Multibeam Advisory Committee (MAC)
2020 RVTEC Update

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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 the protocols & tools for system assessment
  - Document, report, & publish MBES system performance
  - Provide on-board & remote support to ships
  - Share best practices & knowledge

- Technical Reports
  - SAT, QAT, ANT
  - Document each MAC engagement
  - Host Non-USARF Reports

- Technical Resources
  - Cookbooks, guidance, tools, etc.

- Help Desk

http://mac.unols.org
Mapping Systems in the U.S. Academic Fleet

- USARF vessels with MBES
  - 11 Research Vessels
  - 1 USCG Icebreaker

- 16 Kongsberg systems
  - EM710 / EM712
  - EM302
  - EM122 / EM124

- 2 Reson shallow systems

- RCRVs coming online soon

Map once, use many times - every ping counts!
### Kongsberg Systems in the U.S. Academic Fleet

<table>
<thead>
<tr>
<th>Ship</th>
<th>System(s)</th>
<th>Gondola</th>
<th>Arrays</th>
<th>Life Cycle</th>
<th>MAC Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantis</td>
<td>EM122</td>
<td>Y</td>
<td>2010 ?</td>
<td>Late-Life</td>
<td>QAT*</td>
</tr>
<tr>
<td>Healy</td>
<td>EM122</td>
<td>N</td>
<td>2010</td>
<td>Late-Life</td>
<td>QAT, ANT</td>
</tr>
<tr>
<td>Kilo Moana</td>
<td>EM122 / EM710</td>
<td>N</td>
<td>2012</td>
<td>Mid-Life</td>
<td>SAT, QAT*, ANT</td>
</tr>
<tr>
<td>Marcus G. Langseth</td>
<td>EM122</td>
<td>Y</td>
<td>2007 (TX) / 2010 (RX)</td>
<td>Late-Life</td>
<td>QAT*</td>
</tr>
<tr>
<td>Nathaniel B. Palmer</td>
<td>EM122</td>
<td>N</td>
<td>2015</td>
<td>Mid-Life</td>
<td>SAT, QAT, ANT</td>
</tr>
<tr>
<td>Neil Armstrong</td>
<td>EM122 / EM710</td>
<td>N</td>
<td>2016</td>
<td>Mid-Life</td>
<td>SAT, QAT</td>
</tr>
<tr>
<td>Roger Revelle</td>
<td>EM124 / EM712</td>
<td>Y</td>
<td>2020</td>
<td>Early-Life</td>
<td>SAT*, QAT</td>
</tr>
<tr>
<td>Sikuliaq</td>
<td>EM302 / EM710</td>
<td>N</td>
<td>2014</td>
<td>Mid-Life</td>
<td>SAT, QAT*</td>
</tr>
<tr>
<td>Sally Ride</td>
<td>EM122 / EM712</td>
<td>N</td>
<td>2016</td>
<td>Mid-Life</td>
<td>SAT, QAT</td>
</tr>
<tr>
<td>Thomas G. Thompson</td>
<td>EM302</td>
<td>N</td>
<td>2018</td>
<td>Early-Life</td>
<td>SAT</td>
</tr>
</tbody>
</table>

*Includes virtual visits*
Remote support for:

- Atlantis
- Kilo Moana (QAT)
- Armstrong (QAT)
- Revelle (SAT)
- Sikuliaq (QAT)
- Langseth

Assessment Tools

US EEZ SOMP Symposium

Non-MAC testing

- NOAA Ship Okeanos
- E/V Nautilus
MAC System Performance Approach

1. Shipboard Acceptance Tests - SAT -(11)
   - Baseline performance
2. Acoustic Noise Tests - ANT - (9)
   - Characterize vessel noise
3. Quality Assurance Tests - QAT - (24)
   - Monitor existing installations
4. Tools
   - Acquisition and planning
   - Assessment

From Last Weekend
SAT and QAT procedures include:

1. Geometry & Configuration
2. Calibration (patch test)
3. RX noise testing
4. Swath accuracy
5. Swath coverage (extinction)
6. Impedance testing
7. Reporting
Why spend the time reviewing offsets and testing?

Rotated TX Array Orientation

Swath Width ~ 1 x depth
FM outer sectors cannot track bottom

Correct TX Array Orientation

Swath Width ~ 2.5 x depth
FM outer sectors track bottom
Recent Lessons Learned from a Fleet-wide Perspective

- High speed internet to the ship helps greatly with remote support
  - Zoom, Google Drive, Slack? (email is not ideal)
- Use of common tools across data life cycle helps system performance assessment
  - Catch problems early
  - Open access to performance reports is critical
  - Post-cruise quality assessment via R2R and GMRT e.g. GMRT extinction plots
- Mistakes and variability in survey reports continue to be a problem and can affect other sensors
  - MAC guidelines for survey reports
Benefits to US Research Community

- Seabed mapping data is an essential ocean observation
  - Bathymetry, backscatter, water column data have broad applications in interdisciplinary research
- Very little of the ocean has been measured with direct observation
  - ~20% of the global ocean
  - ~50% of US EEZ
- Best practices and routine system checks promote data acquisition even when mapping is not a primary objective
  - US ARF vessels routinely acquire data during transits - providing new data that fills gaps in data coverage globally and within US EEZ
- Mapping data stewarded by complementary efforts of MAC, R2R and GMRT increase return on investment by ensuring that high quality data are acquired, archived and integrated into publicly available data syntheses
Contributions of the US ARF to National and Global Mapping

- US ARF is a significant contributor to:
  - NCEI/IHO MB archive > 60% by cruise
  - US EEZ mapping > 20%
  - Global ocean mapping ~9%
- Coordinated presentations at NOAA-led Standard Ocean Mapping Protocol (SOMP) Symposium
  - R2R, MAC, GMRT
- GMRT synthesis serves as base maps for many national and international web apps
- GMRT contributed directly to GEBCO/Seabed 2030

**based on GMRT v3.8**
GMRT: Tools for QA/QC of processed MBES data

GMRT v3.8 MBS
• 1,192 cruises, 36 vessels
• 34,764,597 square km
• 9.61% global ocean
• >20% US EEZ
Multibeam Assessment Resources

1. Survey report guidelines
2. SAT/QAT checklist
3. Open-source tools in development
   a. File Trimmer (.all only, .kmall*)
   b. Swath coverage plotter (.all, .kmall*)
   c. Swath accuracy plotter (.all, .kmall*)
   d. BIST plotter (SIS4, SIS5)
   e. Install / Runtime Param. Tracker*

http://mac.unols.org/resources/assessment-tools
Data quality depends on correct configuration

Vessel and sensor offsets must be clearly documented

Survey reports directly impact data quality for decades

Vessel and 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

***PLEASE give this to your surveyor!***

http://mac.unols.org/resources/vessel-geometry-and-mbes-offset-recommendations
SAT / QAT Checklist

Standardized procedures in order of priority

Updated collaboratively throughout planning and at-sea operations

SAT/QAT Procedures

1. System integration review and functional testing
2. Configuration review QAT or after any change with change control form
3. Satellite communication system
   a. Multichannel communications
   b. VSAT antenna
   c. EIRP antenna
   d. X-band antenna
   e. Power amplifier
   f. Power supply and redundant power supply
4. Data communications system
   a. Satellite communications
   b. Intra-vehicle communications
   c. VSAT antenna
   d. EIRP antenna
   e. X-band antenna
   f. Power amplifier
   g. Power supply and redundant power supply
5. Navigation/positioning system
   a. Inertial navigation system
   b. GPS/IMU combination
   c. Standalone GPS
   d. GNSS antennas
6. Vessel operations
   a. First person or officer
   b. Second person or officer
7. Vessel survey operations
   a. Vessel survey and vessel configuration

Pro-GAT/QAT Planning

1. Vessel survey planning
   a. MAC and vessel personnel identify suitable sampling sites for vessel planning
   b. MAC and vessel personnel identify suitable sampling sites for vessel planning
   c. Vessel survey configuration
   d. Vessel survey configuration
   e. Vessel survey configuration
   f. Vessel survey configuration
   g. Vessel survey configuration
2. Design working plans
   a. MAC and vessel personnel identify suitable sampling sites for vessel planning
   b. MAC and vessel personnel identify suitable sampling sites for vessel planning
   c. Vessel survey configuration
   d. Vessel survey configuration
   e. Vessel survey configuration
   f. Vessel survey configuration
   g. Vessel survey configuration
3. Mutlithread advisory committee
   a. Multichannel communications
   b. Multichannel communications
   c. Multichannel communications
   d. Multichannel communications
   e. Multichannel communications
   f. Multichannel communications
   g. Multichannel communications

Notes from 2020/10/08 planning call

At: update these notes with any other thoughts/considerations:

1. Initial site review/field testing to be conducted on-site at the site of the MCO
2. Maculine (M) split with the primary task: calibrate and validate the system
3. Additional testing to be conducted on-board the vessel
4. Additional testing to be conducted on-board the vessel
5. Additional testing to be conducted on-board the vessel
6. Additional testing to be conducted on-board the vessel
7. Additional testing to be conducted on-board the vessel
8. Additional testing to be conducted on-board the vessel
9. Additional testing to be conducted on-board the vessel
10. Additional testing to be conducted on-board the vessel

Multibeam Advisory Committee

Mapping System SAT/QAT Checklist

Roger Revelle EM124 / EM712 SAT
San Diego, October 2020

General

- Shaped documents for FR 2023 SAT-planning
- Revelle MT4C survey data
- MAC geometry review
- MAC assessment tools in development

Notes for next planning call (2020/10/14 – 5PM ET)

1. Vessel off-site review and ISS/Sat/Sat/PHINS configurations
2. Updated reference surveys and cruising
   a. Added reference lines for new surveys at existing 118, 1275, and 2500 m sites
   b. Added 400 m site
3. Coverage line and range maps to pass through ISO/SC/01 core - need to file intent (or are we finding a different line)?
4. Expectation for PHIN5 calibration need to repeat with PHIN5 multime attitude velocity?
5. Navigators and radar predictions for rough schedule? Navigating test, their EM124 cal first?
6. MAC: provide updated noise test procedure for BSS 5
7. MAC: provide cruise settings
8. MAC: provide data trimming procedure for EM124
   a. Tested with the latest SIS 5 format?
Assessment Tools

Live demonstration:

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

http://mac.unols.org/resources/assessment-tools
Thank you!

http://mac.unols.org
mac-help@unols.org