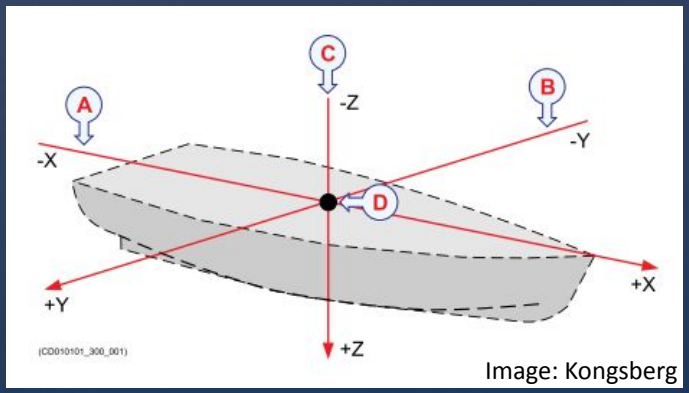


Image: Kongsberg

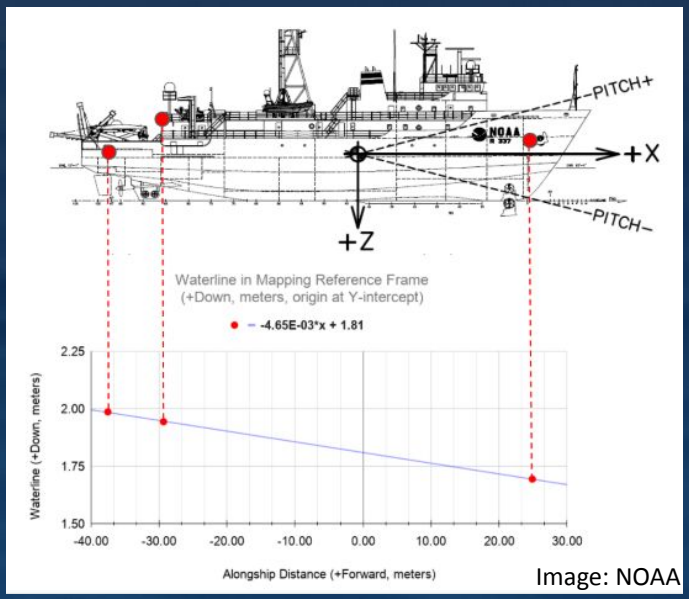
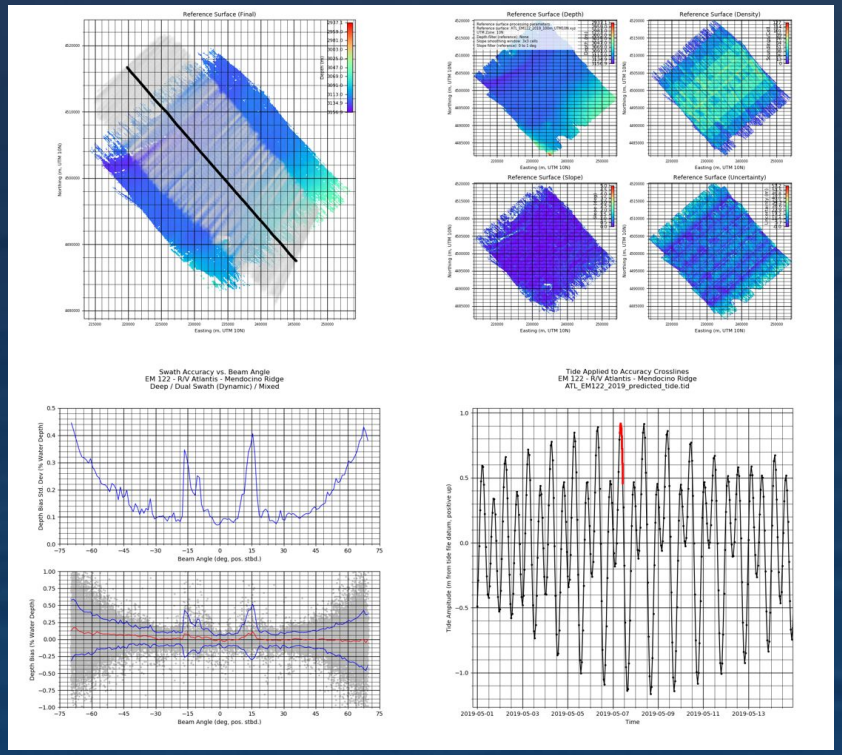


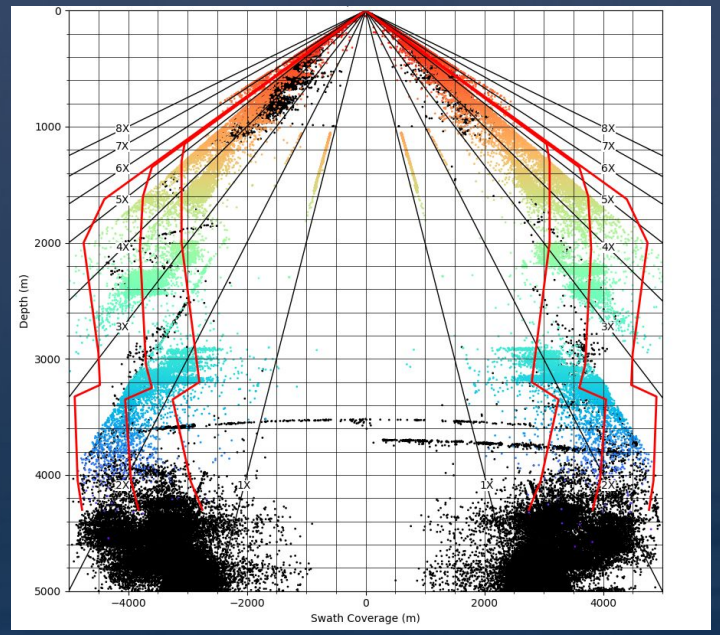
Image: NOAA

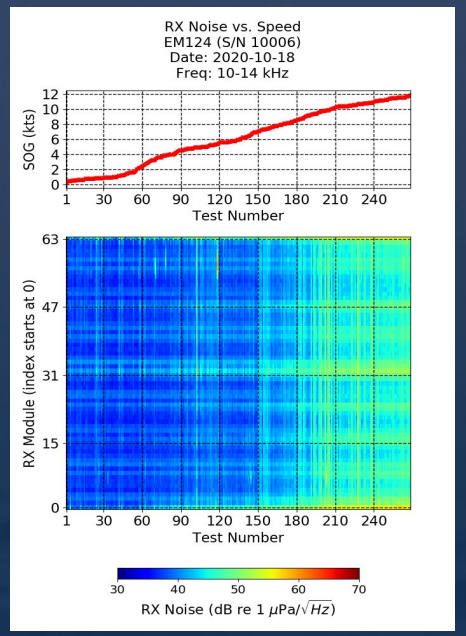
# Assessment Tools

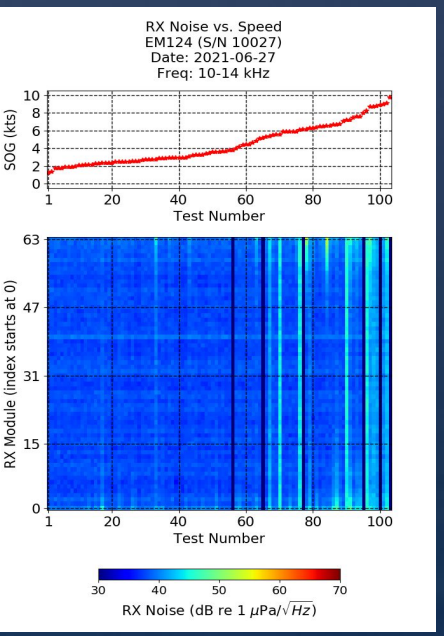
*github.com/oceanmapping/community/wiki/Assessment-Tools*

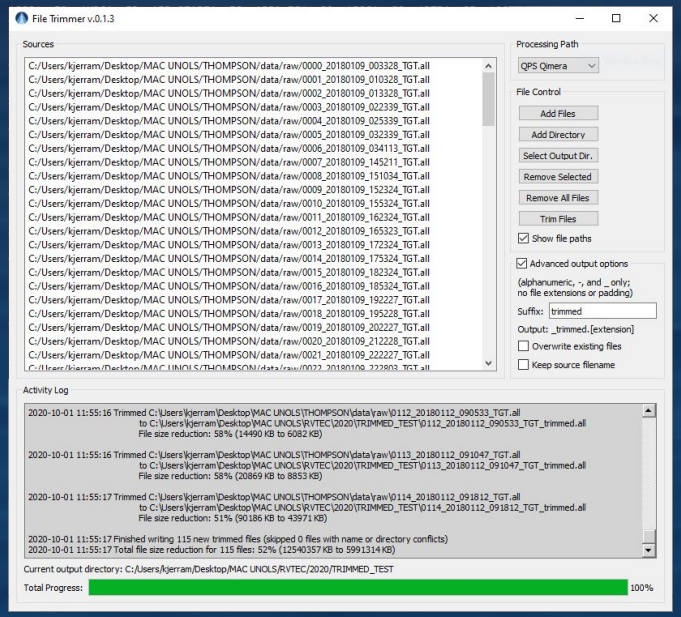
1. File Trimmer
2. BIST Plotter
3. Swath Coverage Plotter
4. **Swath Accuracy Plotter**
5. **ECDIS Converter**

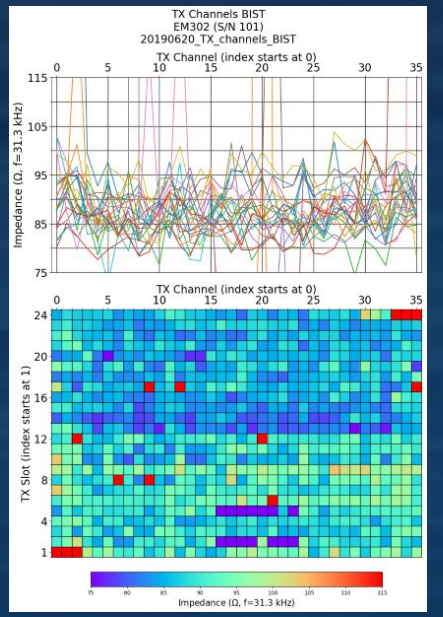


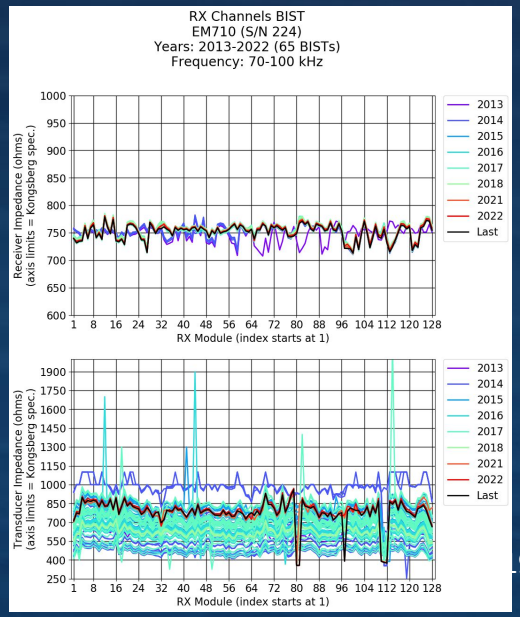




Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

# Ocean Mapping Community Wiki

*github.com/oceanmapping/community/wiki*

*omcadmin@ccom.unh.edu or 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

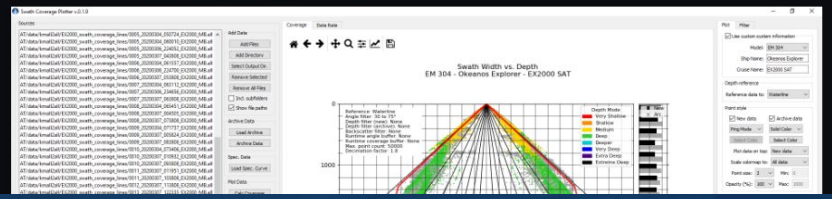
These tools are intended to give users the same plotting and reporting functions used by the MAC for routine performance testing (e.g., sea acceptance trials and quality assurance testing). Currently, only Kongsberg data formats are supported.

**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 .kmall are supported.



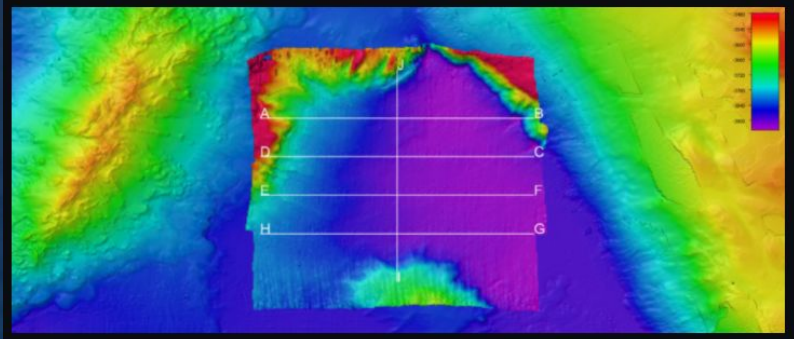

### Reference survey acquisition

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)
4. Number of reference lines to accommodate desired crossline length
   i. Typically 6-10 reference lines at 1 WD spacing, depending on depth, to yield several hundred crossline pings

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.

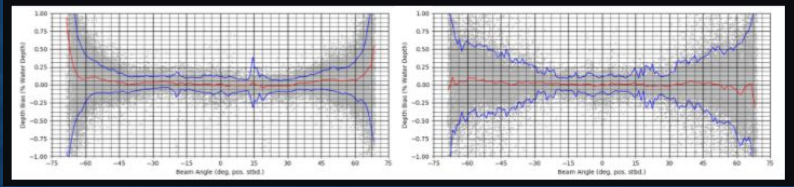



### Crossline data acquisition

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.

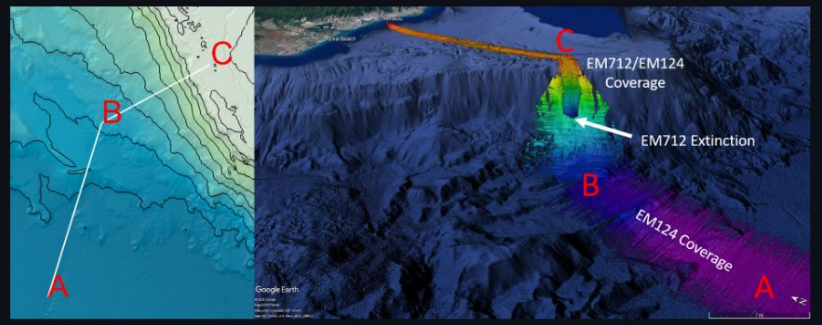
Crosslines are typically run in 'pairs' on opposite headings for each mode to assess any heading-dependent impacts, such as sea state (example below shows accuracy heading with seas and into seas shown on top and bottom, respectively). When seas are calm, this approach also supports deep roll verification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

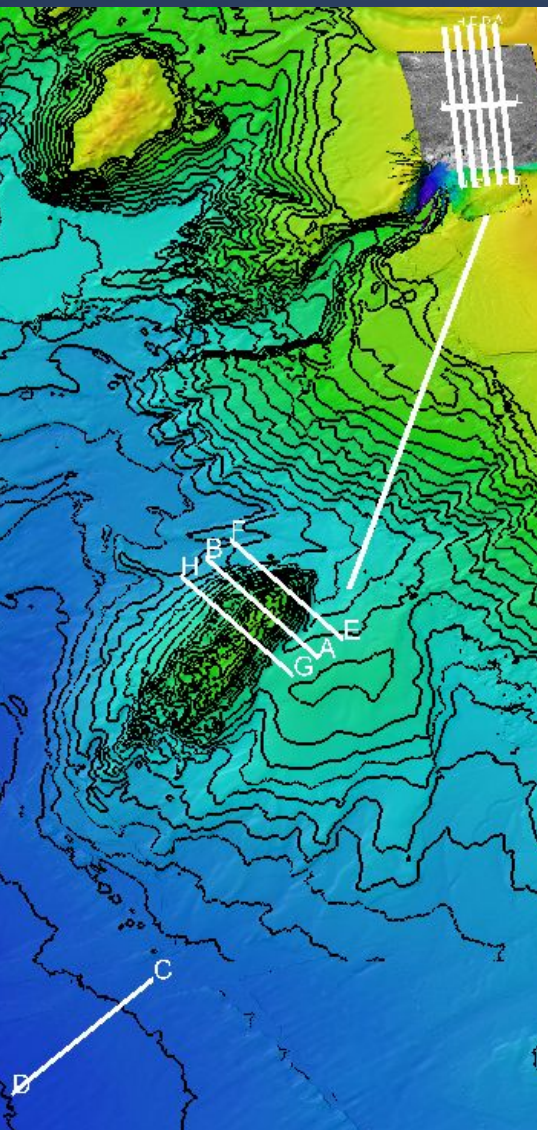
The purpose of testing is to let the multibeam system achieve its maximum coverage under the mode it selects automatically for the given depth.

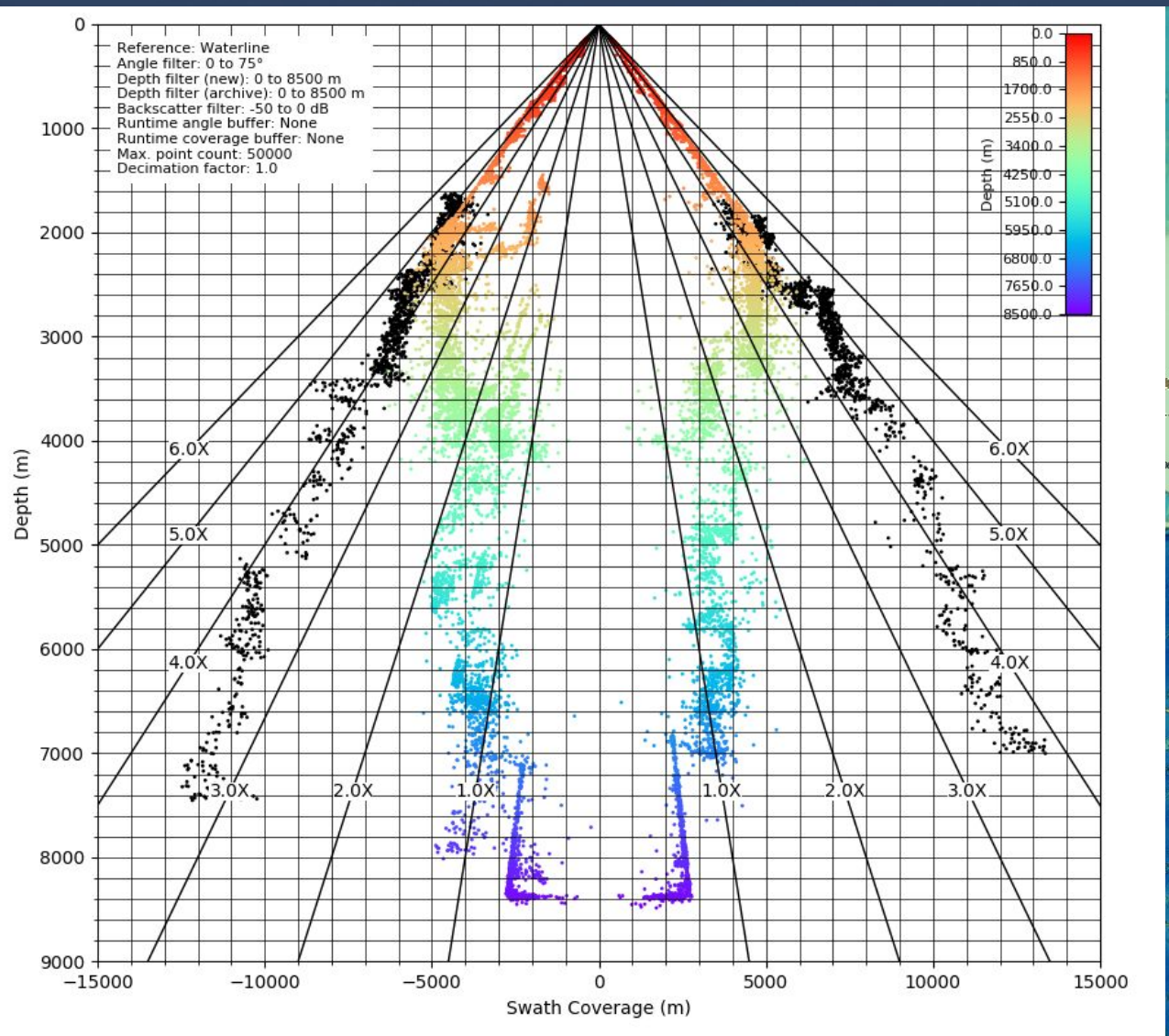
The following settings are generally recommended for Kongsberg EM systems to best illustrate 'automatic' system performance. Vessels that use different parameters during routine mapping should apply those settings where appropriate, aside from the maximum angle, coverage, and depth gates that may inadvertently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

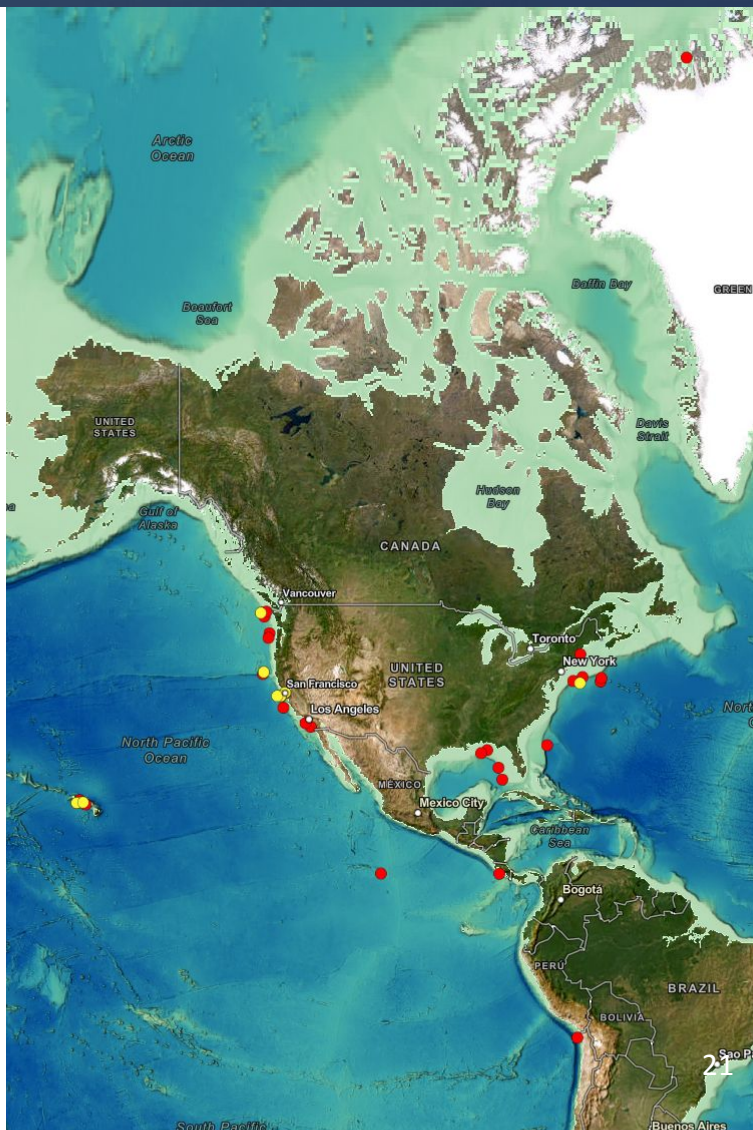
| Parameter | Recommended | Notes |
|---|---|---|
| **Depth mode** | Automatic | |
| **Dual swath** | Dynamic | |
| **FM Transmission** | Enabled | Read checkbox carefully [1] |
| **Max angles** | 75°/75° | 70°/70° for some systems |
| **Max coverage** | Maximum | Varies by model |
| **Depth limits**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

# Multibeam Test Sites Database – Why is it needed?

- **Meaningful comparisons across ships / systems and more efficient use of ship time and personnel**

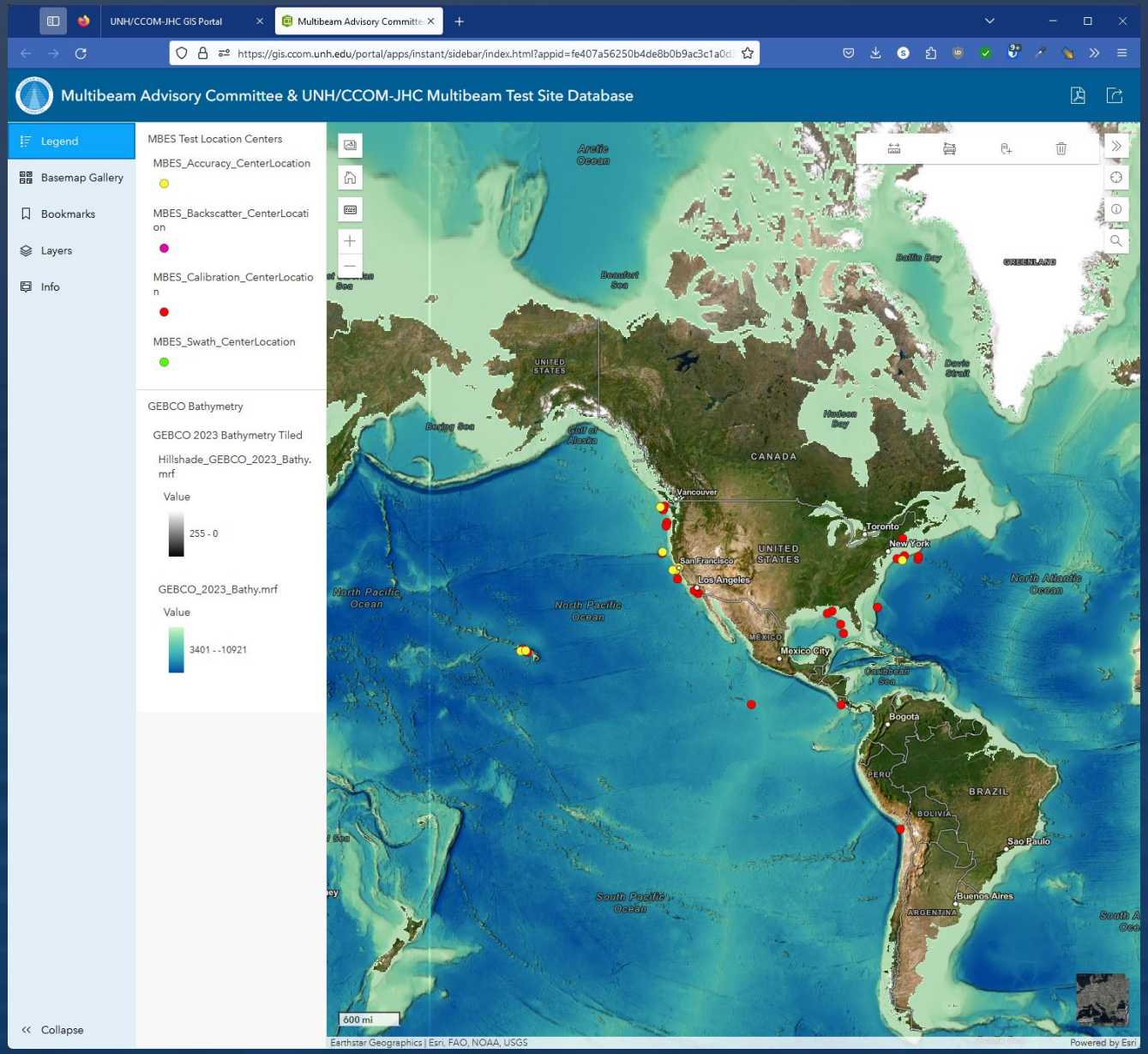


# Multibeam Test Sites Database – Prototype WebApp

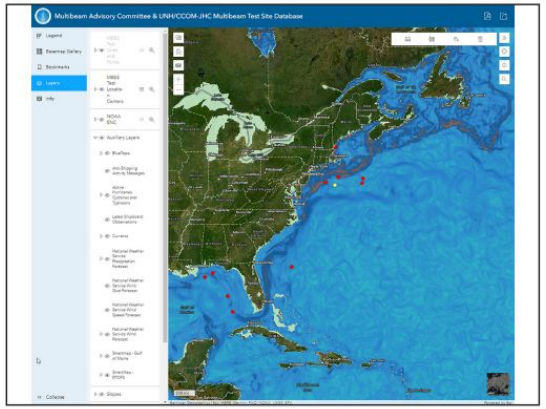
https://ccom.unh.edu/gis/maps/TestSites



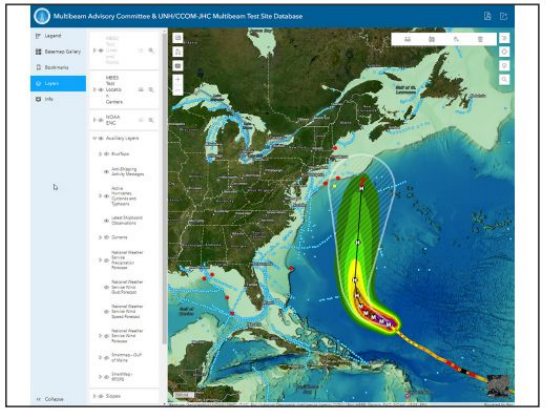

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

# Multibeam Test Sites Database – Planning Layers

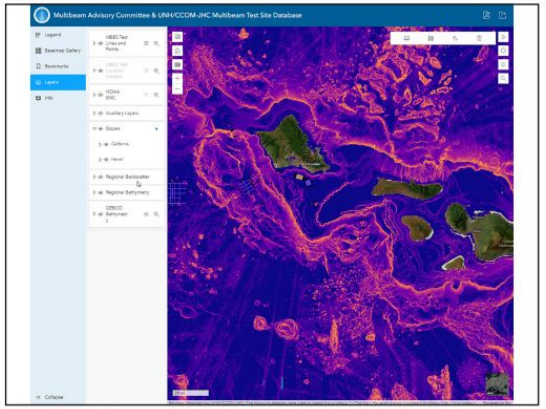
## Planning Information



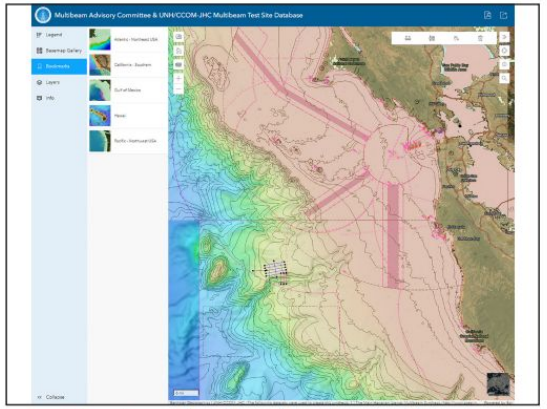
SmartMap Ocean Complexity



Ocean & Weather Conditions

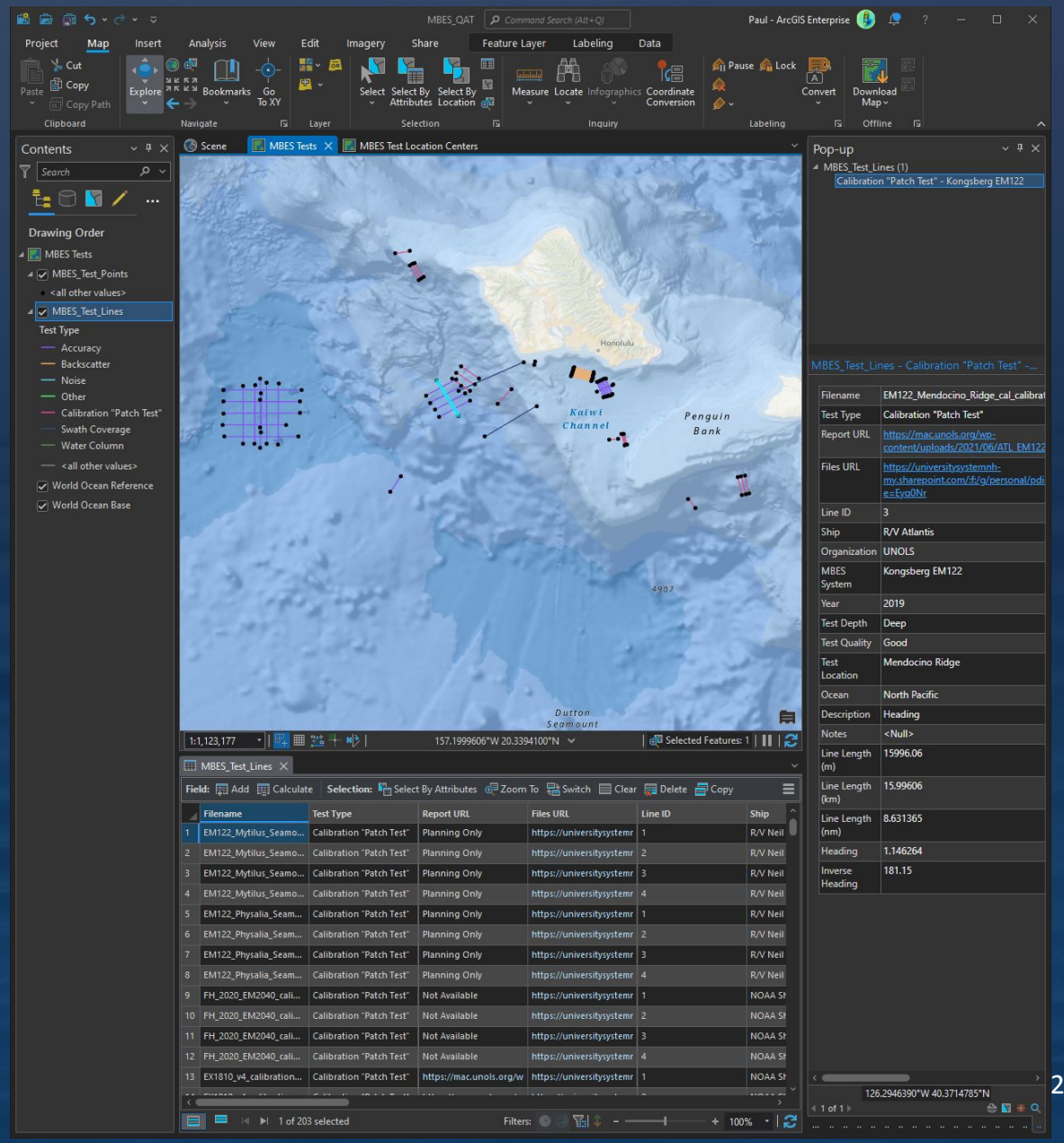


Regional Bathymetry & Slope



Electronic Navigation Charts

**https://gis.ccom.unh.edu**



# Multibeam Test Sites Database – Future Work

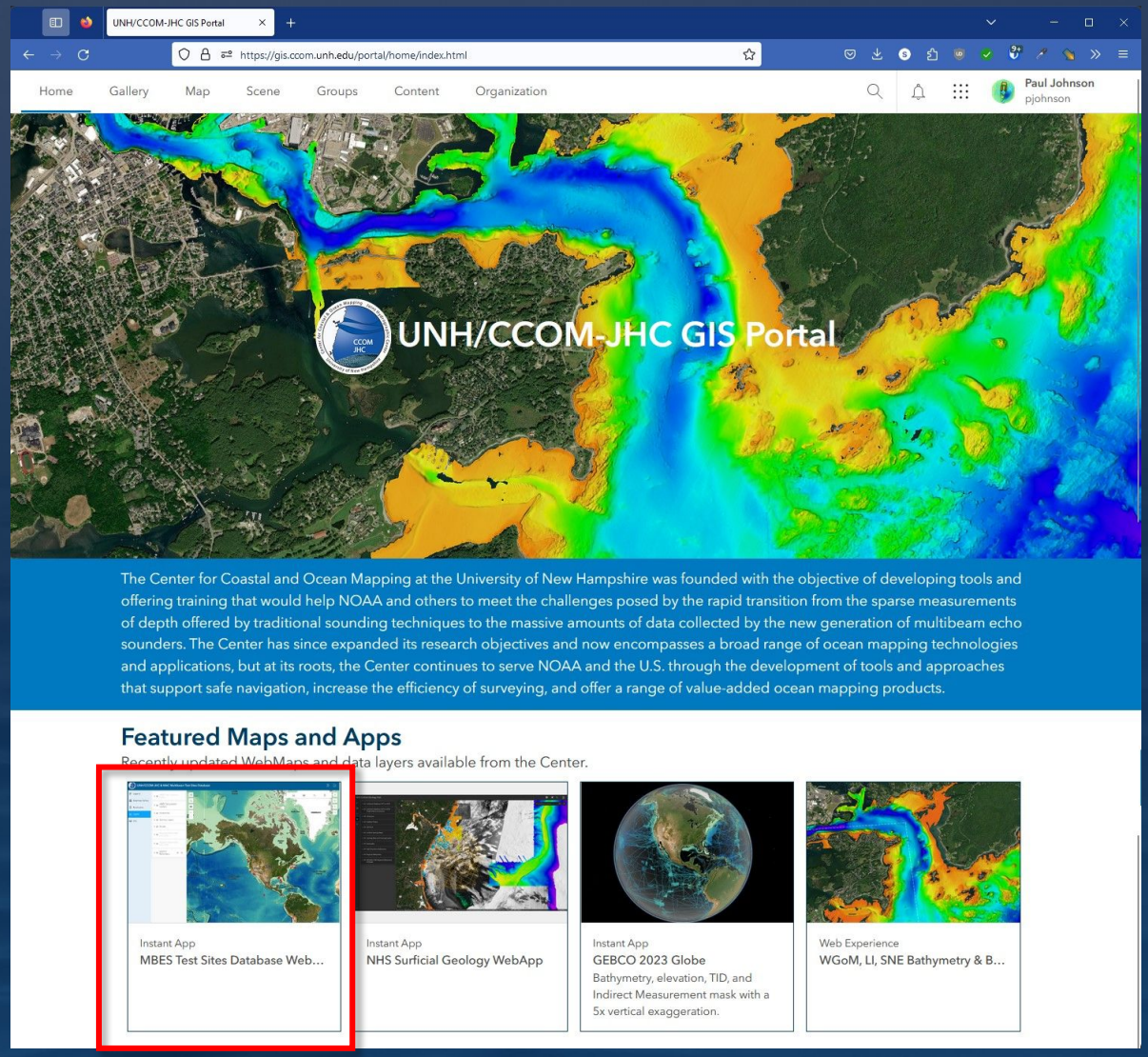
## Now: Adding test sites

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

## Next: Standards for file submission

- Line files
- Bathymetry grids
- Operational parameters

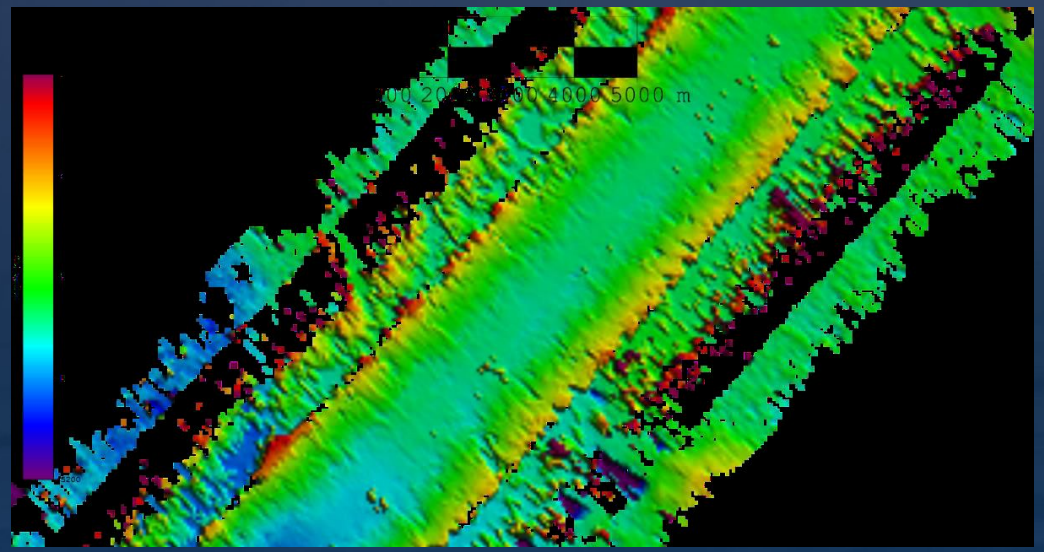
## Nice to have: Speed up the WebApp

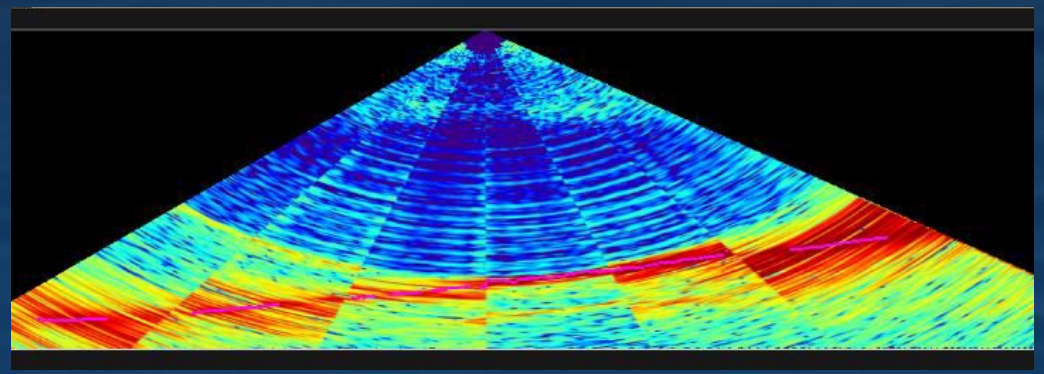


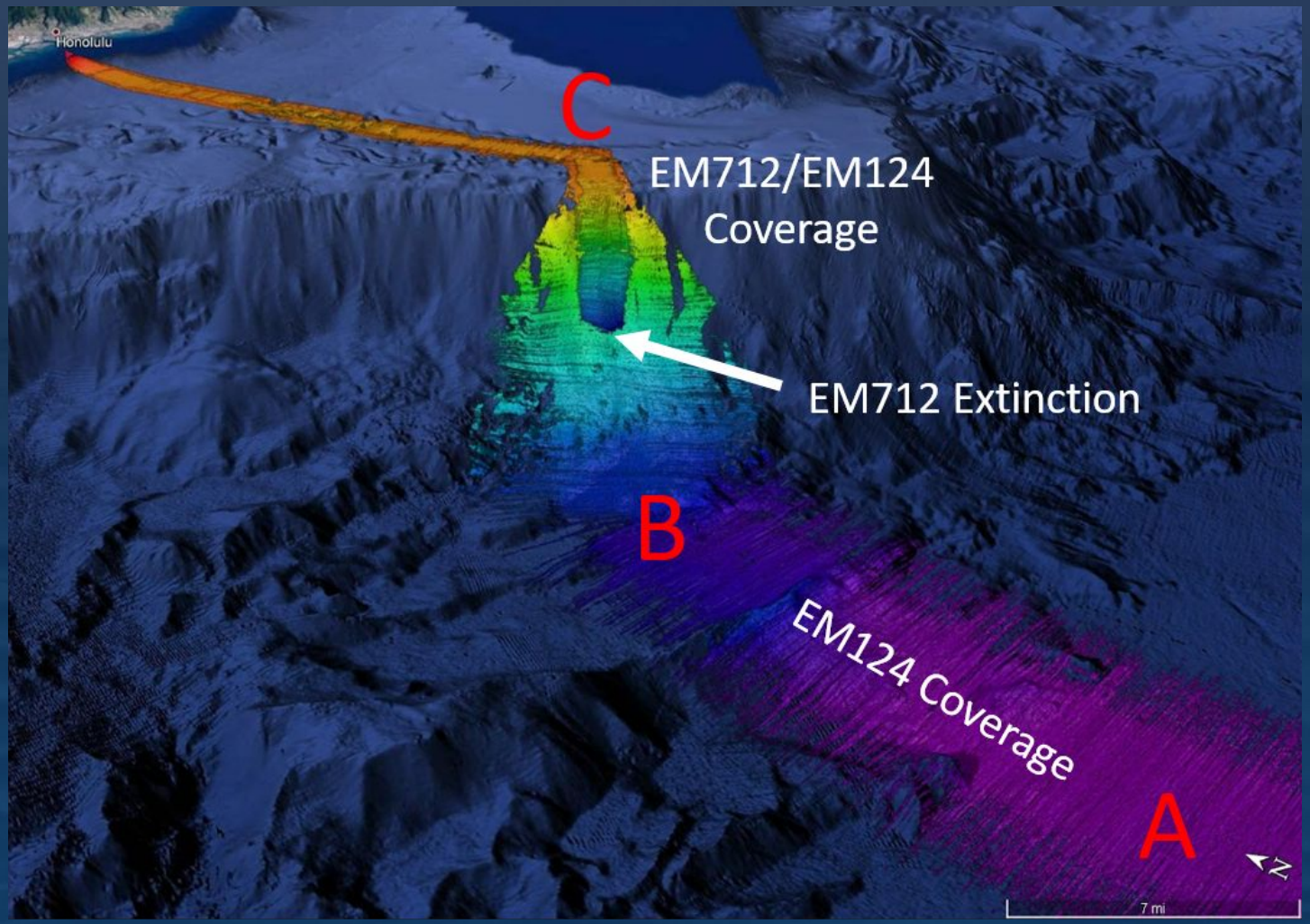

**https://gis.ccom.unh.edu**

# Takeaways from Edinburgh: Transit Mapping

System performance testing **before** ‘real’ mapping cruises





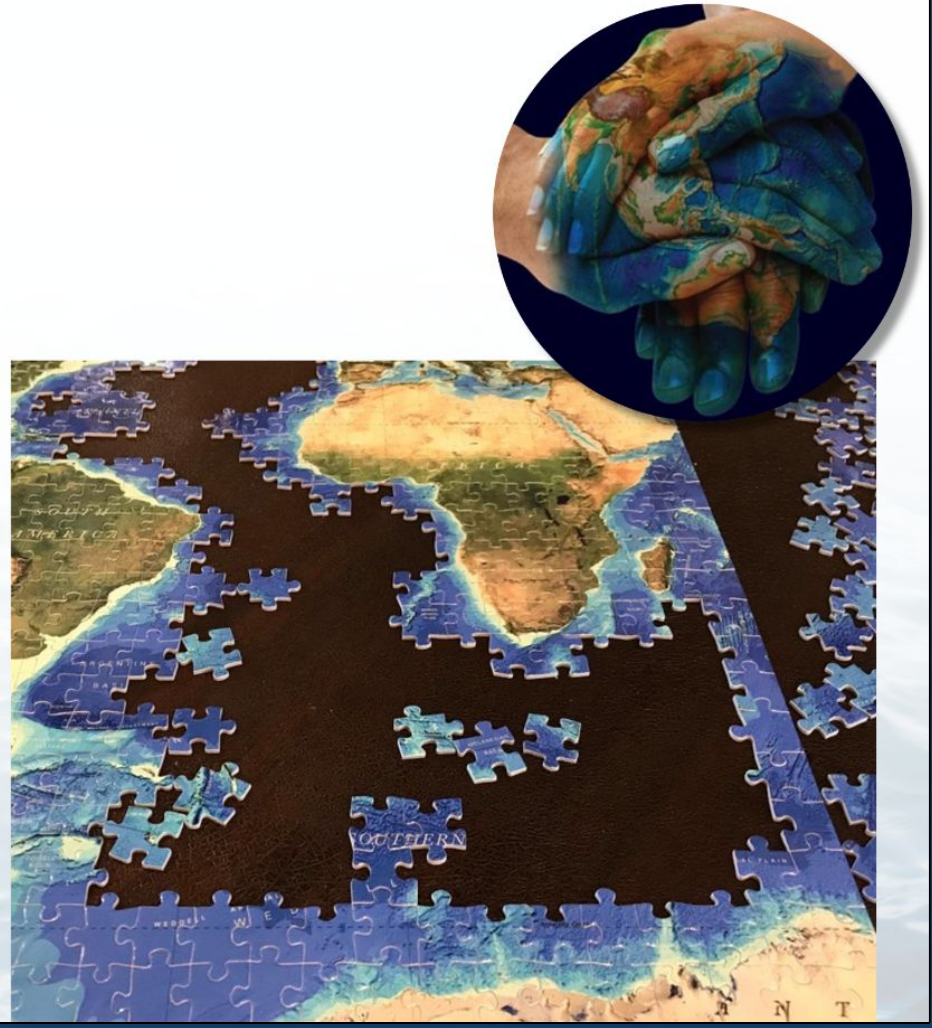


# Call to Action:
# Acquire & Share Transit Data Whenever Possible!


- Technical resources & tools
  - Openly available tools
  - Best practices/SOPs
  - Remote acquisition
  - Data contribution


- Community assistance
  - Data preservation/access
  - Data processing/integration


- Cultural barriers can be overcome
  - Incentives
  - Equity and access



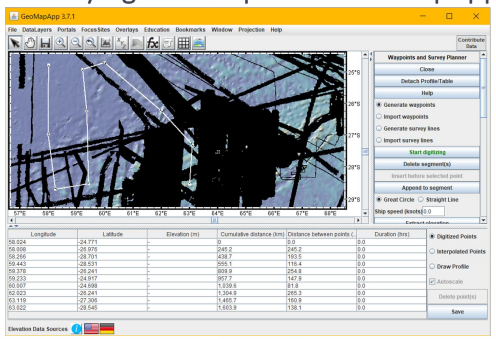


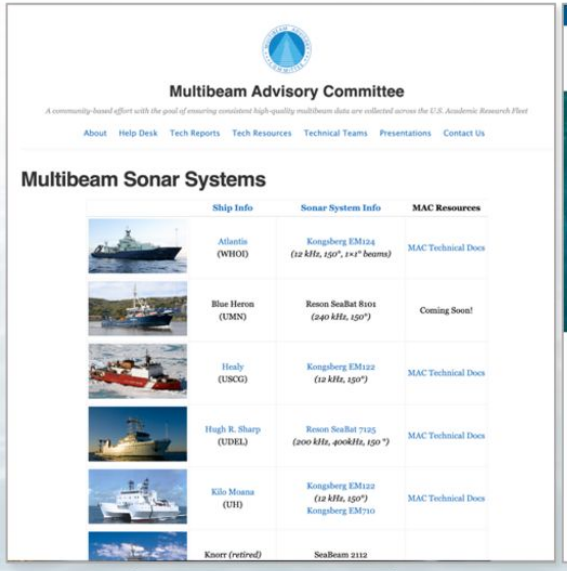
from: Ferrini, 2023 (FEMME)

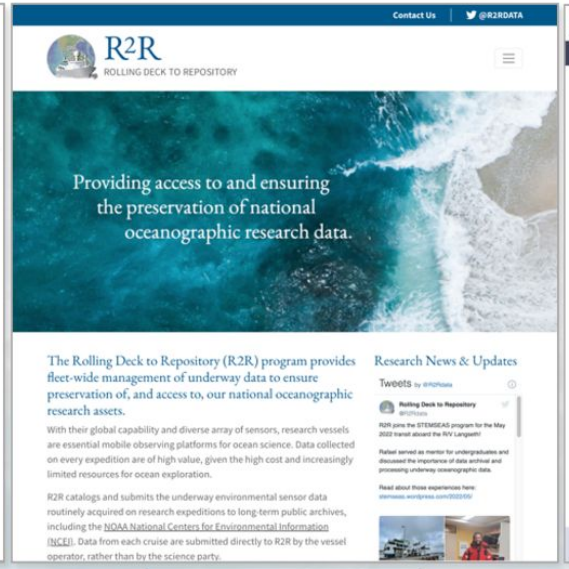
# US Academic Research Fleet

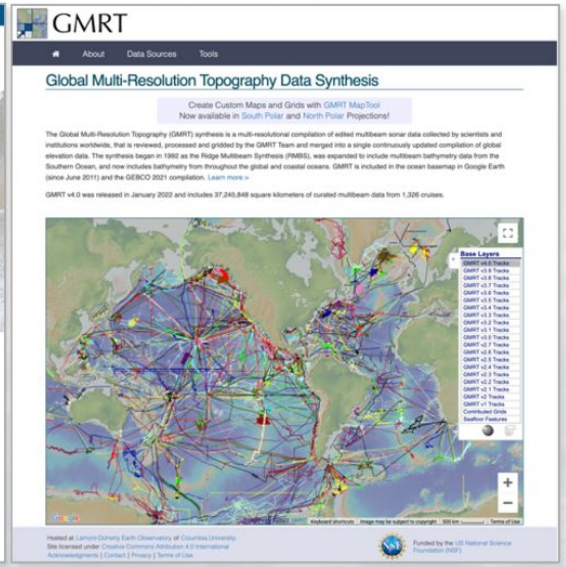
- Comprehensive data stewardship
  - Delivers large volumes of data to public archives
  - Promotes transit data acquisition
- Increases return on investment in MBES capabilities
- Promotes data access *and* data accessibility

Identifying Data Gaps with GeoMapApp







Acquisition → Preservation → Synthesis & Integration → Preservation, Provenance & Access

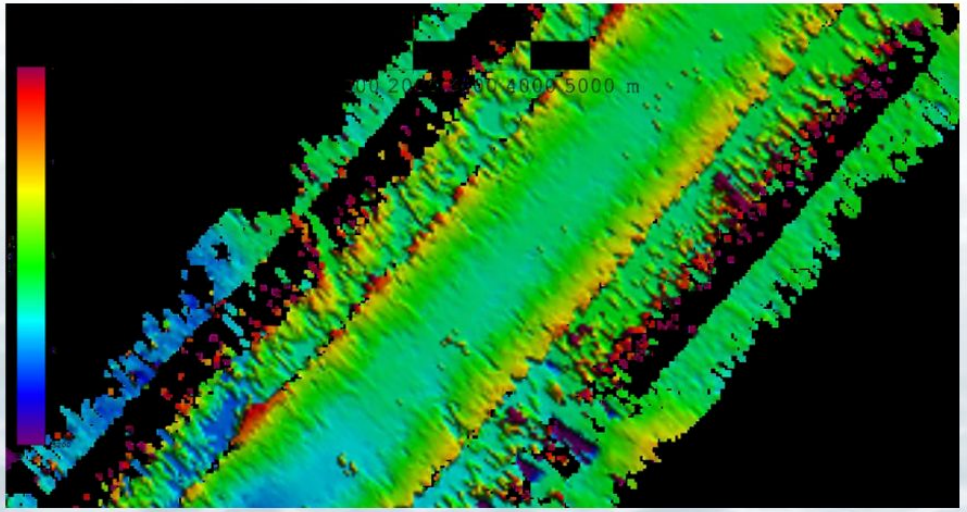
*Supported by the US National Science Foundation*

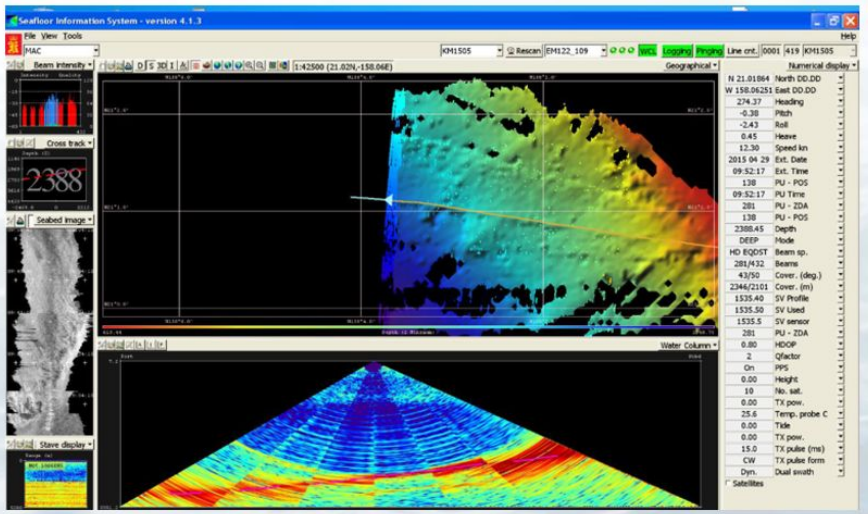


from: Ferrini, 2023 (FEMME)

# MAC Support of Transit Mapping

- Promote a **culture** of routine data acquisition
  - Supports science
  - Provides data for system monitoring
- Sound speed manager to help with SSP



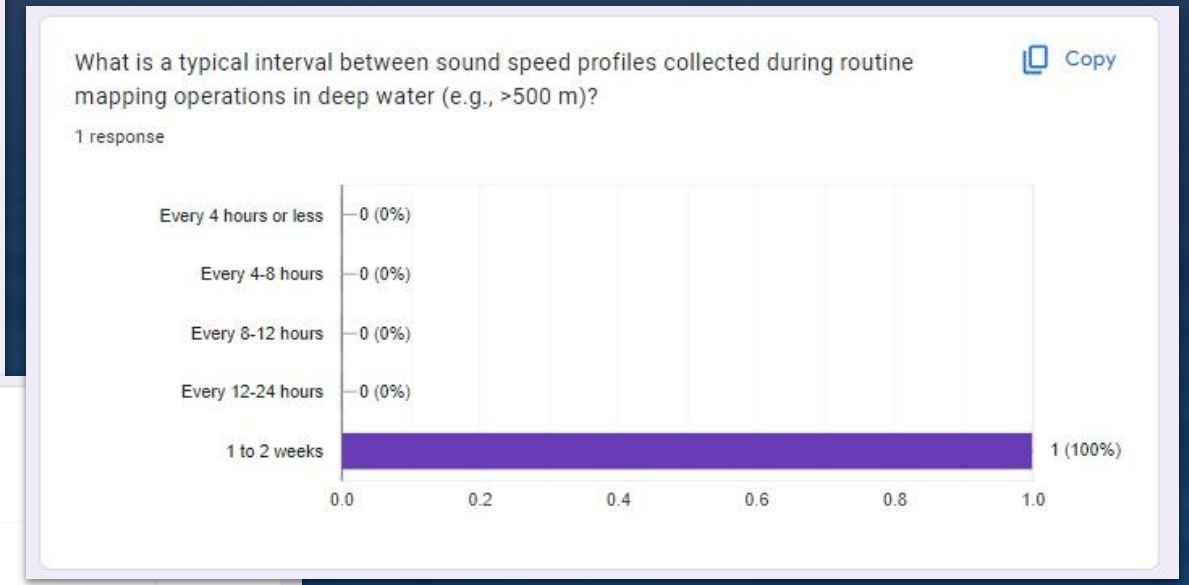


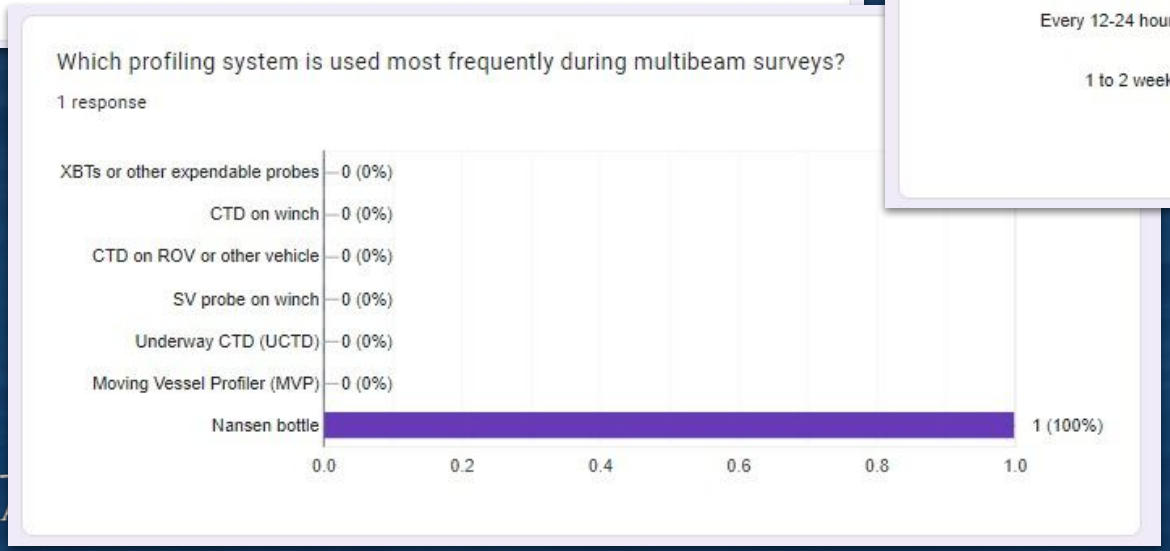
from: Ferrini, 2023 (FEMME)

*MAC Breakout Session*

# Sound Speed Smörgåsbord

## 1:00 PM in Pakalana


Lamont-
COLUMBIA

# Questions? Answers? Reach out!

Ocean Mapping Community Wiki

***github.com/oceanmapping/community***

***omcadmin@ccom.unh.edu***

Multibeam Advisory Committee

***mac.unols.org***

***mac-help@unols.org***

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE