Multibeam Advisory Committee (MAC) Breakout

Paul Johnson, Kevin Jerram, Tomer Ketter, & Giuseppe Masetti

Center for Coastal & Ocean Mapping, University of New Hampshire

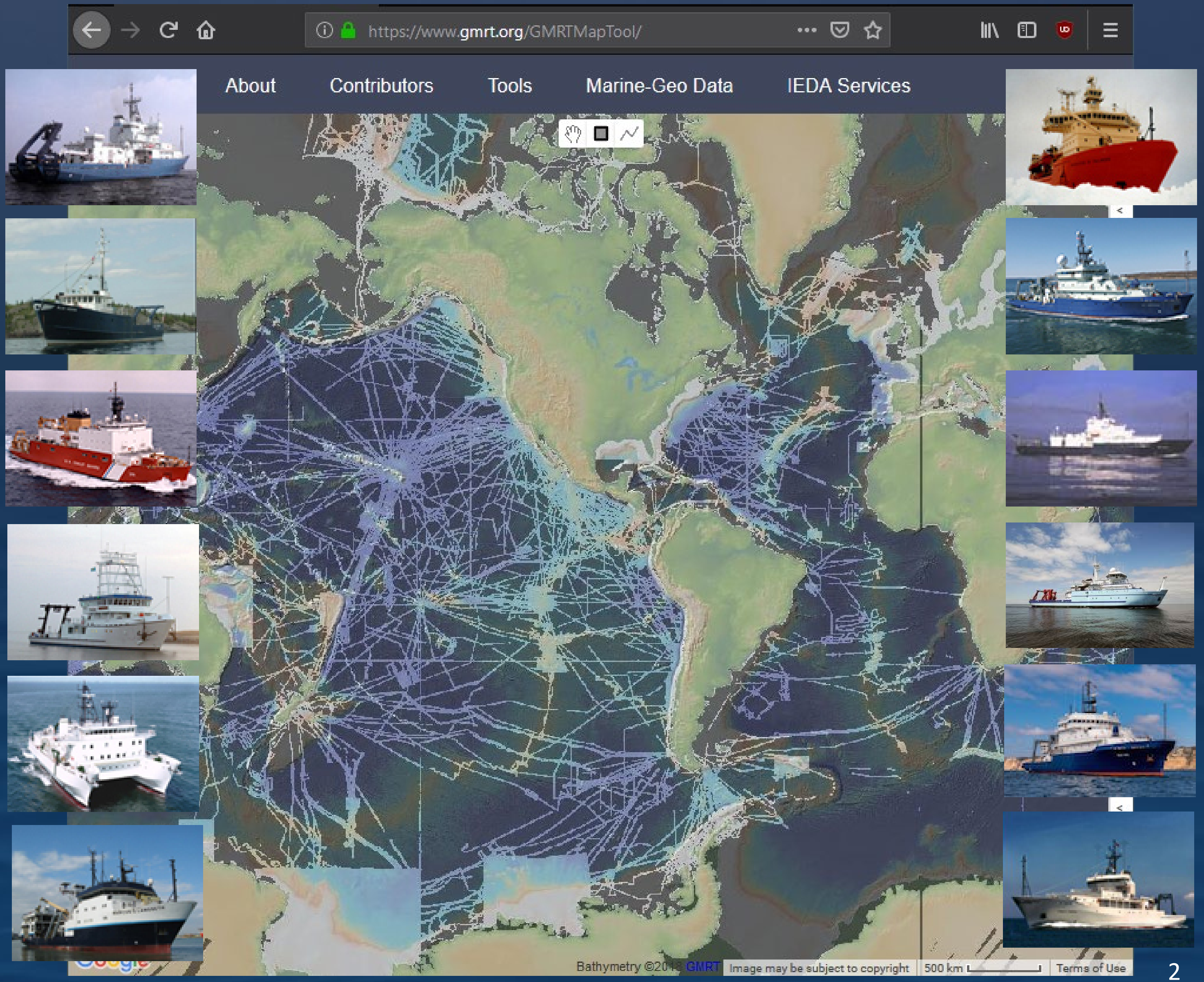
Vicki Ferrini

Lamont Doherty Earth Observatory, Columbia University

Supported under NSF Grant No. 1933720

MBES Performance Testing in the U.S Academic Fleet

- Multibeam Advisory Committee funded by NSF in 2011, 2015, & 2019 (5 year grant)
- Mission to improve the U.S. Academic Fleet's multibeam data quality
- 16 multibeams between 11 Research Vessels & 1 USCG Icebreaker (more coming)
- Standardize the approach and tools for system performance assessment



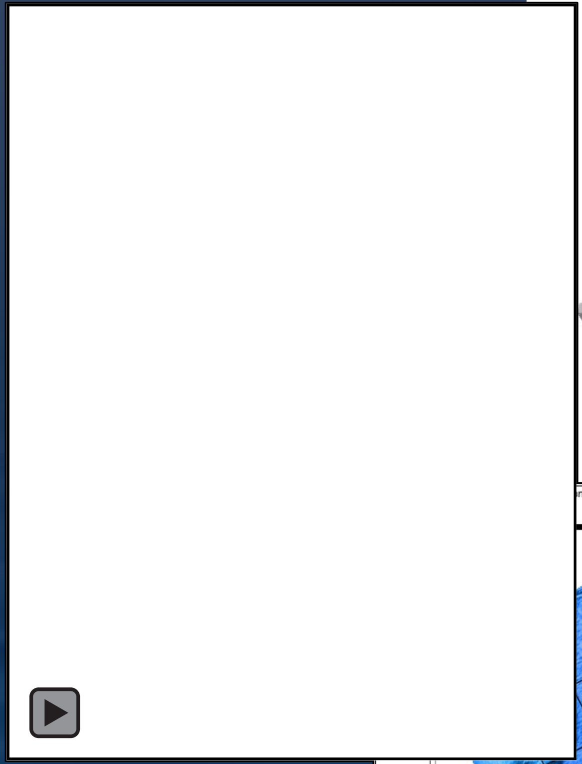
Not working in isolation…

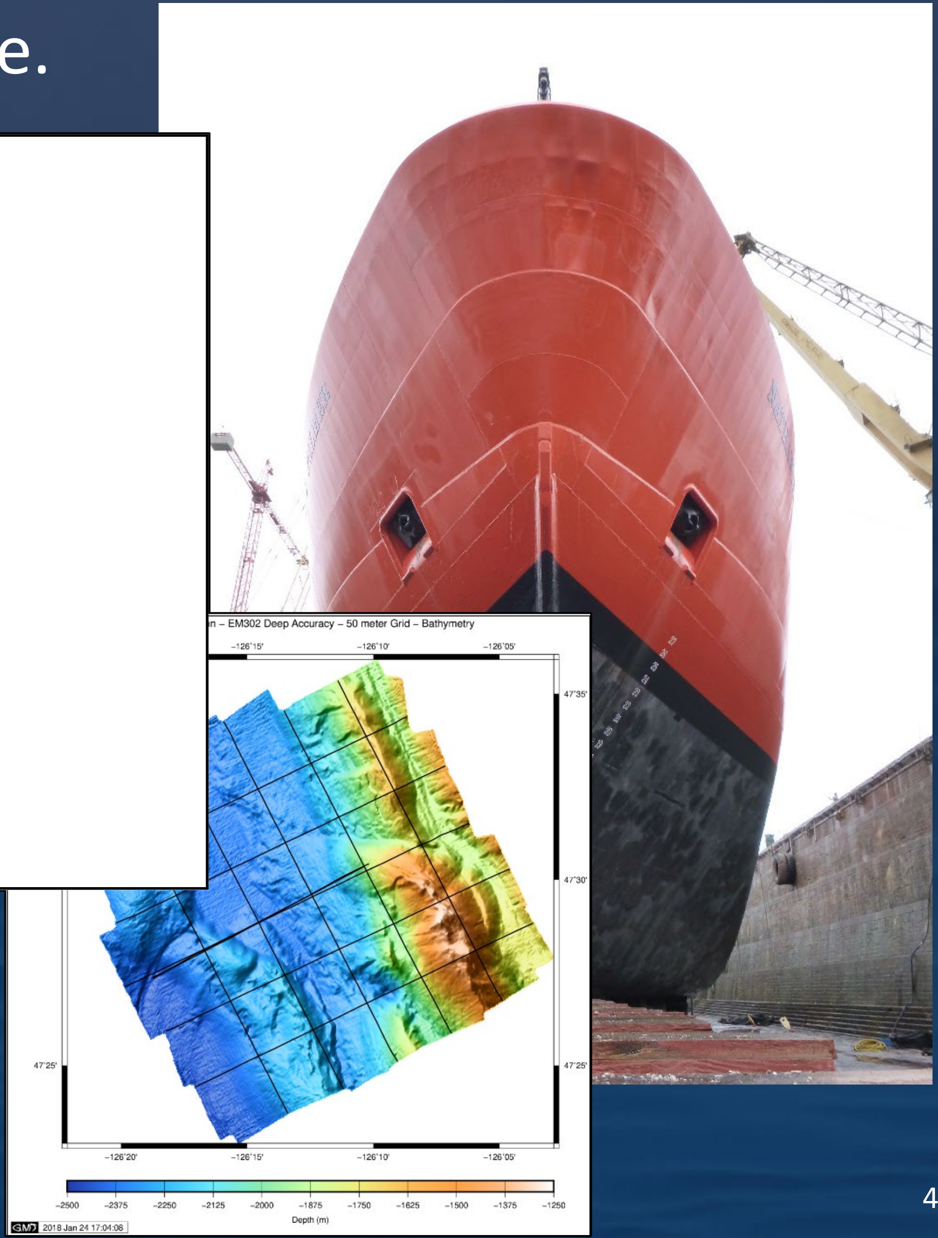
- Additional world wide partners
  - NOAA hydrographic and science vessels
  - Non-UNOLS oceanographic institutes
  - Private ocean exploration vessels
- No cost to NSF
- Reports contribute to overall MBES knowledge base

MAC Approach to System Performance

The MAC is involved throughout multibeam life cycle.

1. Shipboard Acceptance Tests
   - Establish baseline performance (11)
2. Acoustic Noise Tests
   - Characterize vessel noise (9)
3. Quality Assurance Tests
   - Monitor existing installations (22)
4. Monitoring & Support Tools
   - Sound Speed Manager
   - SmartMap
   - Swath Analysis
   - BIST

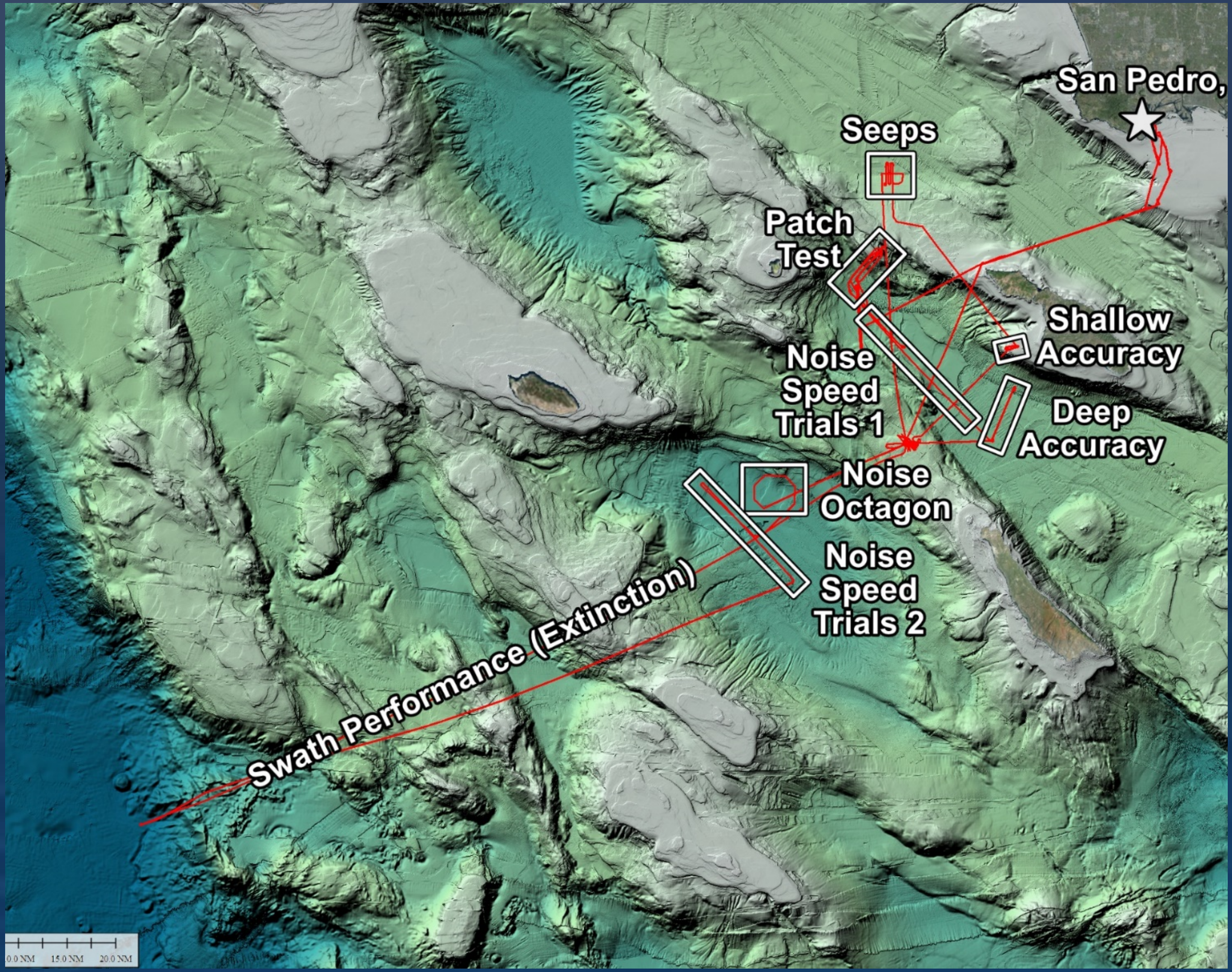




MAC Approaches To System Performance

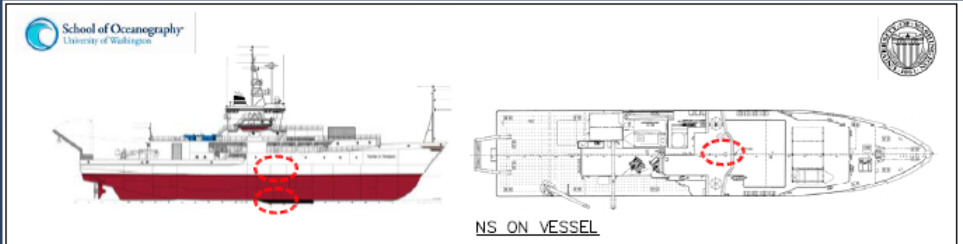
SAT and QAT procedures include:

1. Geometry & Configuration
2. Calibration (patch test)
3. RX noise testing
4. Swath accuracy
5. Swath coverage (extinction)
6. Impedance testing
7. Backscatter assessment
8. Water column assessment
9. Reporting



Geometry & Configuration Review: Approach

- The vessel survey is the foundation for correct sensor integration and high data quality
- Review survey report & advise on interpretation for:
  1. Mapping system origin
  2. Motion sensor and antenna offsets
  3. Transducer array offsets
  4. Waterline
- Establish unified mapping sensor reference frame
- Enter information into acquisition software and/or positioning/attitude system



WCI REF #	LONGITUDINAL OFFSET (X)	TRANSVERSE OFFSET (Y)	BASELINE OFFSET (Z)	DESCRIPTION
3000	-29.5618	4.8745	-2.5462	CL TRANSCEIVER WELL AT DECK LEVEL
3001	-28.2773	2.9314	-12.1748	CL POSMV STARBOARD GPS ANTENNA
3002	-28.2738	0.8017	-12.1736	CL POSMV PORT GPS ANTENNA
3003	-5.0711	0.1508	-24.1740	CL GPA-215 GPS ANTENNA
3005	-4.0396	0.3499	-24.6277	CL CNAV 2000 GPS ANTENNA
3006	-4.0728	2.8119	-24.3673	CL CNAV 3050 GPS ANTENNA
3007	-0.6226	-0.3232	7.5657	CL TRANSCEIVER STEM
3010	-0.6052	0.9723	6.2035	CL ADCP
3011	0.0000	0.0000	0.0000	**CL TDC MARK PORT V5 IMU**
3012	-0.0041	0.2268	-0.0446	CL TDC MARK STARBOARD V3 IMU
3013	0.5998	0.7889	6.1952	CL PORT 12 kHz TRANSCEIVER
3016	0.6000	1.2504	6.1956	CL STARBOARD 12 kHz TRANSCEIVER
3017	0.3179	2.1380	6.1948	CL 3.5 kHz TRANSCEIVER ARRAY
3018	1.4949	4.1621	-17.1050	CL GP-170 GPS ANTENNA
3019	1.7774	0.9172	-16.2376	CL FURUNO GPS ANTENNA
3020	1.8216	1.5230	6.1876	CL TRANSVERSE Rx MULTI BEAM ARRAY
3021	3.7709	2.1319	6.2010	CL LONGITUDINAL Tx MULTI BEAM ARRAY

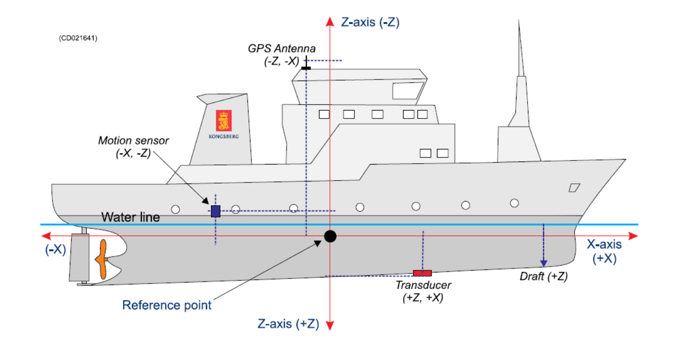
ALL UNITS ARE DECIMAL METERS

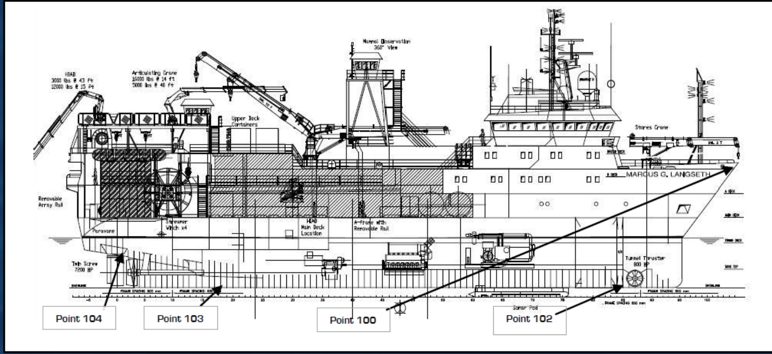
EQUIPMENT ROLL / PITCH / HEADING OVERVIEW
SEE ADDITIONAL SHEETS FOR SPECIFICS

RV TOMMY THOMPSON
SHIP SURVEY, SEPTEMBER 2016
COMPLETED AT VIGOR SHIPYARD
SEATTLE WASHINGTON

DWG: 268101.DWG
DATE: 01-07-2018
DWG BY: PPR
CHK BY: CRB2
SCALE: NTS
REV #: ###
JOB NO: 2681-001

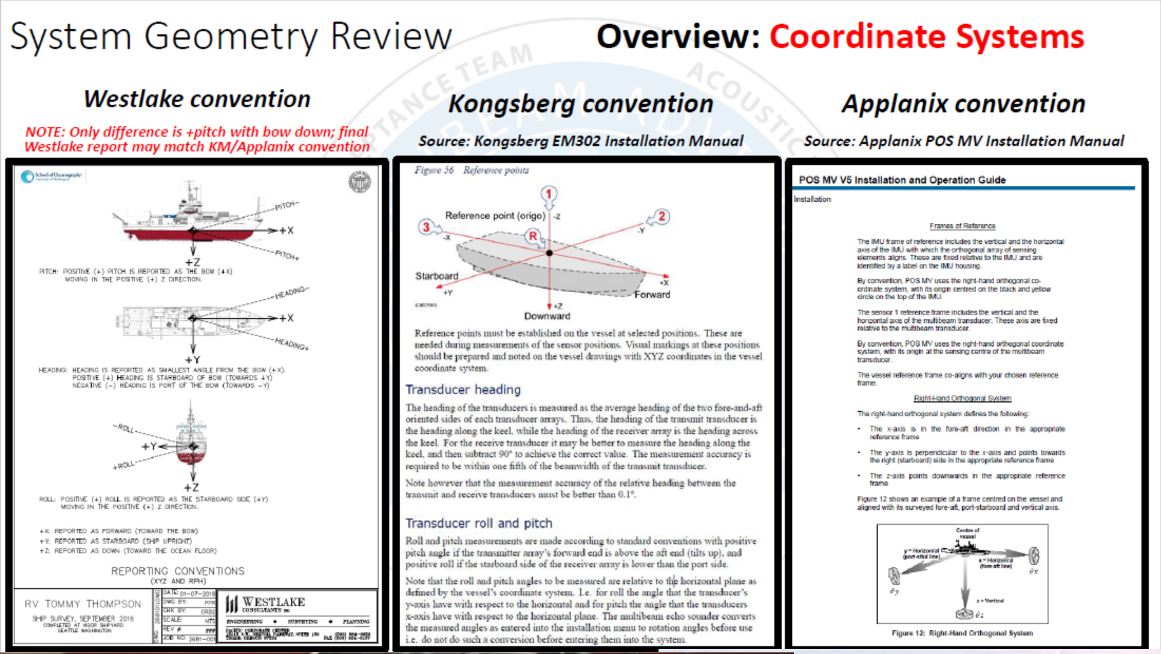
WESTLAKE CONSULTANTS INC.
ENGINEERING ◆ SURVEYING ◆ PLANNING
PACIFIC CORPORATE CENTER
15115 S.W. SEQUOIA PARKWAY, SUITE 150
TIGARD, OREGON 97224
(503) 684-0652
FAX (503) 624-0157

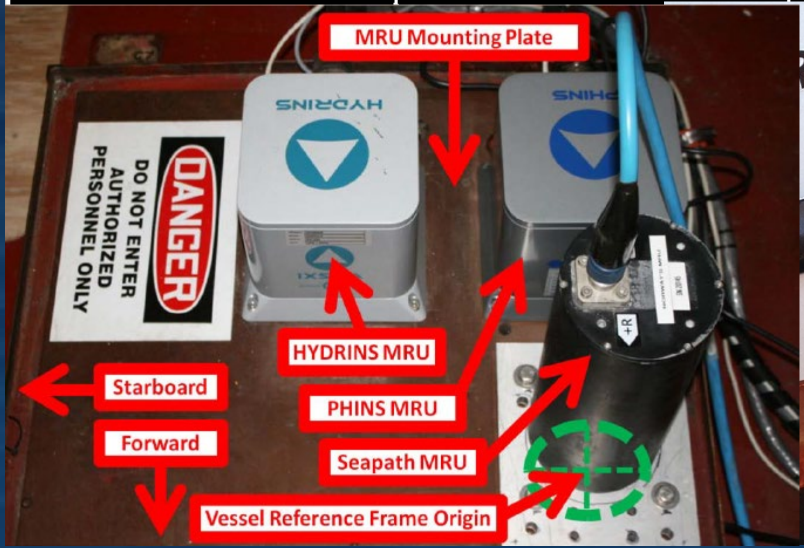


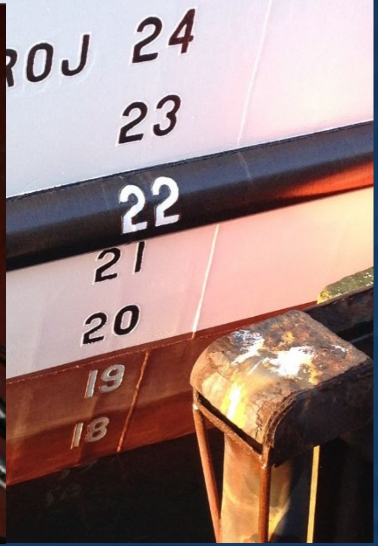


Geometry & Configuration Review : Lessons Learned

- Survey reports used for decades
- Reports are often correct but unclear
- Operators must demand clarity in reporting:
  - Origin of survey
  - Axes, units, and sign conventions
  - Pictures
  - Prompt delivery
- Cost of a high quality survey is small when compared to:
  - Time lost
  - Poor data quality
  - Reestablishing the vessel frame
- Mistakes sneak in and persist
- Documentation can outlast personnel

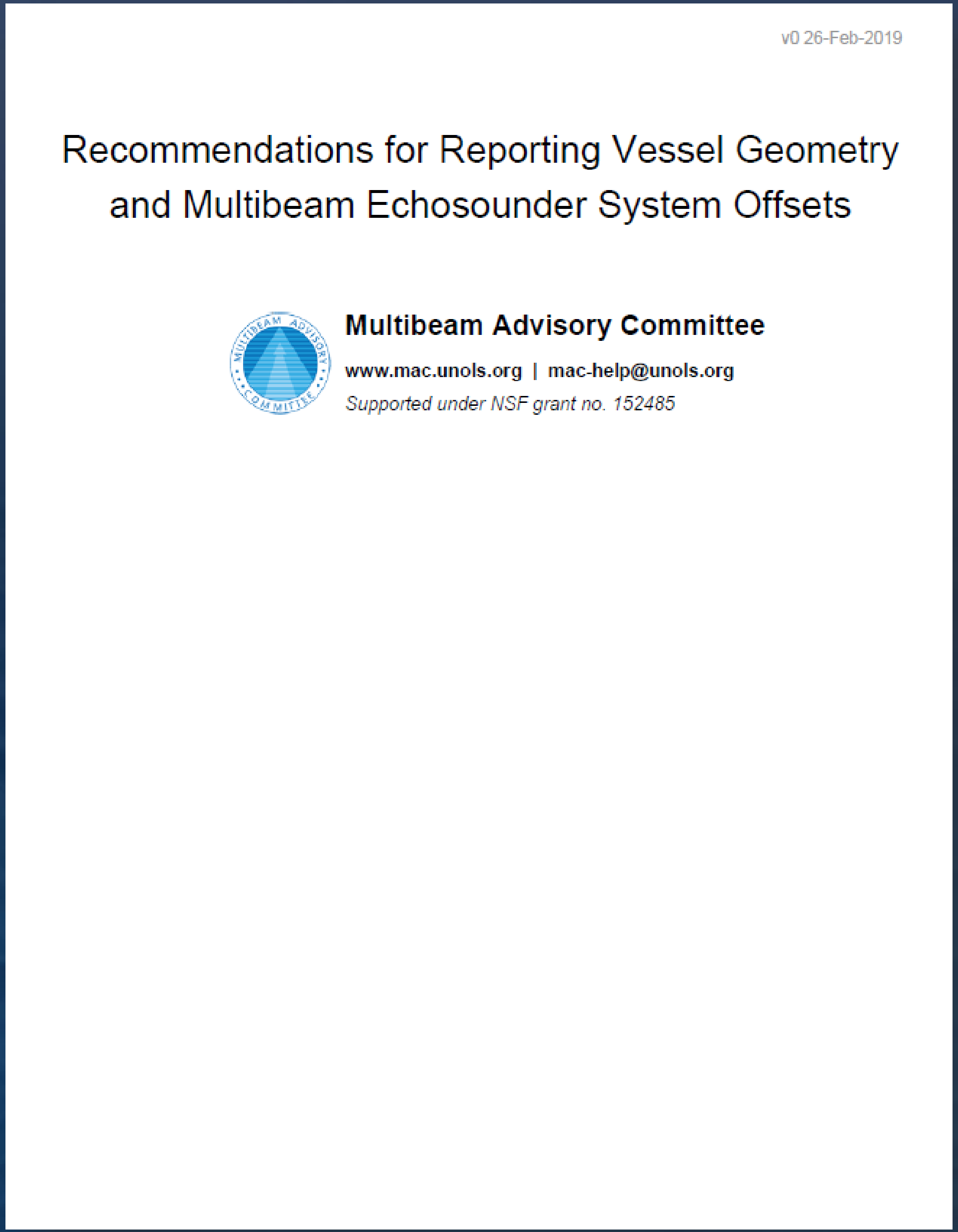






Geometry & Configuration Review : Lessons Learned

- Recommendation document available through the MAC website
- http://mac.unols.org/resources/vessel-geometry-and-mbes-offset-recommendations



v0 26-Feb-2019

Recommendations for Reporting Vessel Geometry and Multibeam Echosounder System Offsets

Multibeam Advisory Committee

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

Supported under NSF grant no. 152485

Geometry & Configuration Review : Recommendations

Recommendations for Reporting Vessel Geometry and Multibeam Echosounder System Offsets

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v0 26-Feb-2019

Purpose

Vessel survey reports (VSRs) play a critical role throughout service life (10+ years) of a multibeam echosounder system (MBES) and provide the foundation for future vessel and sensor surveys. This document provides recommendations for VSRs that minimize opportunity for errors in the configuration of MBES and ancillary sensors.

Introduction

The quality of MBES data depends on the performance and integration of several components in the system (e.g., antennas, motion sensors, and transducer arrays). These sensors are configured in their respective software packages using linear and angular offsets measured by a third-party surveyor and documented in a VSR. The VSR provides the foundation for mapping system configuration and all future vessel surveys, such as those required after the addition or relocation of sensors.

The absolute dependence of MBES configuration on the VSR cannot be overstated. Unclear or ambiguous presentation of the vessel survey results can lead to erroneous sensor configuration and difficulty in re-establishing the vessel reference frame during future vessel surveys. Errors in MBES configuration can manifest in many different forms, such as difficulty during calibration or depth artifacts across the swath correlated with vessel motion. These errors often persist for many years due to the infrequency of opportunities to survey a vessel (especially dry dock opportunities to survey transducer arrays). Sensor offsets are applied in real-time by the position, attitude, and acoustic systems (e.g., beamforming during transmission and reception, Doppler correction for vessel attitude velocities during bottom detection). Errors in these offsets propagate through to the bathymetry data, and often cannot be corrected after acquisition.

Considering the significant costs of MBES installations, ship time for data acquisition, and data processing at sea and ashore (as well as the wide variety of end-users for the bathymetry products), there are significant incentives to ensure a high-quality VSR and its correct translation into MBES configuration. This document recommends reporting practices for the most important MBES elements based on Multibeam Advisory Committee review of a wide variety of reports since 2010. It is intended for reference by ship operators and surveyors throughout planning, surveying, and reporting to improve the translation from VSR to MBES setup.

Geometry & Configuration Review : Recommendations

Critical Components of Useful Survey Reports

MBES configuration is streamlined - and opportunities for error are reduced - when the VSR clearly presents and demonstrates the following:

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 of survey results
6. **Second review** before submission

In addition to these elements, the VSR should include a simplified table of results that can be applied directly to MBES configuration; an example table is included below.

1. Origin of the survey reference frame

a. The origin of the survey reference frame should be a permanent, physical location on the hull or other fixed location. Many vessels employ an etched plate specifically designated as the origin of the vessel reference frame. It must be accessible for follow-up surveys and absolutely unambiguous; ideally, for ease of reference, the origin is not 'in air' or underwater.

b. The origin can be co-located with that of the MBES reference frame at a specific sensor, such as a manufacturer-designated survey target on a motion sensor housing.

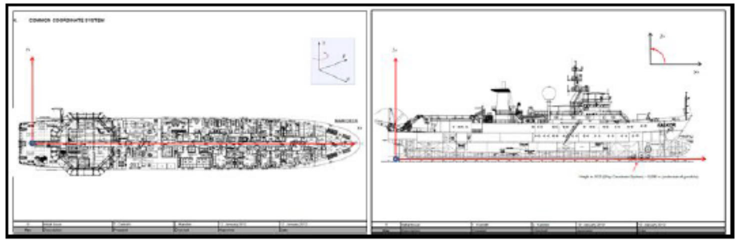

Figure 1. This survey origin is logically based on major hull features and clearly documented. However, the origin is not physically located on the hull, making it less intuitive for the wide audience of survey report readers. The origin is a point in air (or water) based on centerline at the keel height near the stern; depending on the accessibility of other benchmarks, this survey origin may complicate re-establishing the vessel frame outside of dry dock. (Images: Parker Maritime)

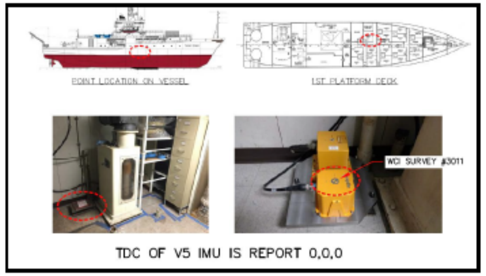

Figure 2. The most useful and intuitive origins described in survey reports are unambiguous, durable, physical markers that are accessible at any time. This example survey origin is a clear, permanent target on the motion sensor housing that is conveniently co-located with the origin chosen for mapping system configuration. (Image: Westlake Consultants, Inc.)

Geometry & Configuration Review : Recommendations

2. Axes of the survey reference frame

a. The survey report must clearly describe the three major axes (alongship, athwartship, and vertical) using common axis labels (e.g., X, Y, and Z).

b. If the survey is conducted in a reference frame that is not aligned with the major axes of the hull, the final report must transform the results into a vessel-based reference frame. Linear offsets must be clearly reported using these major alongship, athwartship, and vertical axes.

c. Likewise, regardless of the reference frame(s) used for survey calculations, all angular offsets must be clearly reported as rotations about these major alongship, athwartship, and vertical axes.

d. The survey results must be reported in one consistent reference frame.

e. See #3 below for additional notes on sign conventions.

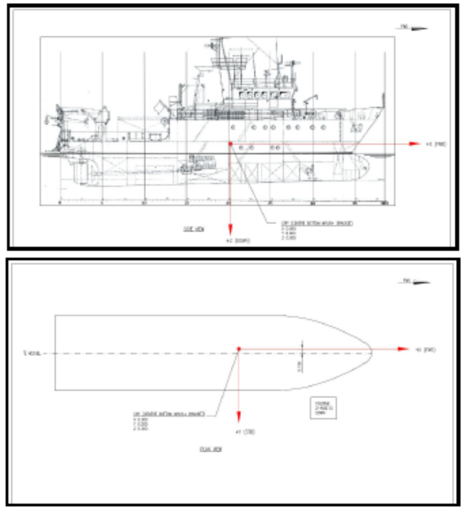

Figure 3. The major coordinate axes and origin are clearly presented for this vessel survey. (Images: Parker Maritime)

3. Sign conventions of the survey reference frame

a. The sign conventions must be clearly described for the three major positive axes (+X, +Y, and +Z) and the rotations about these axes (+Roll about the alongship axis, +Pitch about the athwartship axis, and +Heading about the vertical axis). All linear and angular offset results must be reported using consistent sign conventions, such as the manufacturer conventions outlined below.

b. Final results for all sensors should be reported using the echosounder manufacturer's sign conventions. Linear and angular sign conventions are described below for the two manufacturers of multibeam echosounder most widely installed throughout the UNOLS fleet:

   i. **Kongsberg** uses a right-handed coordinate system with all rotations following the 'right-hand rule'* about these axes:
      1. X is positive forward
      2. Y is positive to starboard
      3. Z is positive down
      4. Roll (rotation about X) is positive with starboard side down / port side up
      5. Pitch (rotation about Y) is positive with forward side up / aft side down
      6. Heading (rotation about Z) follows the compass convention (positive with rotation of the forward side starboard)
      7. Note: These conventions are also used for the most widely installed positioning systems in the UNOLS fleet (Applanix and Seapath).

   ii. **Reson** uses a right-handed coordinate system with Roll and Pitch (but not Heading) following the 'right-hand rule'* about these axes:
      1. X is positive to starboard
      2. Y is positive forward
      3. Z is positive up
      4. Roll (rotation about Y) is positive with starboard side down / port side up
      5. Pitch (rotation about X) is positive with forward side up / aft side down
      6. Heading (rotation about Z) follows the compass convention (positive with rotation of the forward side starboard)
      7. Note: Reson transducer bracket diagrams may use other conventions locally for the bracket dimensions, but the overall configuration in Reson software uses the convention described here.

c. The sign conventions applied in the survey report must be described clearly in a separate section outside of the results, as well as within each table of results. See the example table at the end.

*The 'right-hand rule' is a common description of rotations about axes. Under this rule, when a right-hand thumb is aligned with a positive linear axis, the curvature of the fingers indicate a positive rotation about that axis.

Geometry & Configuration Review : Recommendations

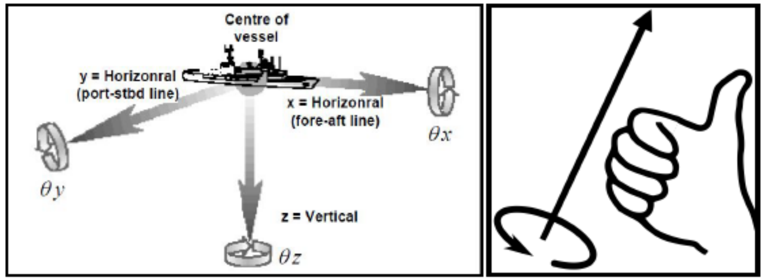

Figure 4. Example 'right-handed' coordinate system with +X forward, +Y to starboard, and +Z down, such as the convention used by Kongsberg. Reson uses another 'right-handed' coordinate system with +X to starboard, +Y forward, and +Z up. Under any orientation, the rotations about these axes must be described using a consistent sign convention, such as the 'right-hand rule' for positive rotation. (Left image: Applanix. Right image: commons.wikimedia.org/w/index.php?curid=6844647)

	Offset depositions			Correction 1 (MRU = COG)		
	Multiplikator depositions			Y+ (bow)	X + (SB)	Z +(down)
				-49,914	1,593	-6,166
				1	-1	-1
	Ship Coordinate System			Correction 1		
	X+ (bow)	Y+ (PS)	Z+ (up)	X+ (bow)	Y+ (Sb)	Z+ (down)
JAV_PS	33,554	6,147	12,799	-16,360	-7,740	-6,633
JAV_SB	33,577	-6,102	12,807	-16,337	4,510	-6,641
MS	80,922	0,000	12,801	31,007	-1,590	-6,635
JAVH	0,000	0,000	8,337	-49,914	-1,590	-2,171
DGPS_SB	54,867	-4,695	18,615	4,953	3,092	-12,449
SVSND	72,596	-0,094	0,829	22,682	-1,498	5,338
FNDSO	73,778	0,056	0,894	23,863	-1,648	5,272
ODS_01	67,976	1,764	0,055	18,062	-3,357	6,112
ITC_01	66,418	0,367	0,058	16,504	-1,960	6,108
JAVBUG	80,891	0,207	12,734	30,976	-1,800	-6,568
KIEL01	60,216	0,177	0,704	10,301	-1,770	5,463
KIEL02	28,392	0,184	0,609	-21,523	-1,777	5,558
DGPS_PS	54,838	4,704	18,646	4,924	-6,297	-12,480
SPEEDLOG	70,184	0,446	0,075	20,269	-2,039	6,091
TMS2UK01	75,798	-0,290	5,916	25,884	-1,303	0,251
GTMS4UK01	70,525	-1,461	5,495	20,610	-0,132	0,672
Center Top MRU S	49,914	-1,593	6,166	0,000	0,000	0,000
Center 710 RX	67,366	0,687	0,064	17,452	-2,279	6,102
Center 710 TX	68,755	0,531	0,073	18,840	-2,123	6,094
Center 302 RX	66,853	0,012	0,057	16,939	-1,605	6,109
Center 302 TX	68,802	-0,272	0,073	18,888	-1,321	6,094
EA 38 kHz	68,769	1,123	0,068	18,855	-2,716	6,098
EA 12 kHz	68,541	0,911	0,072	18,627	-2,504	6,095
EA 200 kHz	68,537	1,333	0,066	18,623	-2,926	6,101
EA 12 kHz	68,107	1,120	0,065	18,193	-2,713	6,101
KNUD	66,183	0,628	0,049	16,269	-2,221	6,117
Seapath center	48,895	0,043	25,989	-1,019	-1,636	-19,823

Figure 5. The survey may be conducted using axis and sign conventions (set by a company protocol) that differ from the desired reporting convention. The survey report should clearly present any transformations that were applied to arrive at the final MBES offsets. For instance, this example shows the conversion of sensor locations from the native survey reference frame (with origin on the stern, centerline, at keel height, with +X toward the bow, +Y to port, and +Z up) to the desired mapping system reference frame (with origin at the MRU, +X toward the bow, +Y to starboard, and +Z down).

4. Images

a. The survey report must include images of the surveyed items with clear indications of which features and targets were measured. These images are instrumental in helping readers to interpret the results (e.g., configuring antenna phase center height from measurements on the antenna base) as well as aiding future surveyors in identifying benchmarks to re-establish the vessel frame.

b. Images in the report should be included at appropriate levels of detail that will help readers unfamiliar with the vessel grasp the general layout as well as the detailed orientations of sensors. In all cases, the images must include notation on the viewer's orientation relative to the vessel (e.g., 'looking aft').

c. A complete report will include 'overview' schematics of general locations for areas of survey activity (e.g., indicating the approximate locations for antennas, motion sensors, and transducers) as well as detailed diagrams and images (e.g., schematics of a transducer gondola and pictures of the survey targets on each transducer).

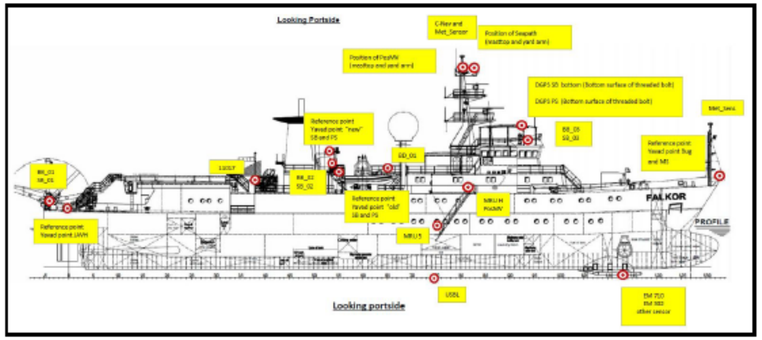

Figure 6. A vessel overview diagram that gives the reader a clear sense of the general layout of sensors. Even though it is obvious in this example, the image is labeled with the viewer's orientation (looking toward port). In this example, results for each sensor are presented later in the report with appropriately detailed images and annotation. (Image: Fugro)

Geometry & Configuration Review : Recommendations

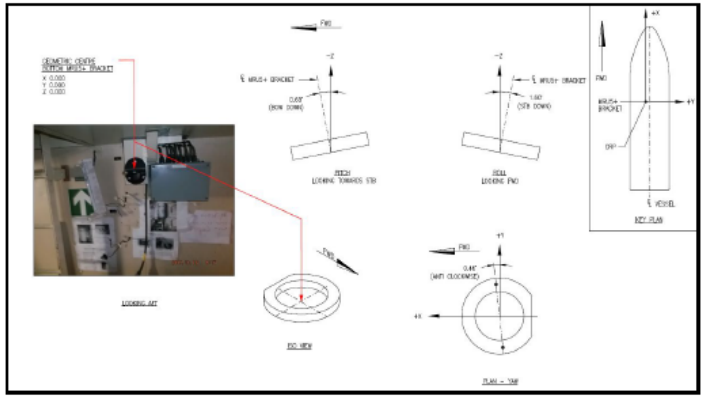

Figure 7. Detailed images and survey results for a motion sensor bracket. The center bottom of this bracket coincides with a designated target on the motion sensor housing (after installation), and is used, in this case, as the origin of the mapping system reference frame. The bracket's general location on the vessel is noted in the key plan, and all images are labeled with the viewer's orientation. All linear and angular survey results are clearly described with reference to the major axes. This combination of views and notes helps all readers to readily understand the orientation of this sensor bracket in the mapping system reference frame, leaving practically zero opportunity for misinterpretation. (Image: Parker Maritime)

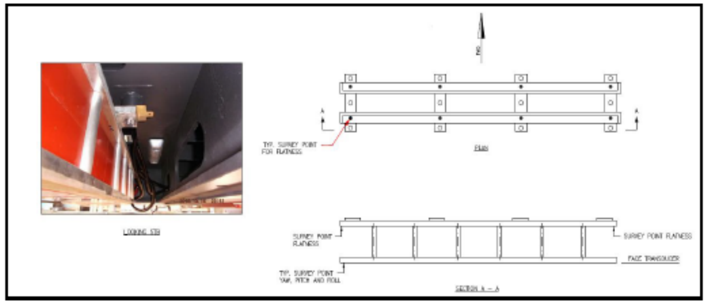

Figure 8. This schematic clearly describes the difference between points surveyed for transducer array flatness and those surveyed for angular offsets. The reader can better understand the survey process, clearly visualize the difference between these sets of measurements, and confidently interpret the correct set for configuration. (Image: Parker Maritime)

5. Sigma / uncertainty of the survey results

a. The survey report must include descriptions of the estimated uncertainty or maximum potential error in the final results. Ideally, the total propagated uncertainty is calculated and presented for each offset.

b. Copies of relevant instrument calibration certificates should be included in all reports.

c. Manufacturers of all multibeam echosounders and positioning / attitude systems installed in the UNOLS fleet provide guidance for the maximum allowable uncertainty in surveying their linear and angular offsets. Survey results exceeding these thresholds may compromise the bathymetric data on a fundamental level. In this case, additional measurements must be taken to satisfy the manufacturer's uncertainty requirements and the updated results must be presented in the final report.

Measurement Precision and Uncertainty
Coordinate uncertainty values are based on fit to the previous survey values and may be more or less than shown, there are (Table 3) Several outliers at PBM 1 and 13.

Region to Region, i.e., Reference Plate to antennae, EM122 TX/RX and other hull features:

$X \leq 5$ mm
$Y \leq 4$ mm
$Z \leq 5$ mm

TABLE 1- POTENTIAL UNCERTANTY

FEATURE	Azimuth	Pitch	Roll
HIPPIE	N/A	±0.100°	±0.100°
PHINS	±0.25°	±0.25°	±0.25°
MRU	±0.25°	±0.25°	±0.25°
EM122 TX	±0.006°	±0.002°	±0.15°
EM 122RX	±0.011°	±0.028°	±0.001°

Figure 9. Descriptions of estimated maximum potential errors in linear offsets (left) and angular offsets (right). These values are ideally calculated for each result, as for the table (right), and described with some confidence level for comparison to the manufacturers' requirements for each sensor. (Images: IMTEC)

Geometry & Configuration Review : Recommendations

6. Second review before submission

a. The survey report must be reviewed completely before submission to the vessel operator. The review process must ensure that a 'new' reader who is generally familiar with mapping systems, but unfamiliar with the particular vessel, can confidently and correctly interpret the report for configuration of each sensor.

b. At a minimum, the report must present the criteria #1-5 outlined above; moreover, consistent application of these guidelines will significantly streamline this review.

c. The end goal of the second review is to rectify potential errors ahead of delivery to the client. At a minimum, errors identified by the client will require a revised report; errors not caught by the client may be carried into the mapping system configuration and seriously compromise data quality.

d. Ideally, the surveyor has sufficient time to complete their reporting and discuss the results with the client well ahead of mapping system configuration and calibration. If it is absolutely necessary to deliver preliminary results (e.g., for an imminent at-sea calibration effort), these numbers must be reported in a way that very clearly warns all users of their preliminary status. The final report must state when preliminary results were delivered and clearly explain any differences from the preliminary results. These steps are critical for the client in managing any impacts of these differences and planning, as needed, to reconfigure and recalibrate with the updated results.

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Example table of mapping sensor results

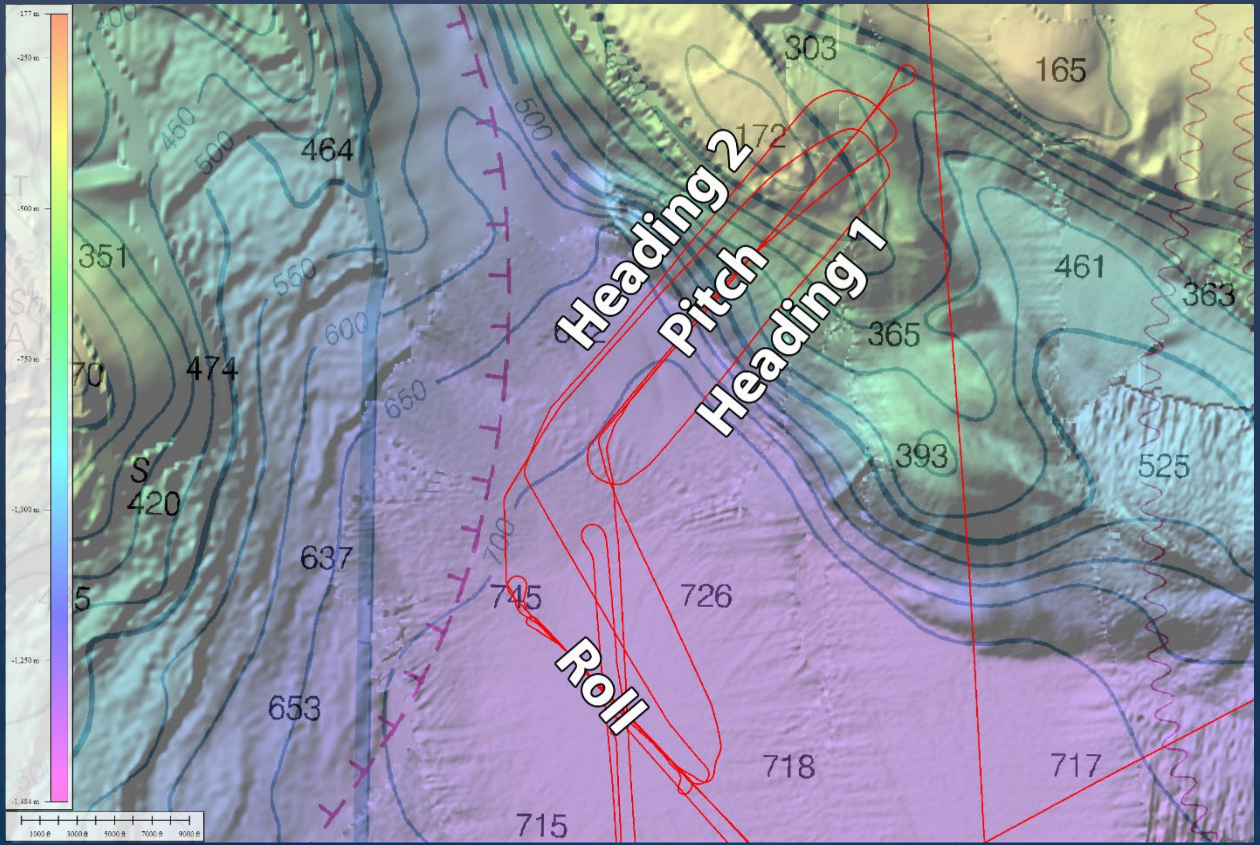
The ultimate purpose of the VSR is the confident and correct interpretation of the survey data for mapping system configuration. Building on criteria #1-6 presented above, this is best addressed with a simplified table of results for the relevant sensors using the chosen MBES manufacturer's reference 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							

Calibration: Approach

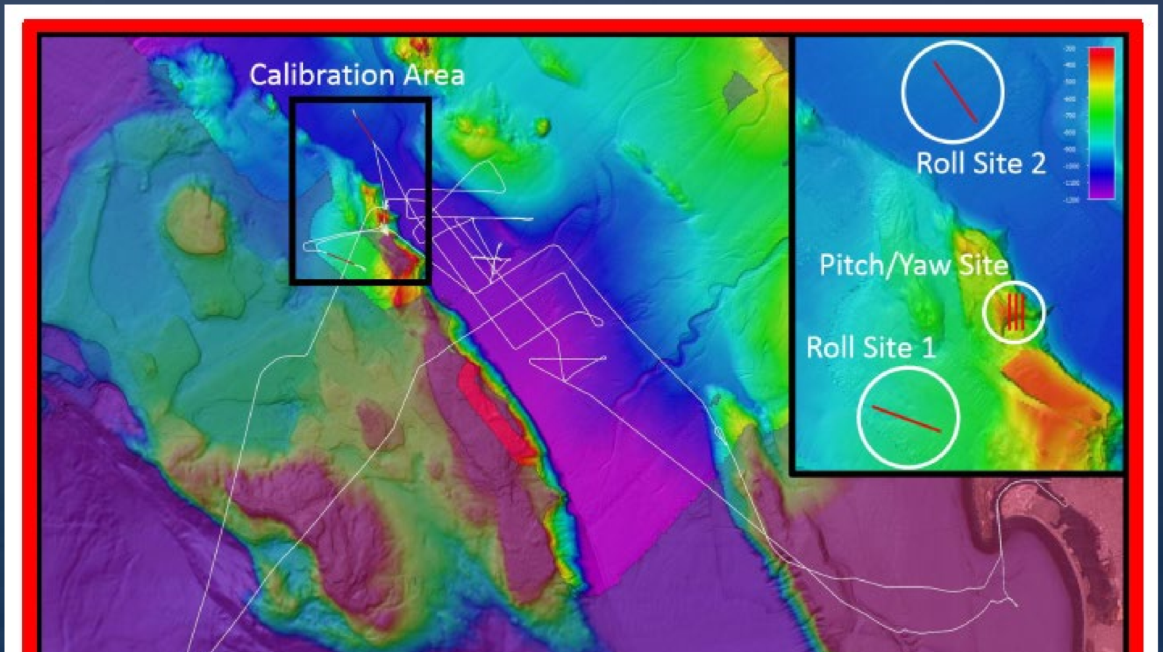
- Deliver calibration lines points, runtime parameters, & time estimates
- On-board or **remote** support for acquisition, analysis, & final configuration
- Residual pitch, roll, and heading are attributed to the motion sensor and applied in SIS

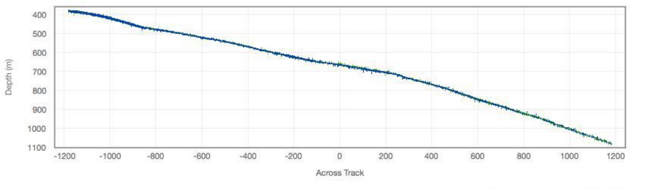


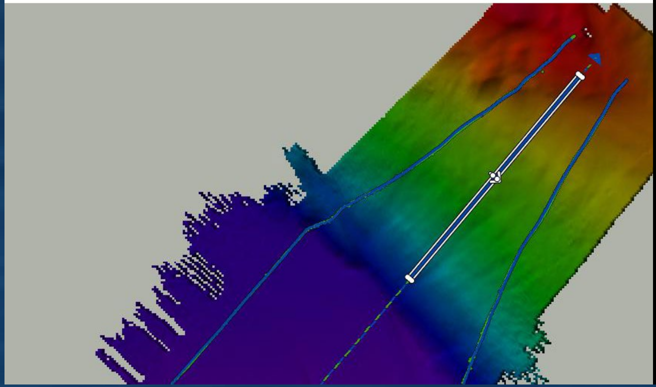
Line Acquistion Information																			
Test	Pre-test settings	Transit to Cal	Pitch Verification Pass 1	Turn	Pitch Verification Pass 2	Transit A to C	XBT	Roll Verification Pass 1	Turn D to D	Roll Verification Pass 2	Transit C to H	XBT	Yaw Verification Pass 1	Transit G to F	Yaw Verification Pass 1	Transit G to A	Est. Transit to Cal Hours	Est. Cal. Hrs	Est. Verif. Hrs
XBT Prior to Line			No		No			Yes		No			No		No				
SIS Line Name			55	56	57			60		62			65		69				
Start Point (see figure)			A		B			C		D			H		F				
End Point (see figure)			B		A			D		C			G		E				
Speed (kts)		10	6	6	6	10		6	6	6	10		6	10	6	10			
Distance (nm)		200	4.3		4.3	6		3.8		3.8	6.5		4.3	4.6	4.3	3.5			
Course Over Ground			210		30			225		45			210		210				
Time (est. minutes)		1200	43	15	43	36	15	38	15	38	39	15	43	28	43	21	20	7.2	7.2
Pre-test MRU Angle (SIS, AS-RUN)				0.00					0.00					0.00					
EM302 Result - 1st Pass				-0.18					0.01					-0.05					
EM302 Result - Verification				-0.02					0					0.05					
EM302 Results - Final				-0.2					0.01					0					

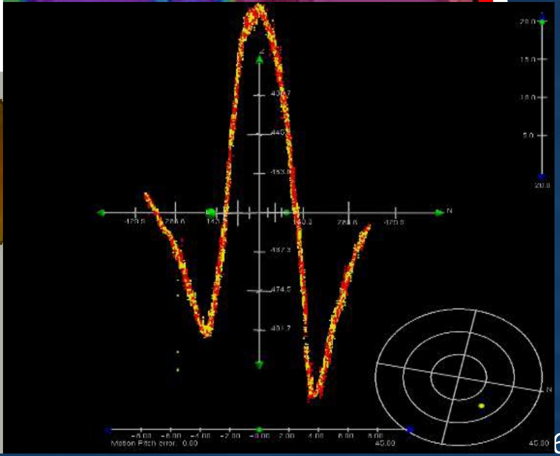
Calibration: Lessons Learned

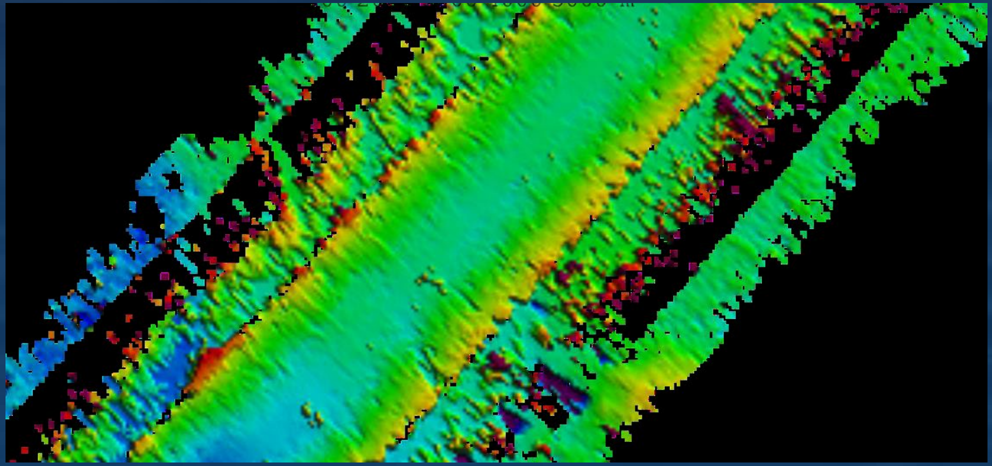
- Planning windows vary widely
- Executed opportunistically
- Multiple reviewers
- Overcome “it is just for science”
- 1st critical look at the data







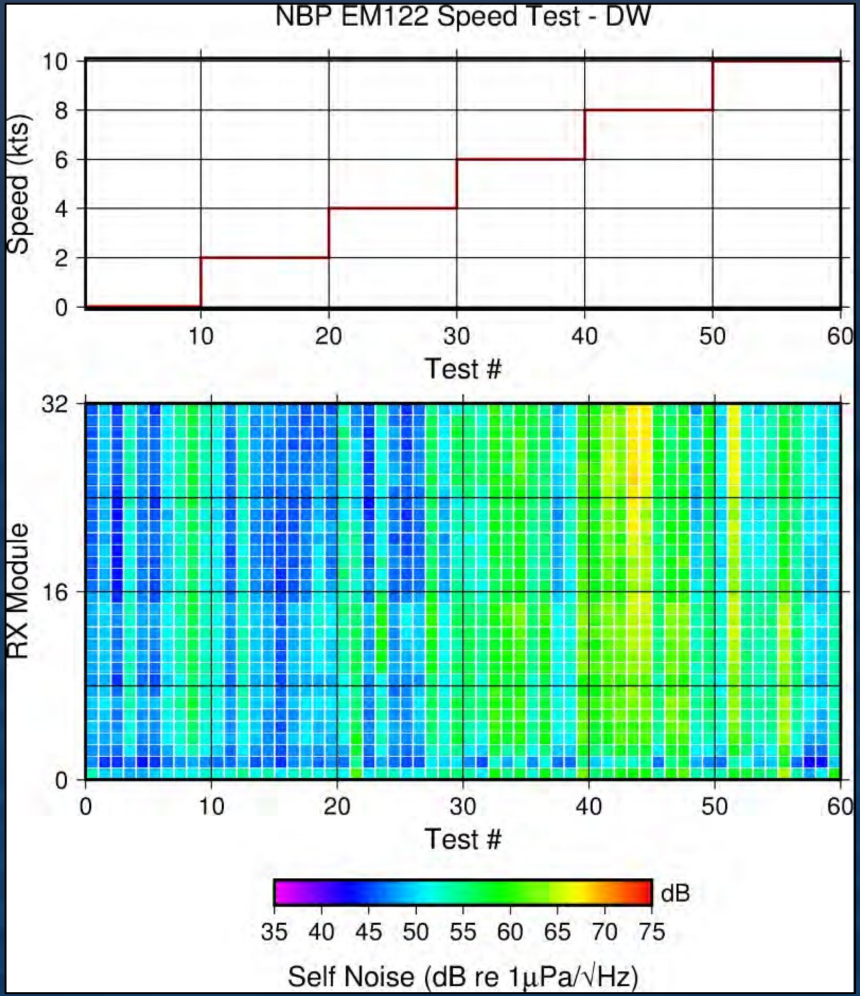


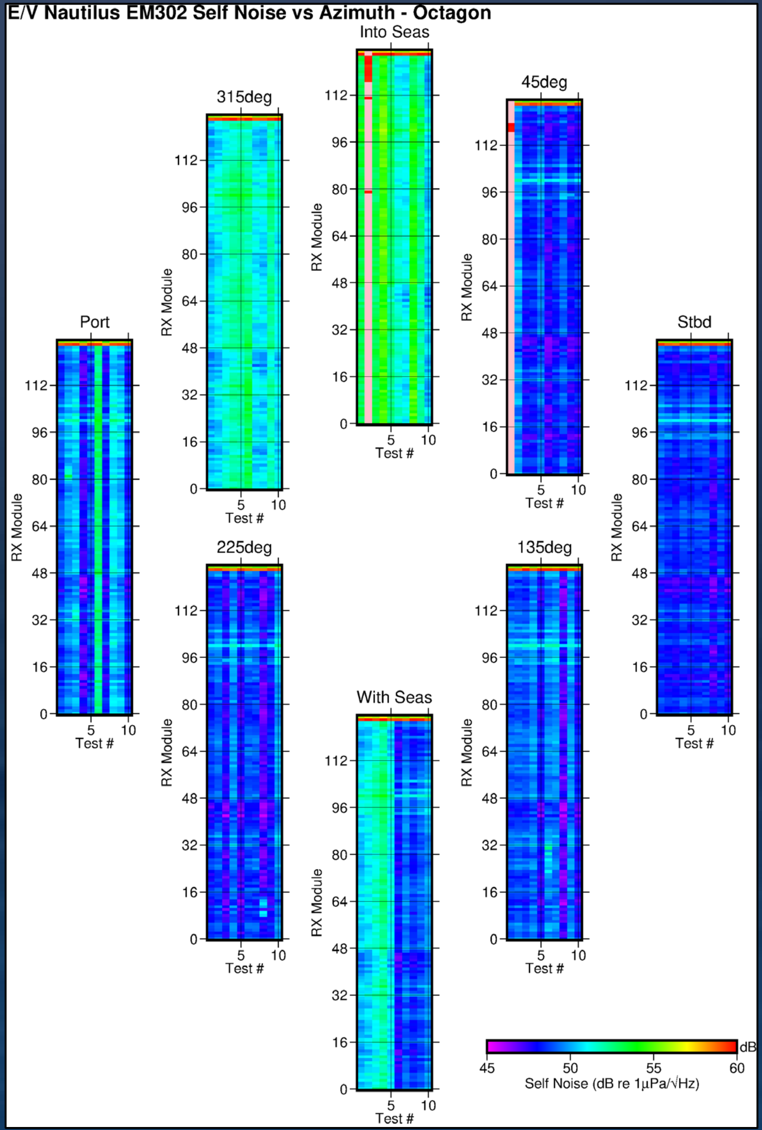


MULTIBEAM ADVISORY COMMITEE

RX Noise Testing: Approach

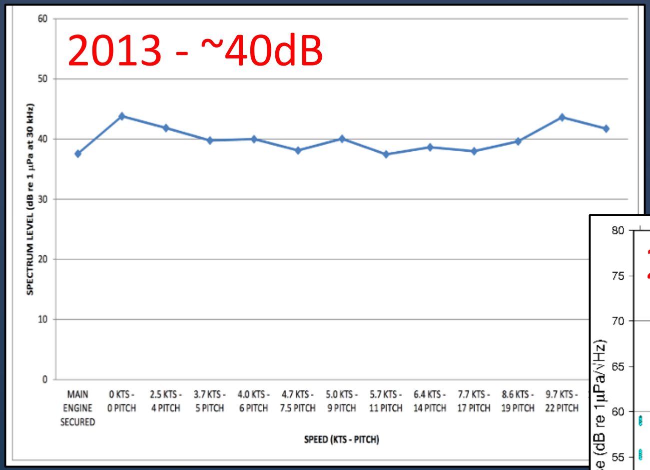
- Secure other acoustic systems
- RX Noise BIST done in SIS
  - Noise vs. Speed/RPM
  - Noise vs. Heading
  - Noise vs. Machinery
- Do early in SAT or QAT
- Involve engineers!

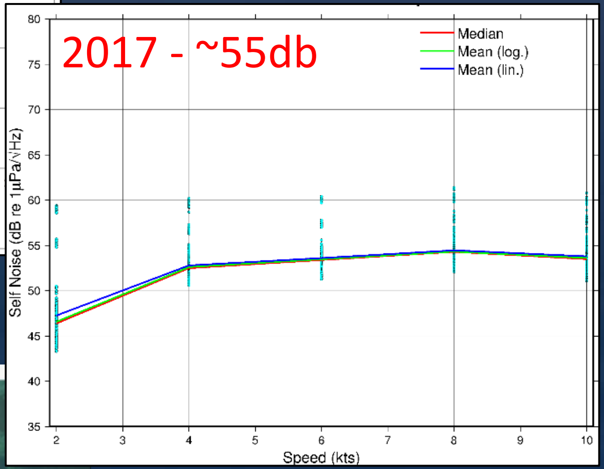


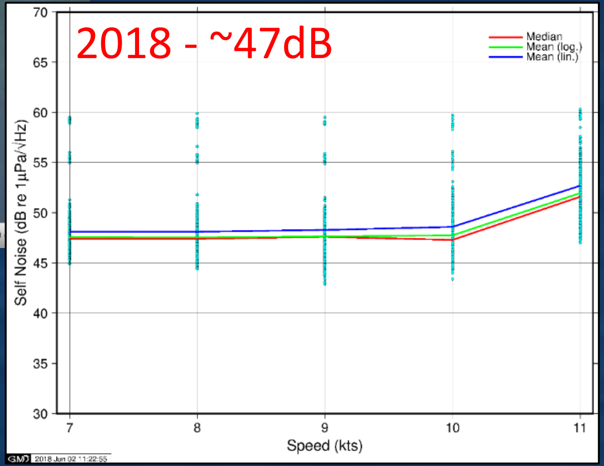


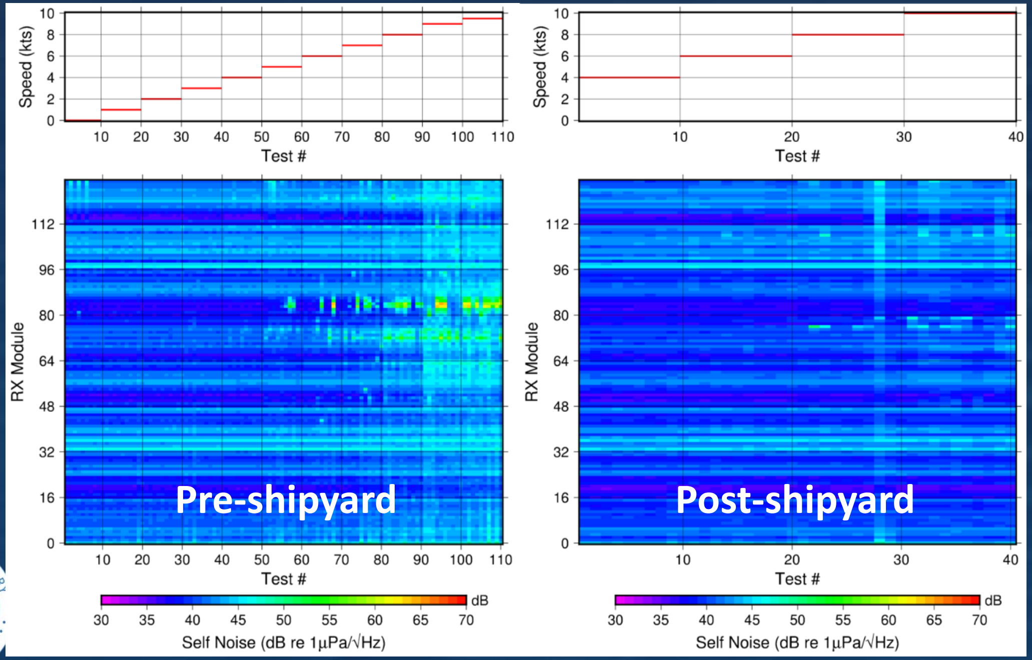
RX Noise Testing: Lessons Learned

- Critical test for identifying problems
- Detect small changes over time
- Can Identify:
  1. Optimal speeds
  2. Best machinery lineups
  3. Impacts of sea state and biofouling



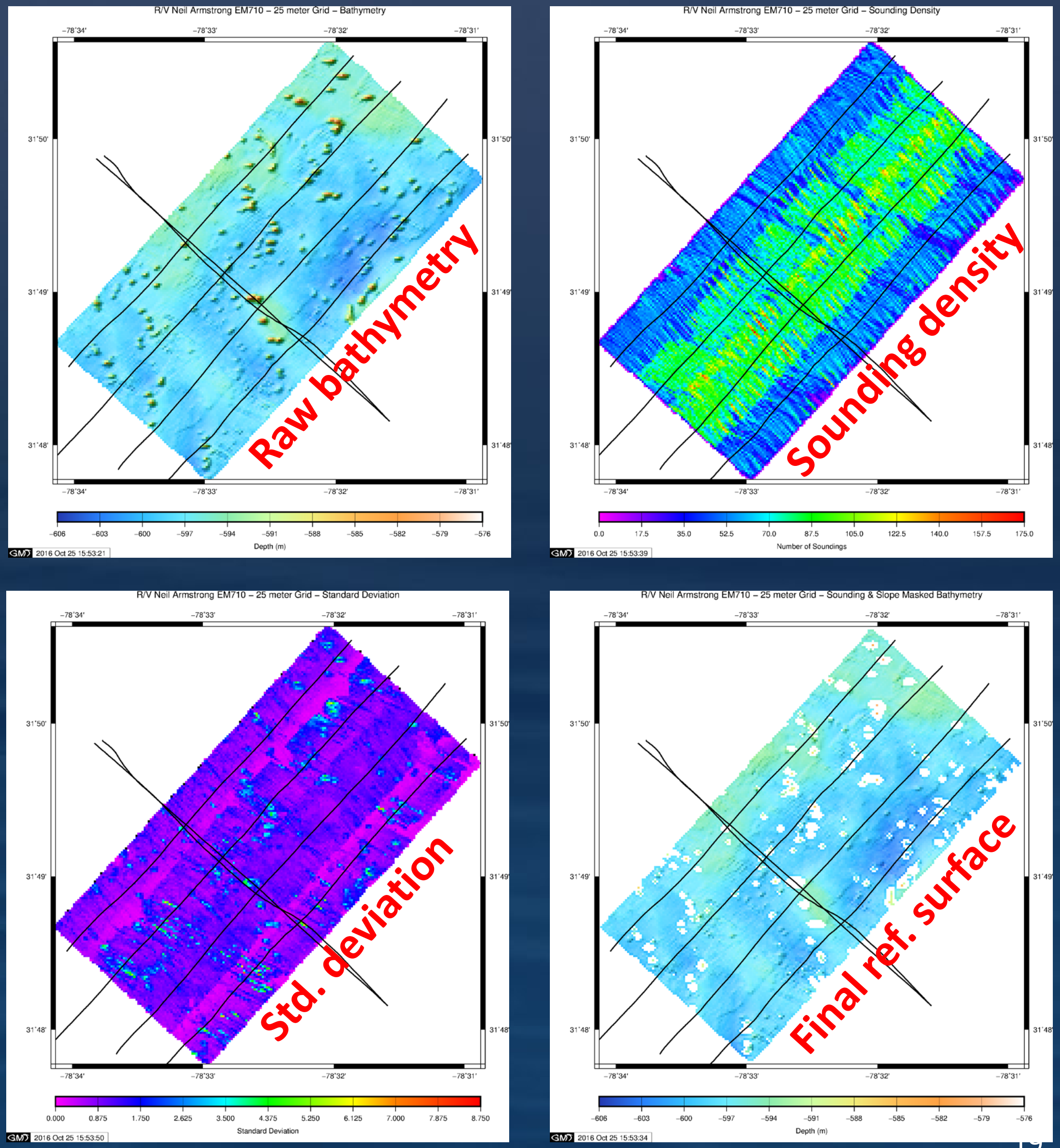






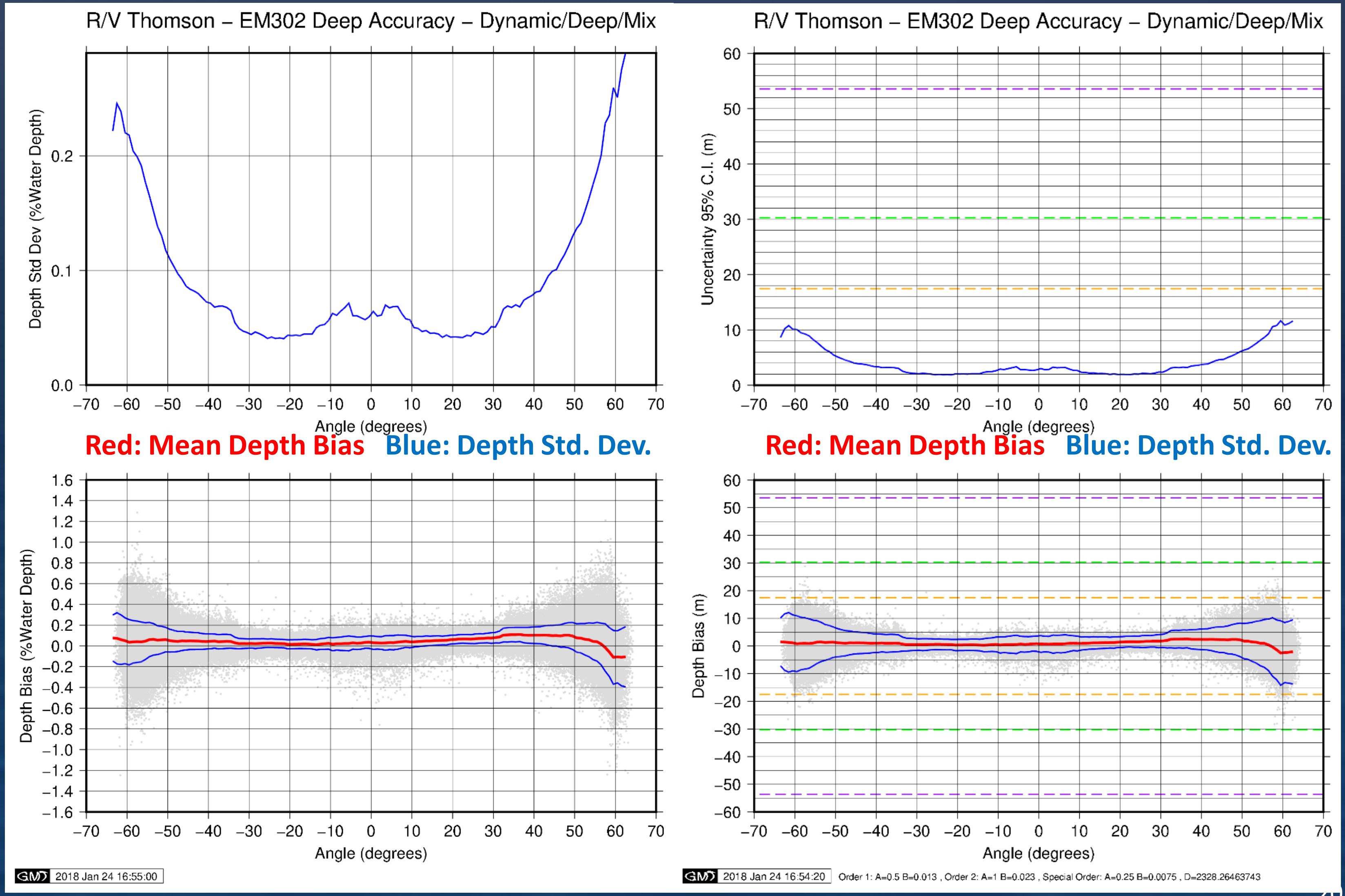
Swath Accuracy: Approach

1. Collect a high-density reference surface over flat seafloor
2. Mask grid cells with low sounding density, high standard deviation, &/or high slopes
3. Collect crosslines in ‘typical’ survey modes
4. Calculate differences between soundings and corresponding reference surface cells
5. Group differences by beam angle, plot mean and std. dev. of differences across swath



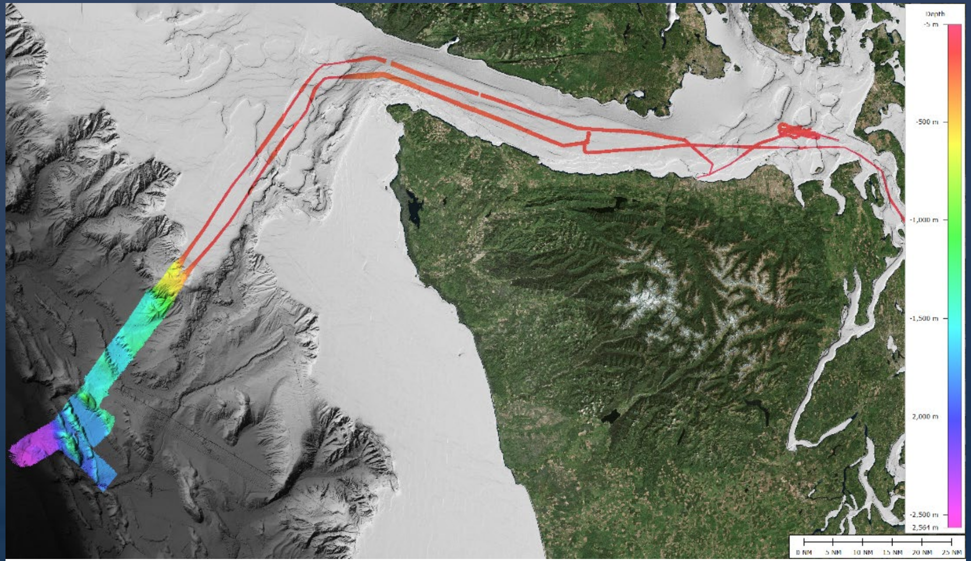
Swath Accuracy: Lessons Learned

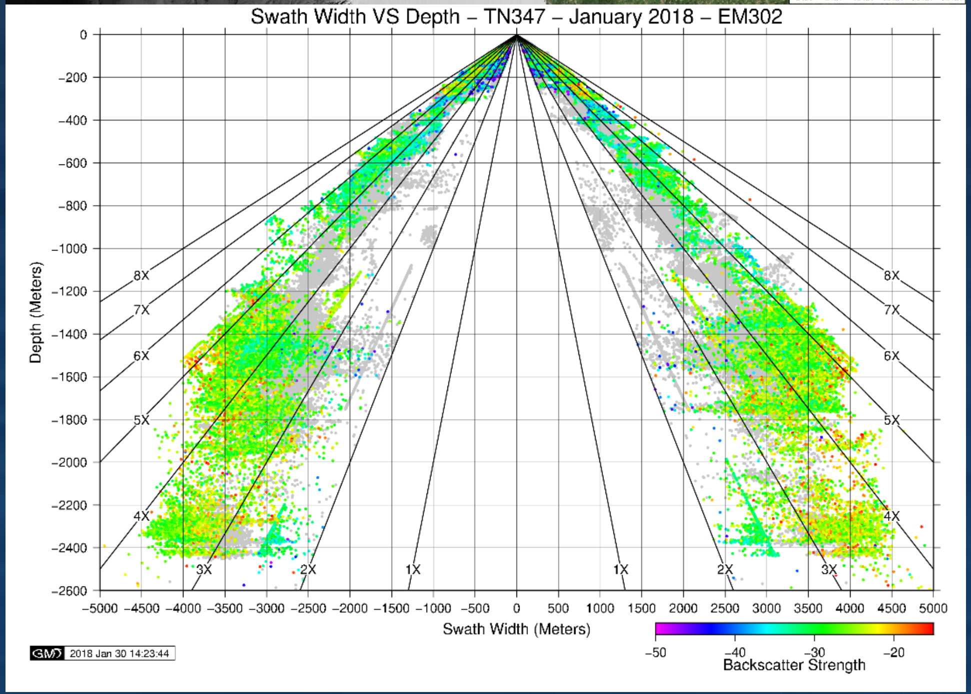
- Detect changes in system performance
- Sea state challenges
- Refraction and tidal correction can make interpretation challenging
- Reuse reference sites
  - Save time/money
  - Opportunistic collection
  - Simplifies comparison



Swath Coverage: Approach

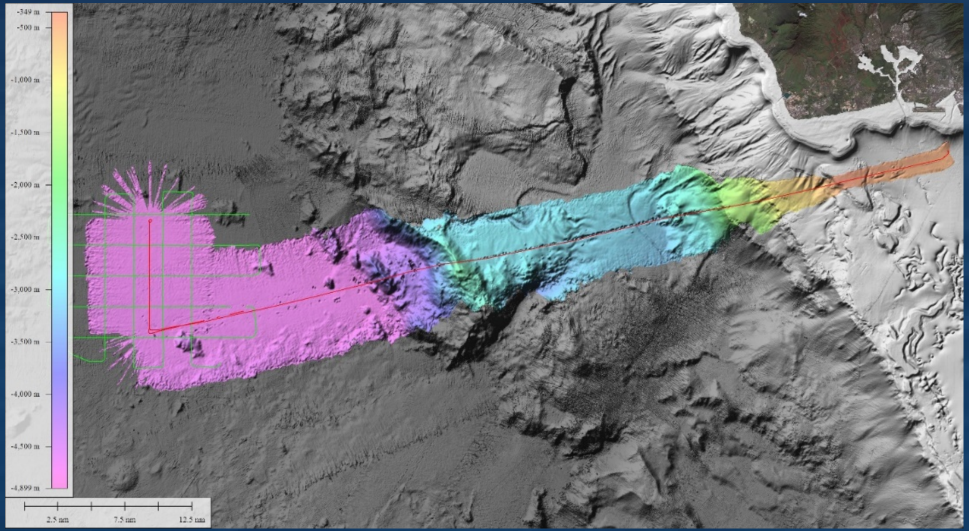
1. Collect data over wide range of depths in fully automatic mode with maximum swath limits
2. Gentle slopes and lines perpendicular to the slopes
3. Extract outermost valid soundings and remove those with extremely high / low reflectivity
4. Plot cross-track distance to sounding vs. depth

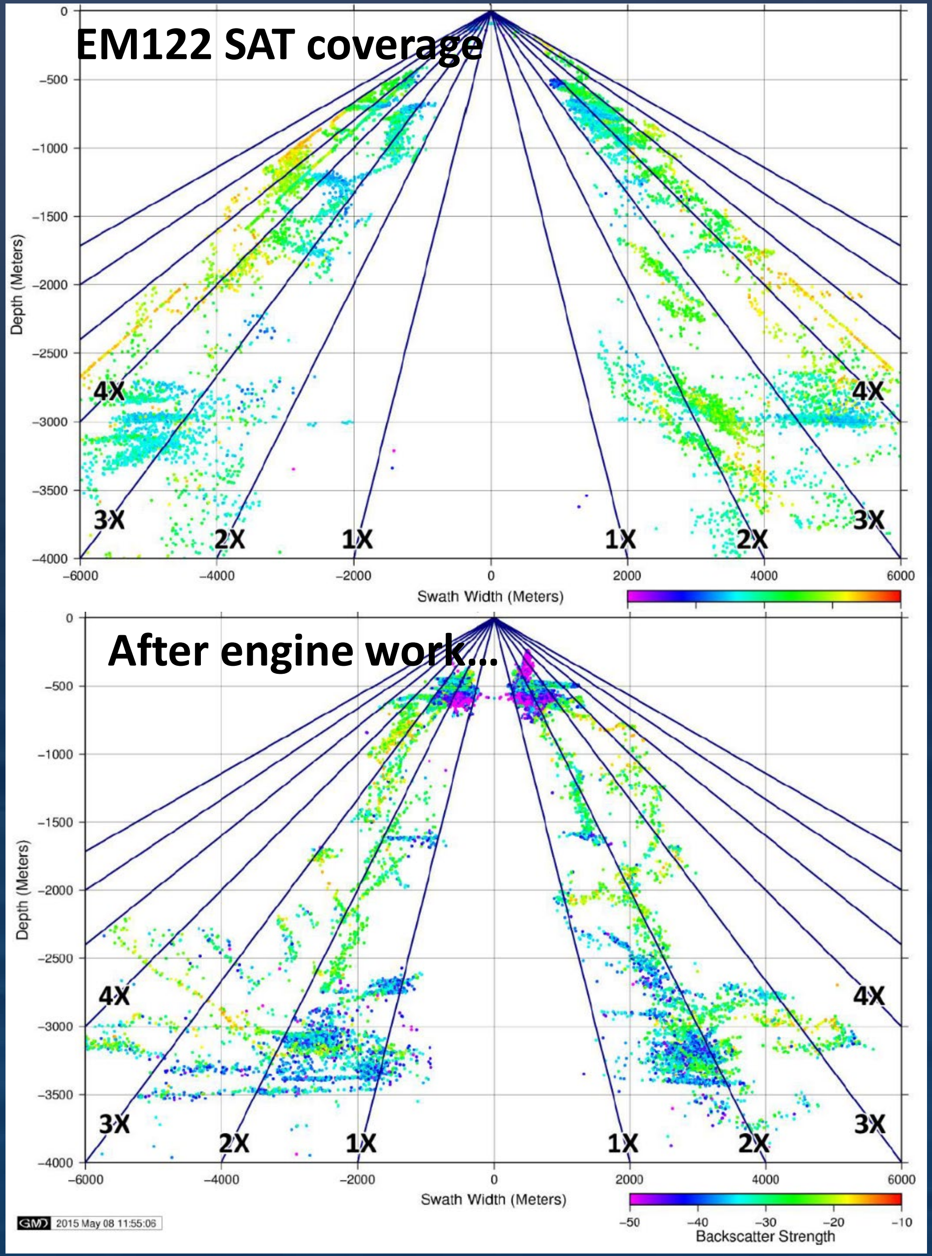




Swath Coverage: Lessons Learned

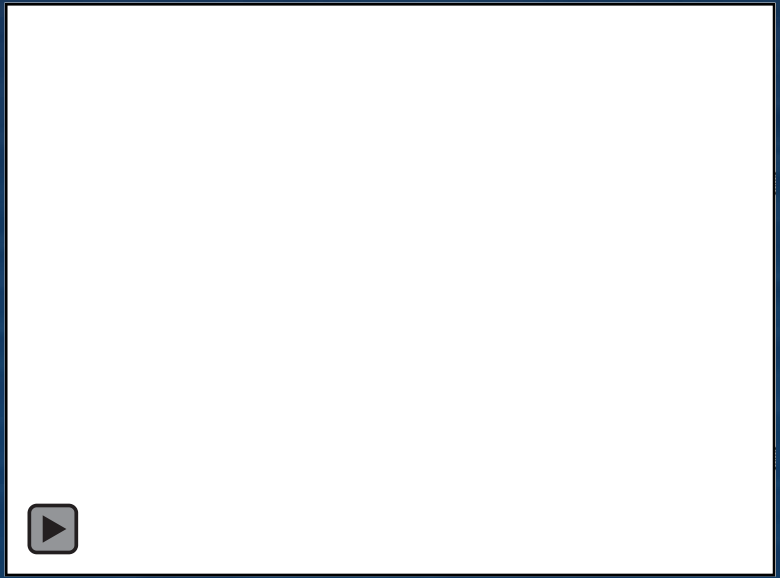
- Easy transit activity
- MAC code or commercial software
- Rapidly see changes from baseline
- Ship to ship comparison
- System to system comparison
- Realistic swath width estimate

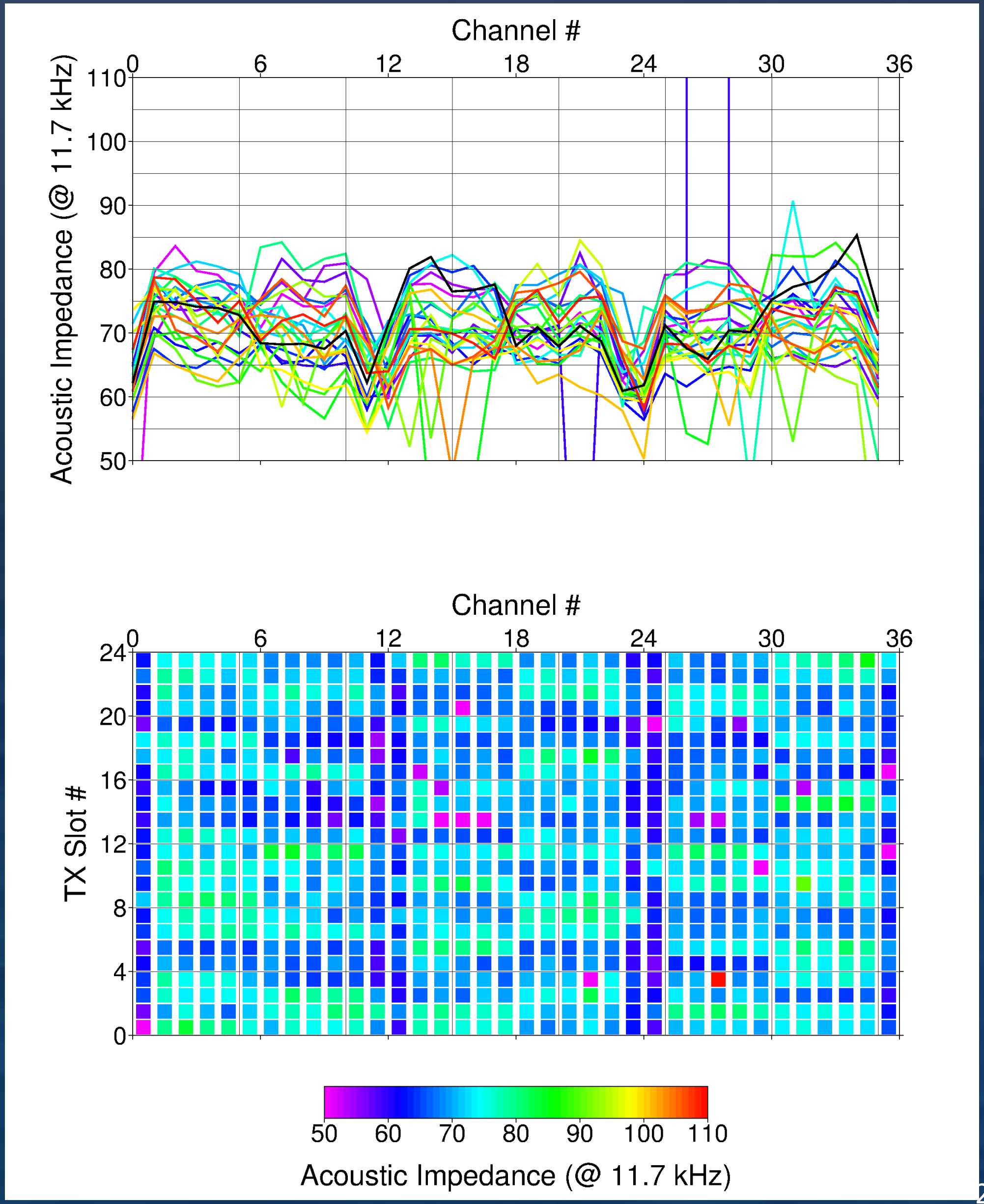




Impedance Testing: Approach & Lessons Learned

- TX Channels and RX Channels BISTs monitor:
  1. TX transducer acoustic impedance
  2. RX receiver electrical impedance
  3. RX transducer electrical impedance
- Not a replacement for direct measurements
- Proxy for array health
- Test at least annually (or more frequent)



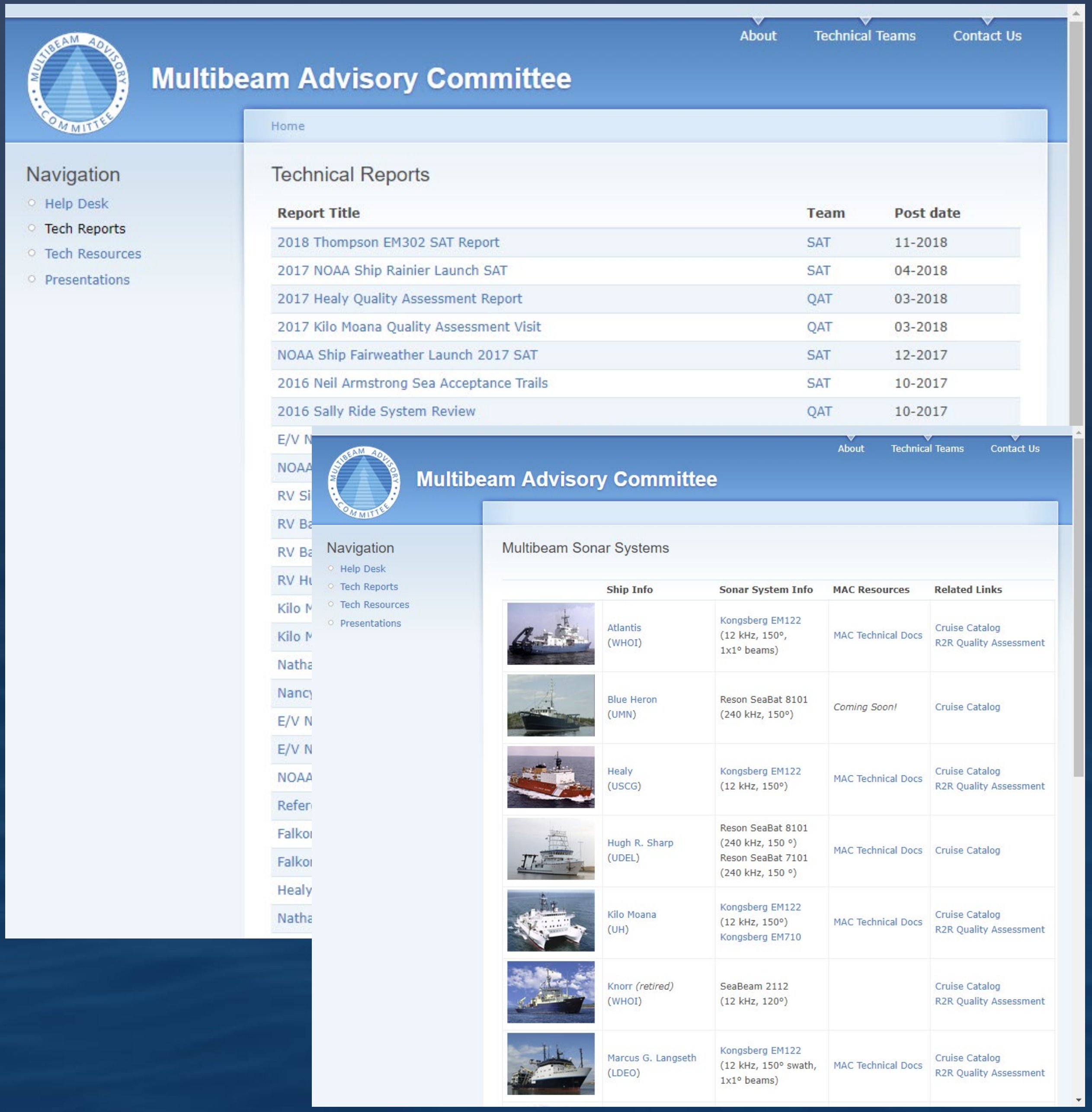


12-kHz TX array after 10 years of icebreaking

Reporting: MAC Approach & Lessons Learned

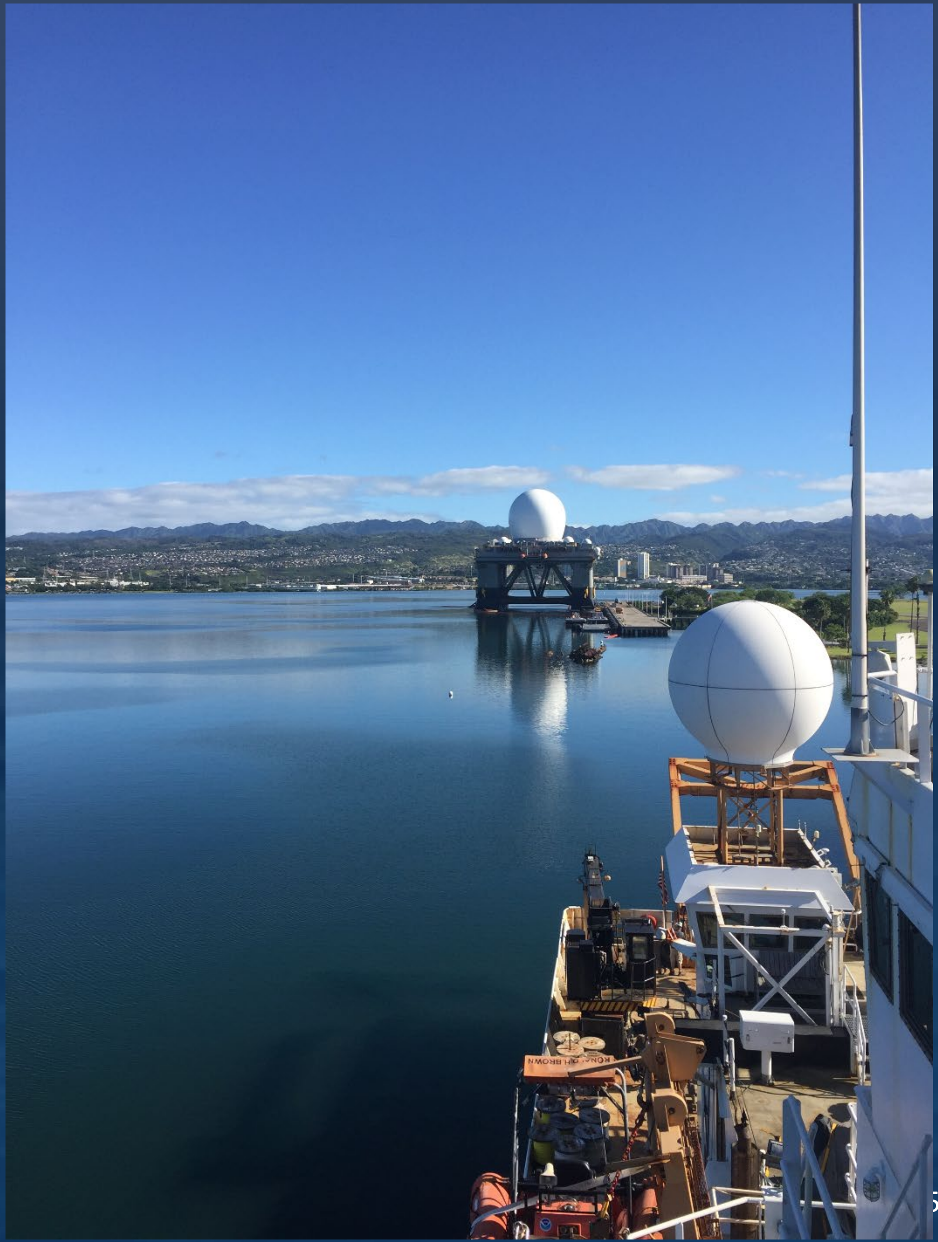
- System Performance Data
- Ship & System Documentation
  - system geometry
  - calibration/ installation parameters
  - acquisition configurations
  - positioning / attitude system configurations
- New report standard
  - started with R/V *Thomas G Thompson*, still evolving
- Shared resource for community

https://mac.unols.org



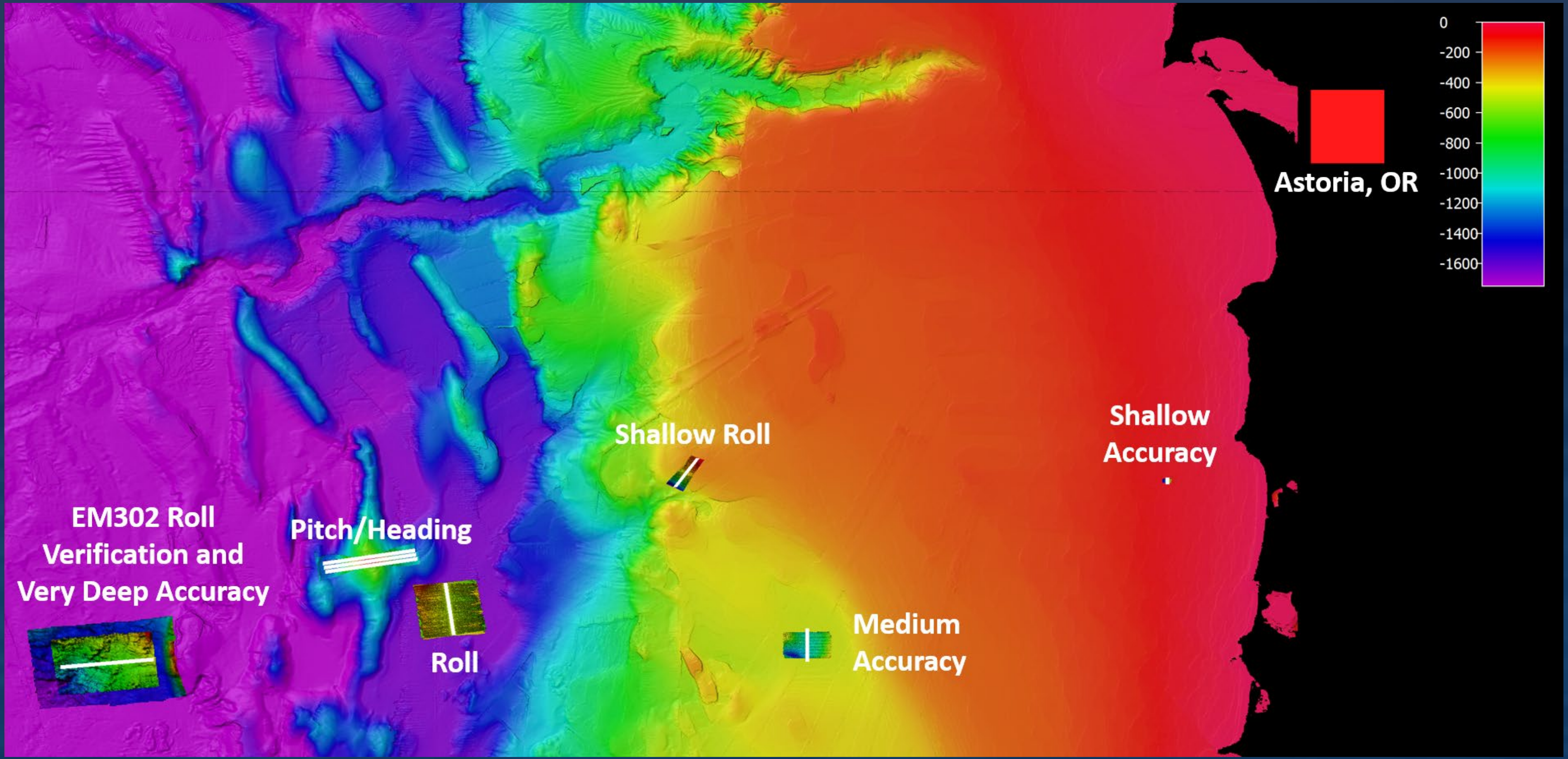
MAC Main Takeaways

- **Vessel surveys** must be correct and clearly reported using system conventions
- **Vessel noise** should be tracked, especially before/after shipyard periods
- **Swath coverage** is easy to do and reductions may be first indicators of complications
- **Array Impedance** should be tracked as a proxy for hardware health
- **Routine testing** can detect problems early



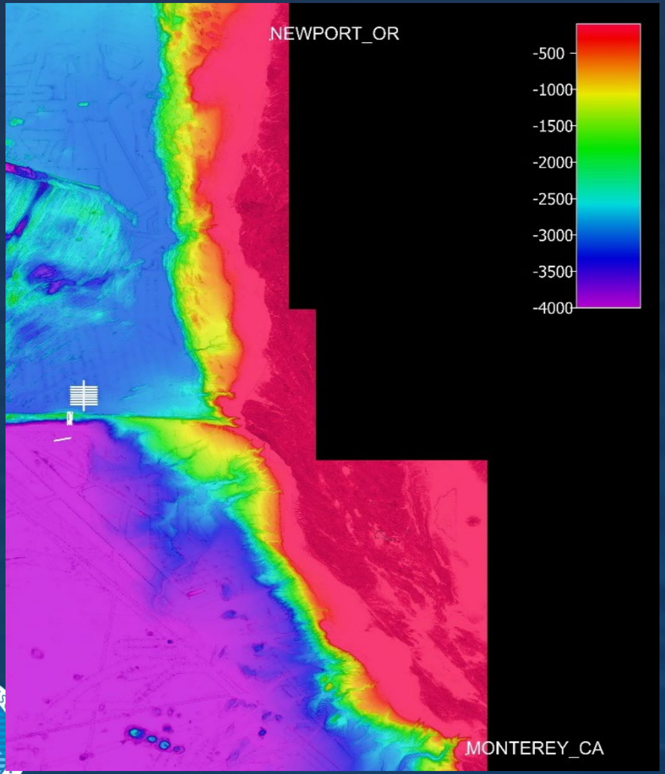
MAC Ship Support 2018-19

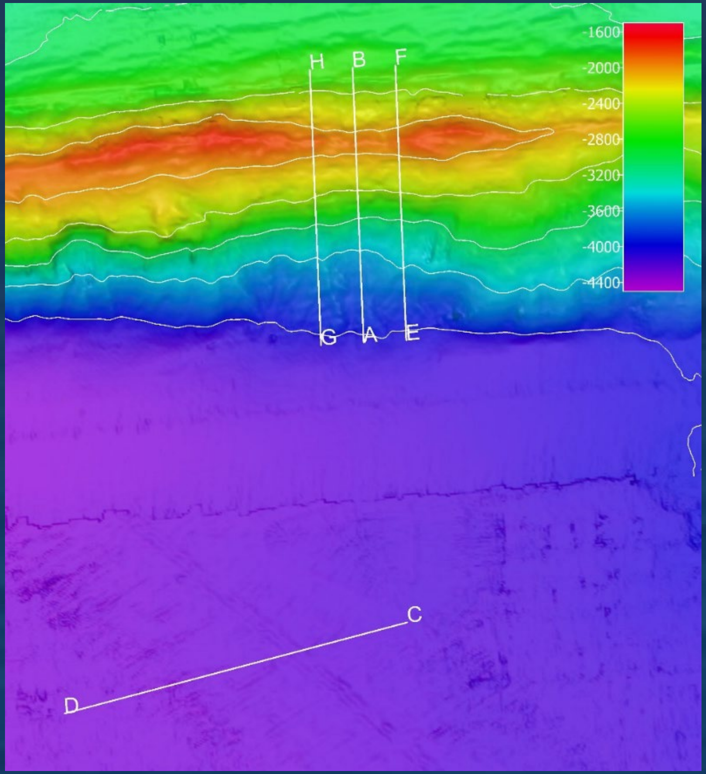
- R/V *Sikuliaq* Quality Assurance Testing
  - Remote support for geometry review, calibration, accuracy crosslines, swath coverage
- Efficiencies using existing sites, routine QATs

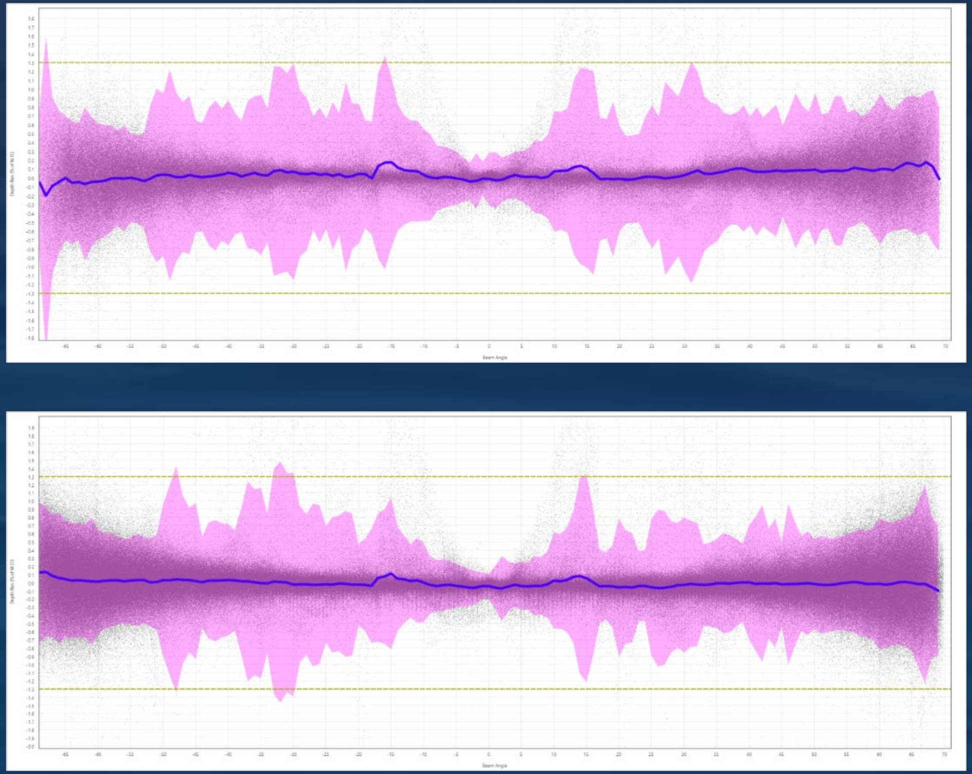


MAC Ship Support 2018-19

- R/V *Atlantis* Quality Assurance Testing and Seapath demo
  - New survey review, Seapath config, calibration, accuracy crosslines, swath coverage
- Realtime remote support during calibration/verification
- R/V *Marcus G Langseth* will use this site as well in November 2019

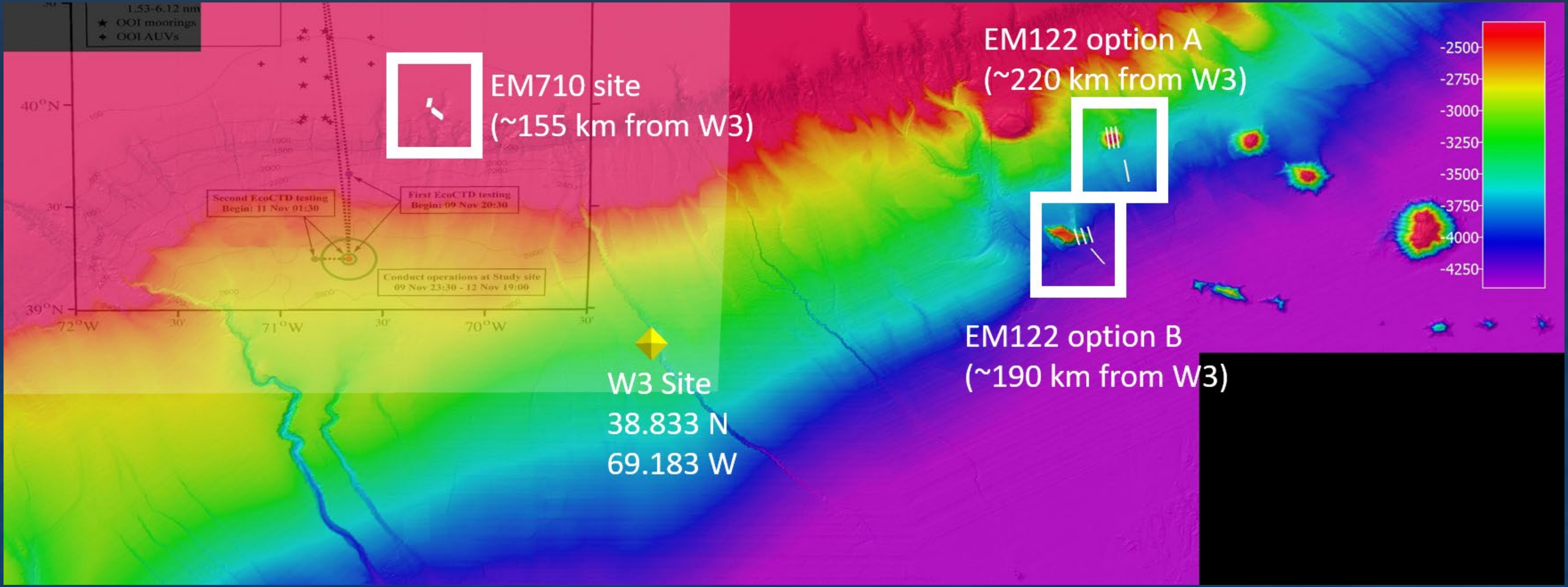






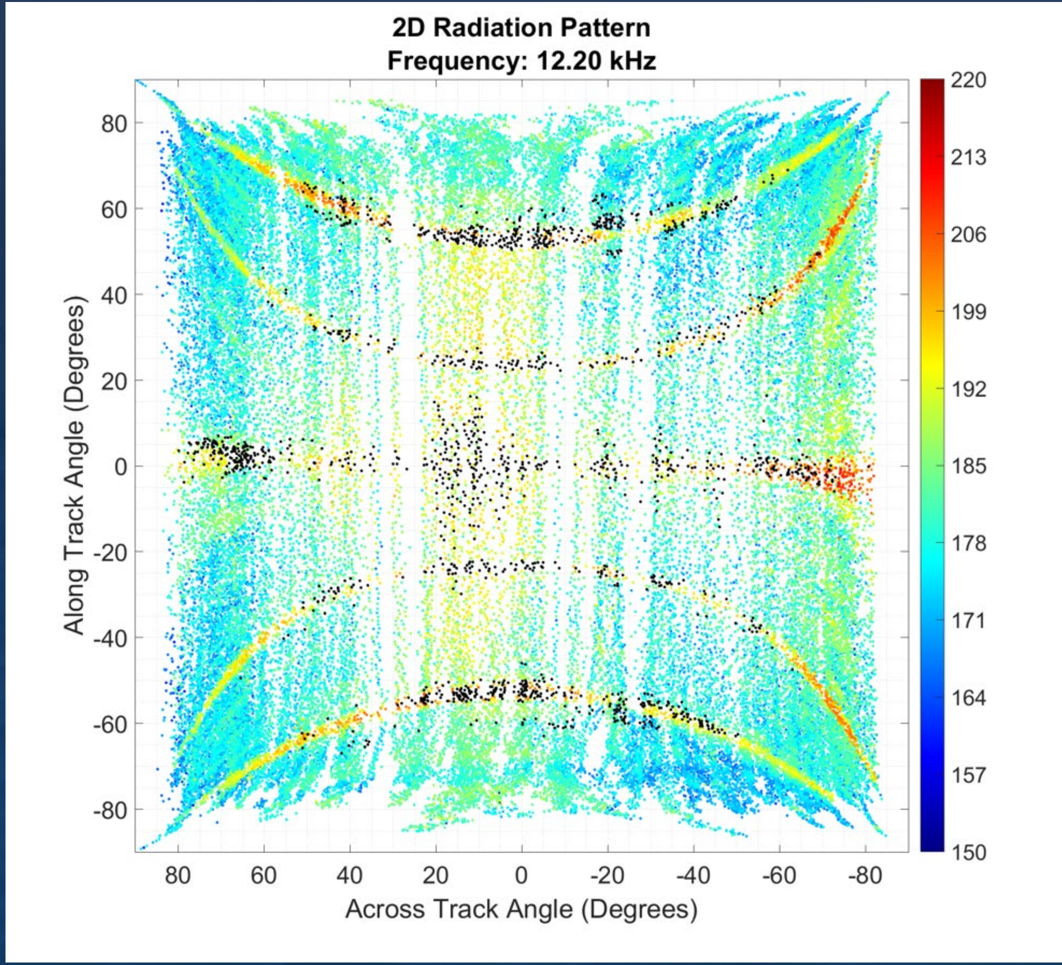
MAC Ship Support 2018-19

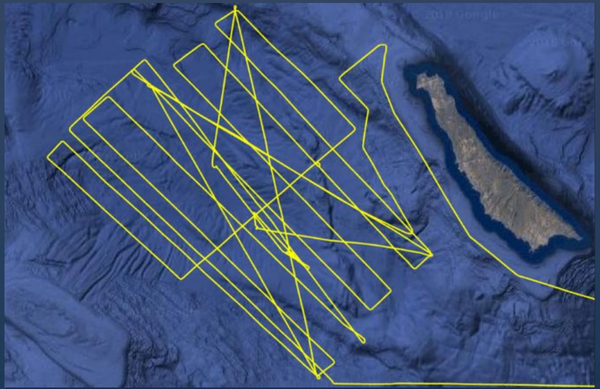
- R/V *Neil Armstrong* Quality Assurance Testing (Nov. 2019)
  - Geometry review, calibration, swath coverage
- On-board support, opportunity for students

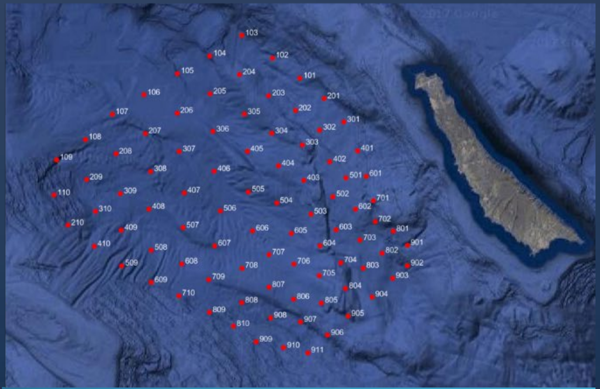


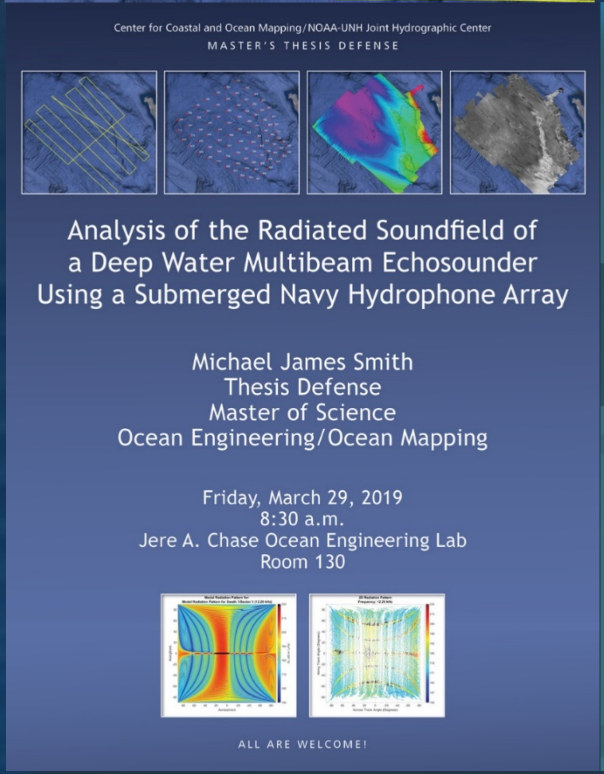
Related NSF (MAC) Funded Field Programs

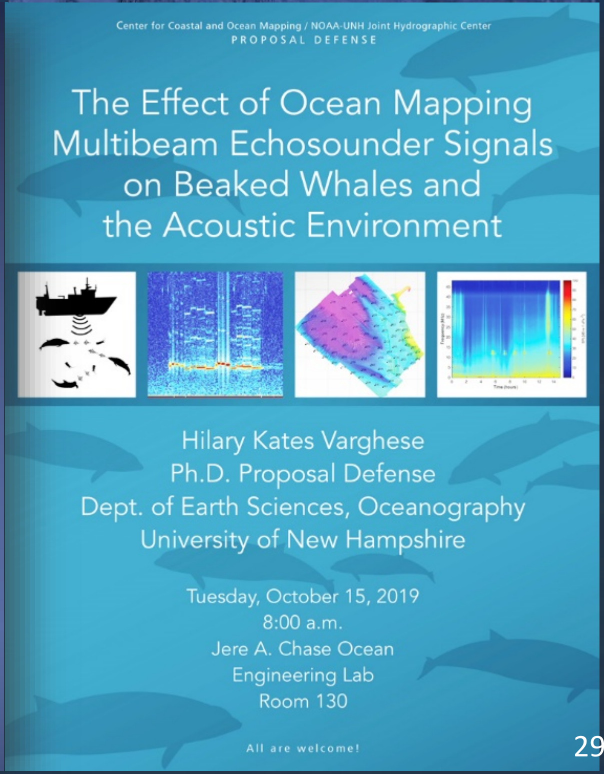
- EM122 and EM302 TX beam patterns
  - R/V *Sally Ride* (SCORE 2017, 2019)
  - NOAA Ship *Okeanos Explorer* (AUTEC 2018)





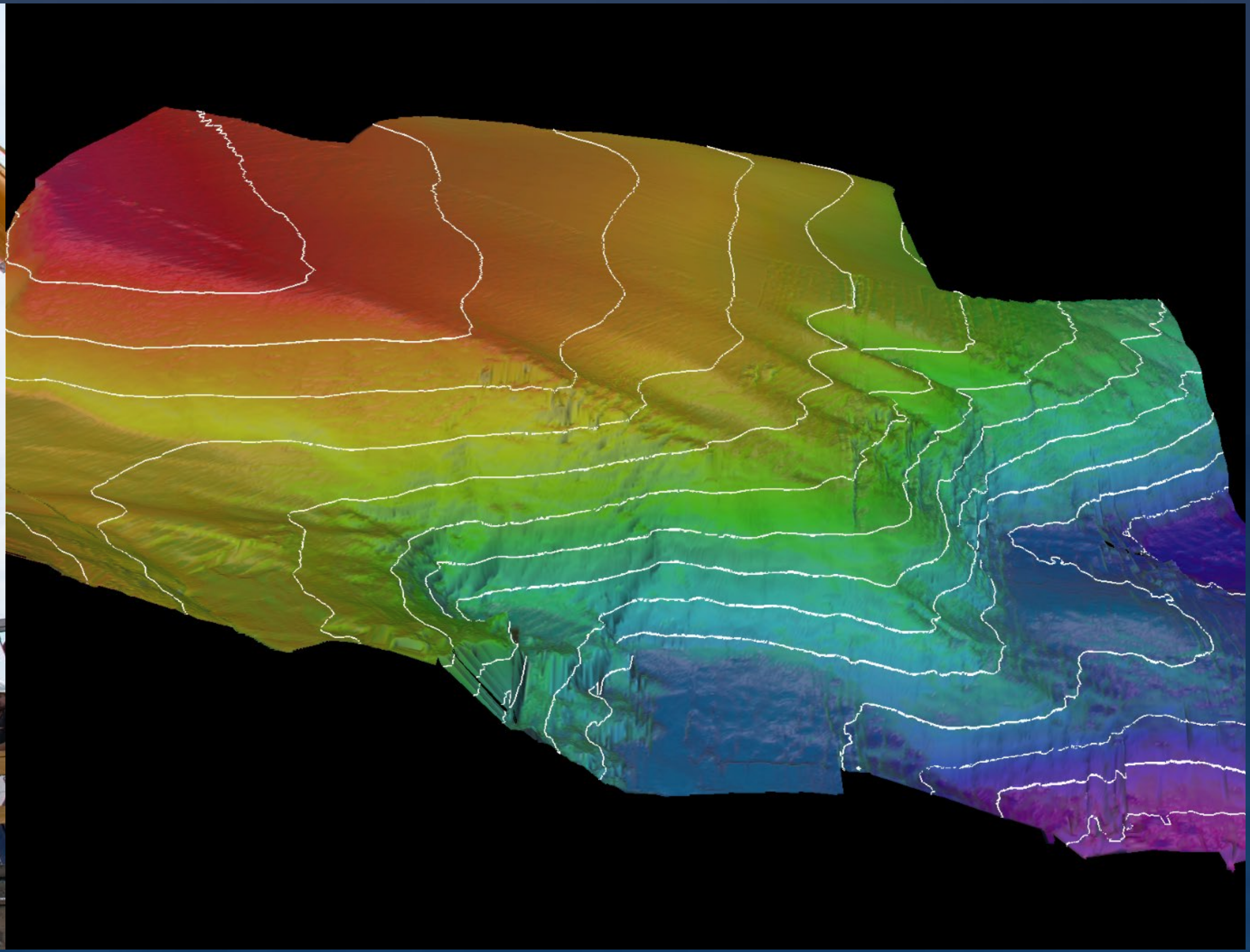






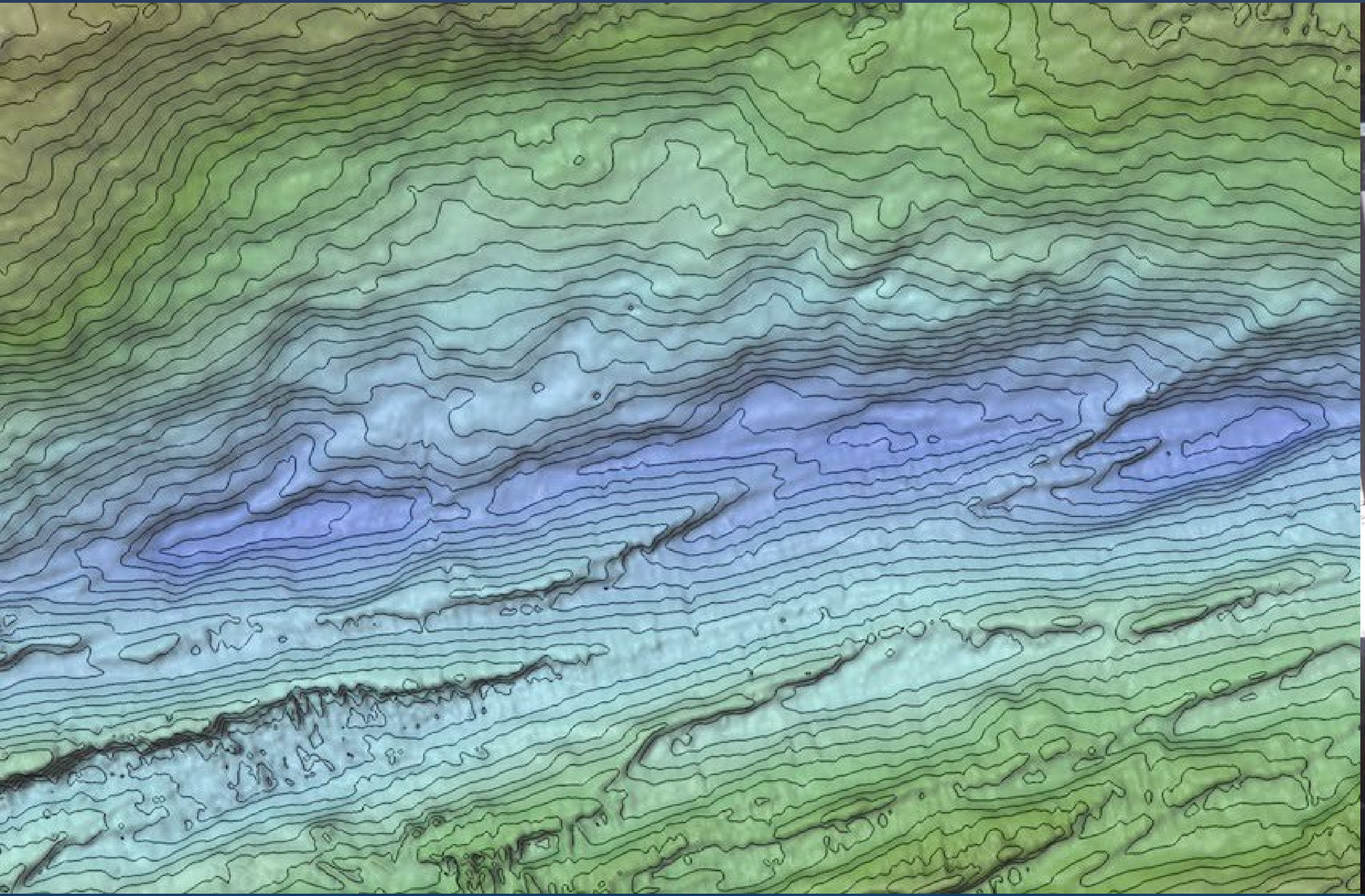
Related Non-NSF-Funded Field Programs

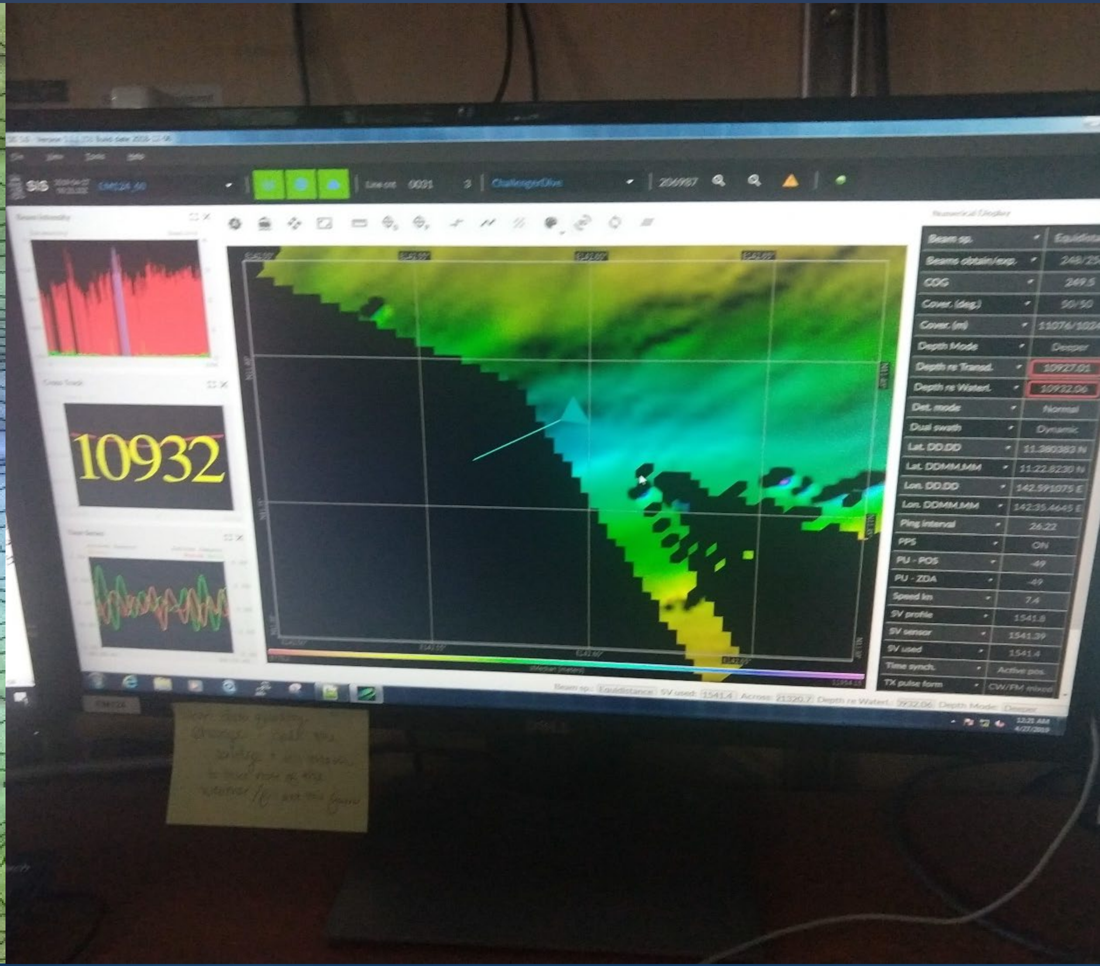
- GEBCO-NF Alumni Team for Ocean Discovery XPrize



Related Non-NSF-Funded Field Programs

- Five Deeps Expedition





Related Non-NSF-Funded Field Programs

- Amelia Earhart search aboard E/V *Nautilus* with UNH ASV *BEN*

The New York Times

The Amelia Earhart Mystery Stays Down in the Deep

Robert Ballard's expedition to a remote island in the South Pacific found no evidence of the vanished aviator's plane. But the explorer and his crew haven't given up.

The Nautilus, a research vessel, towing an underwater remotely operated vehicle that was used to hunt for the airplane of Amelia Earhart, which disappeared in 1937. Robert Lyall/National Geographic

By Julie Cohn

Published Oct. 14, 2019 Updated Oct. 16, 2019

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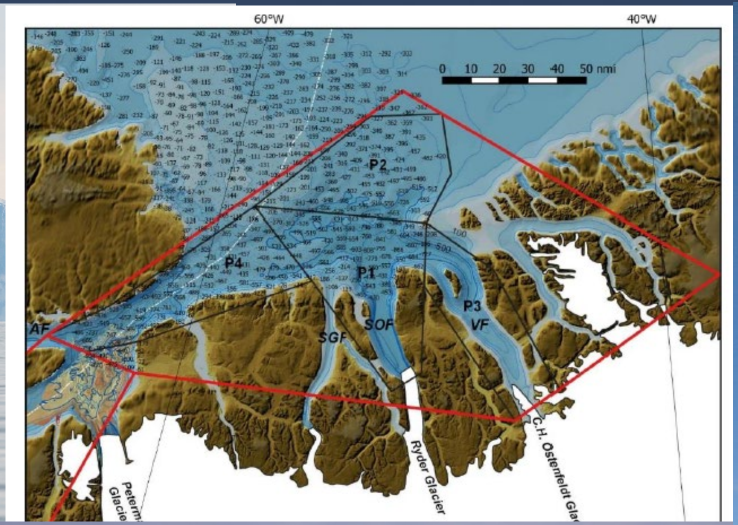
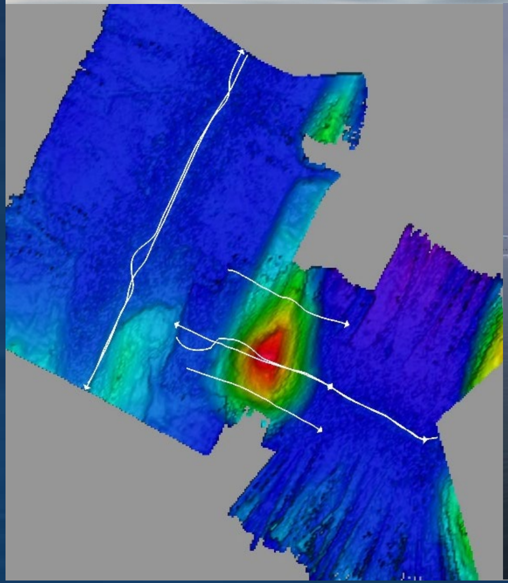
Related Non-NSF-Funded Field Programs

- *ODEN* expeditions to NW Passage, Ryder Glacier, and Petermann Glacier



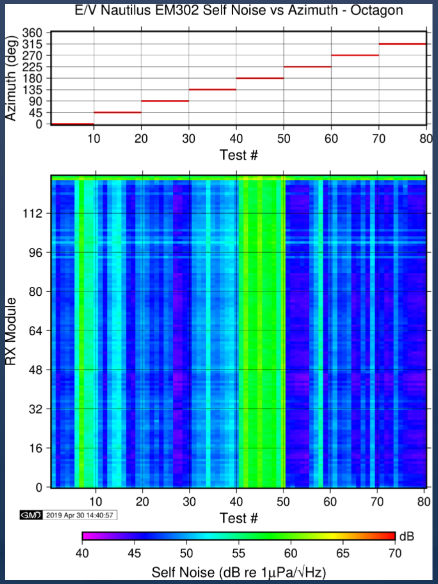


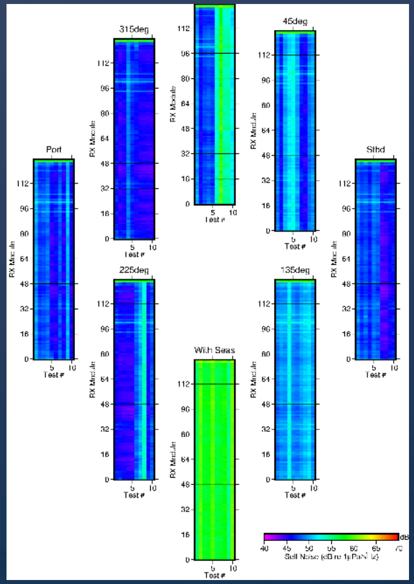
Multibeam Assessment Tools

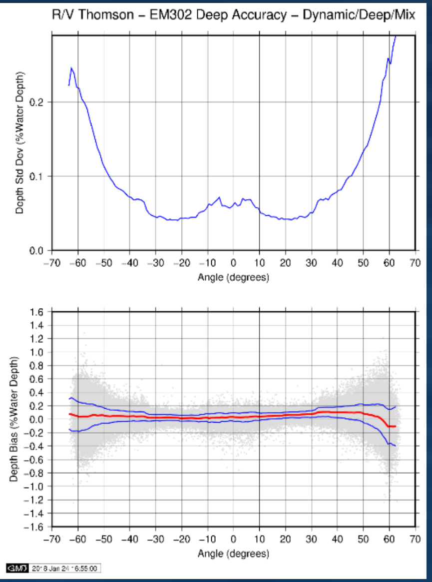
- NOAA/CCOM/MAC collaboration
- Open-source tools for system performance testing and tracking based on MAC and NOAA processes
- Will be Python-based in HydrOffice and Pydro frameworks
- Complements commercial tools
- First joint developer meeting Dec. 2019

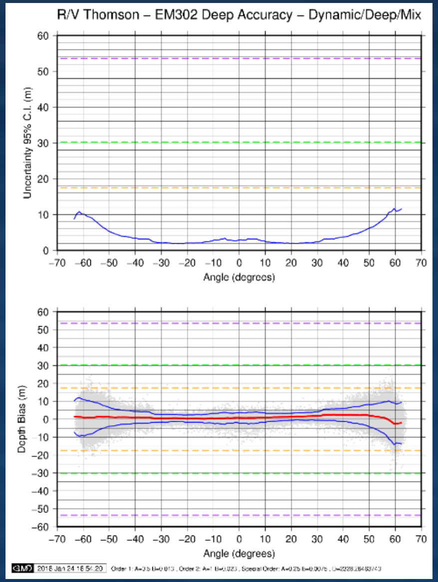
Multibeam Assessment Tools

- **Swath coverage**
- Swath accuracy
- RX noise and spectrum
  - vs. speed
  - vs. heading
- TX channels impedance
- **Datagram stripper for file transfer**
- BIST and PU Parameter tracker
- System geometry visualizer
- Runtime Parameter review / query
- Others? Open for suggestions!



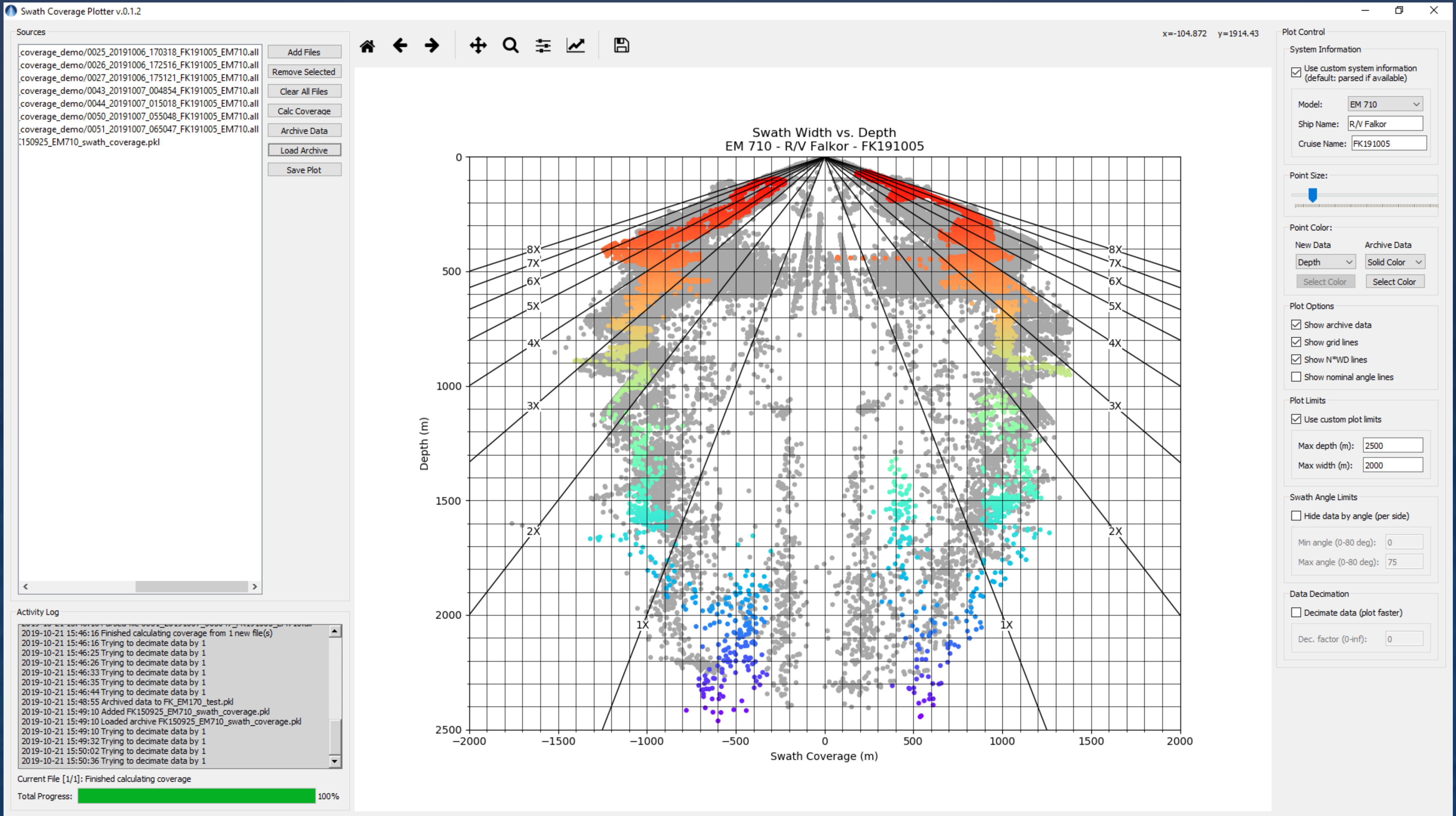






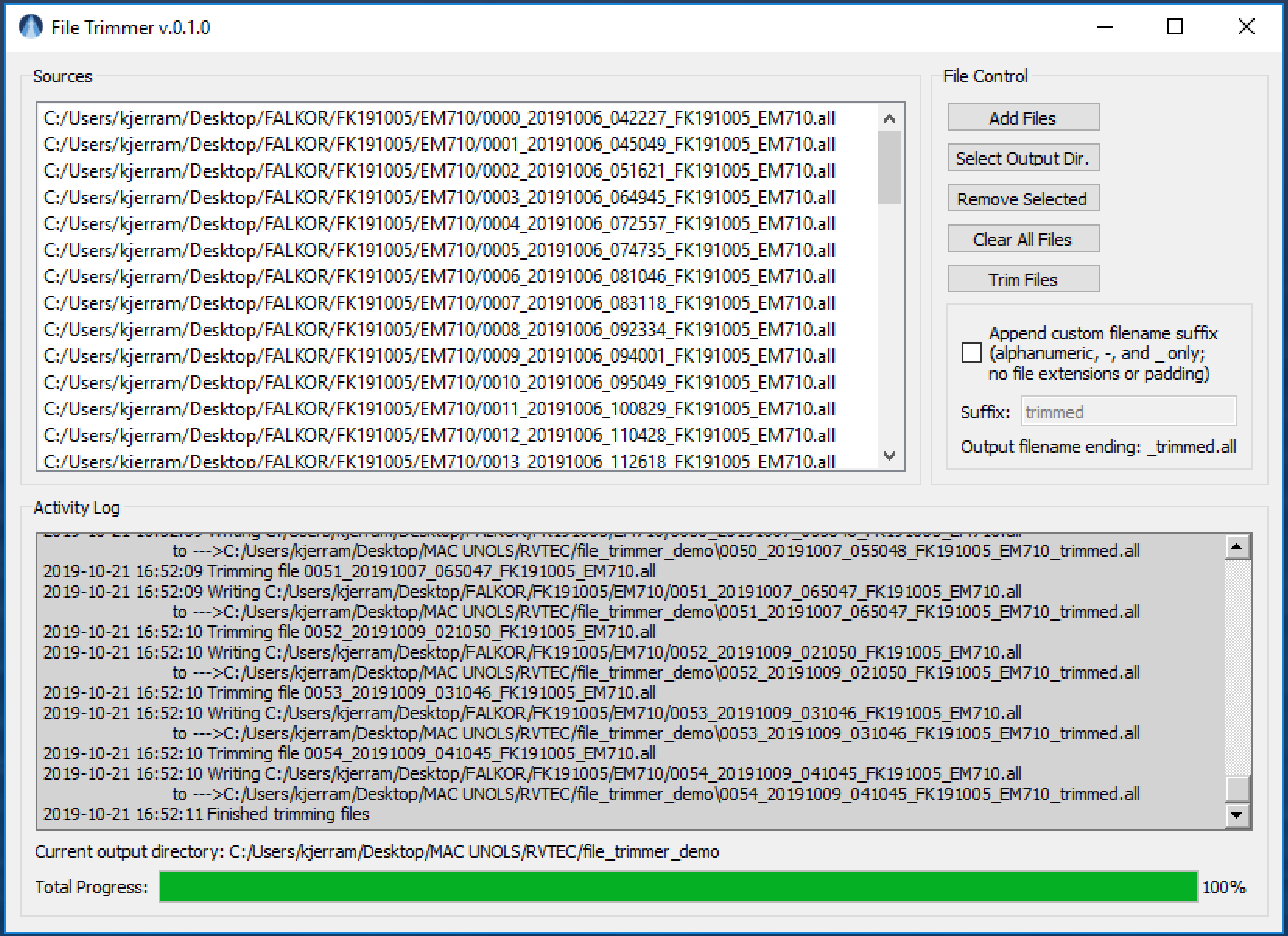
Multibeam Assessment Tools: Swath Coverage

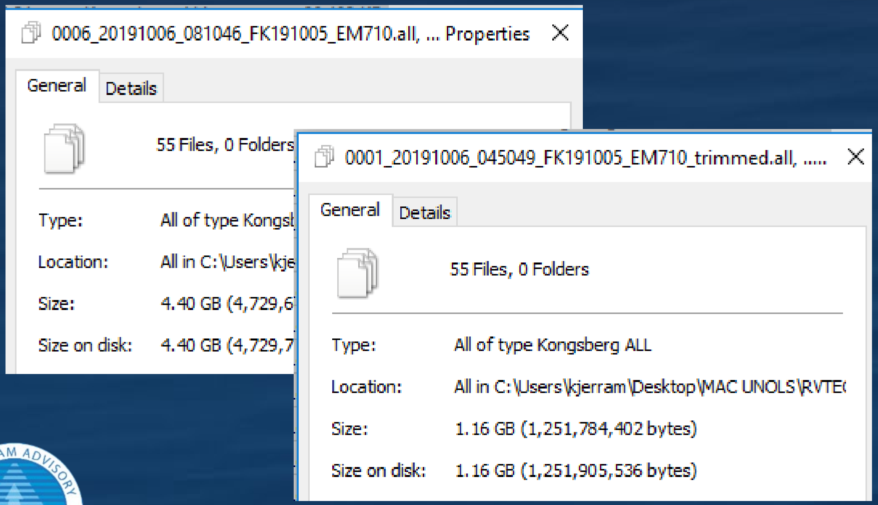
- Demo swath coverage tool



Multibeam Assessment Tools: File Reducer

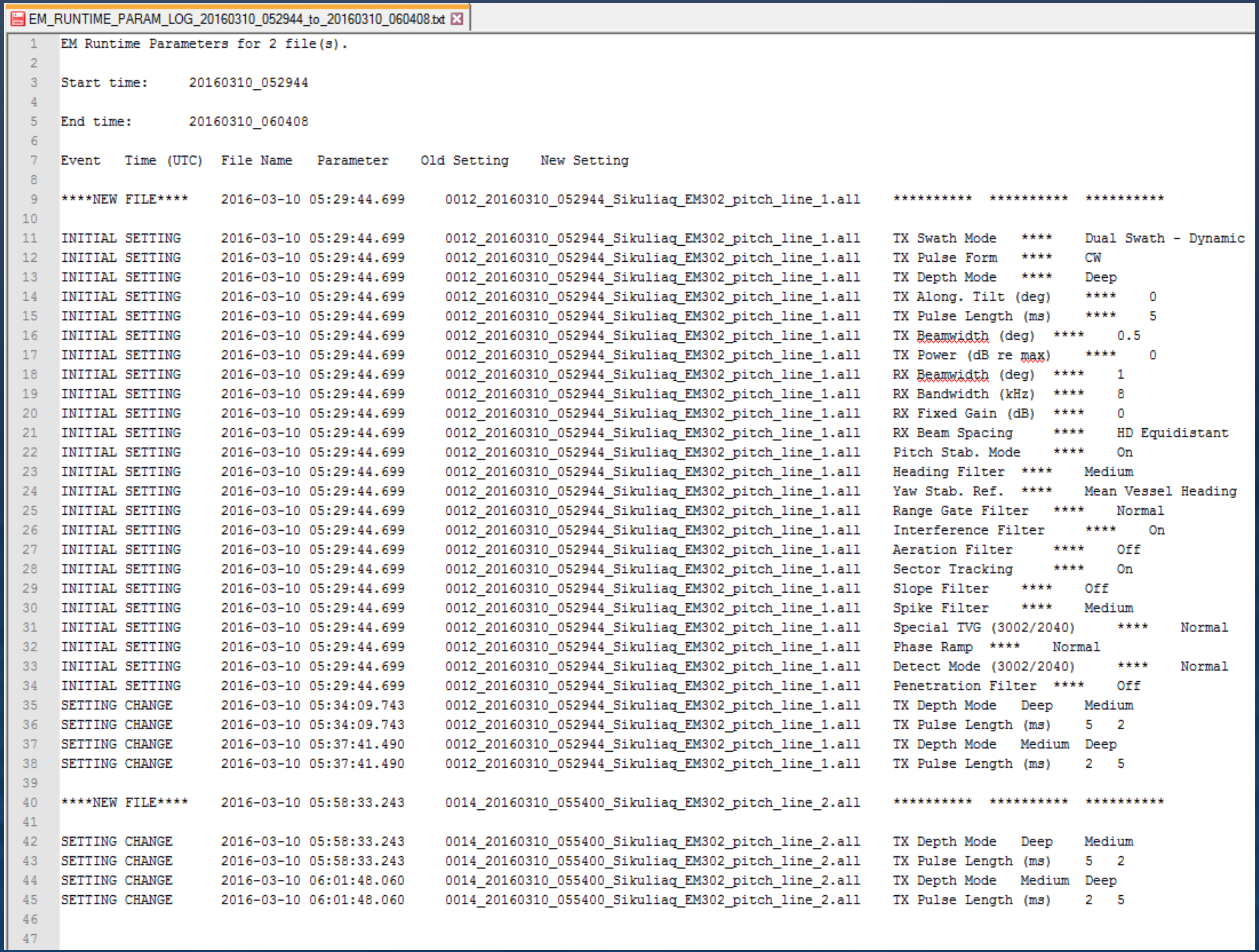
- Remove non-critical datagrams (e.g., 100 Hz att. vel. in QPS)
- Ship-to-shore file transfer for remote support (e.g., ATL)
- Protects original files
- Future: custom datagram selection, automatic options





Multibeam Assessment Tools: RTP Tracker

- Generate logs of Runtime Parameters from large batches of .all files
- Exports initial settings and subsequent changes to text
- MATLAB → Python GUI


EM_RUNTIME_PARAM_LOG_20160310_052944_to_20160310_060408.txt

```
EM Runtime Parameters for 2 file(s).

Start time:     20160310_052944

End time:       20160310_060408

Event   Time (UTC)  File Name   Parameter   Old Setting   New Setting

****NEW FILE****    2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    **********  **********  **********

INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Swath Mode   ****    Dual Swath - Dynamic
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Pulse Form   ****    CW
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Depth Mode   ****    Deep
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Along. Tilt (deg)    ****    0
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Pulse Length (ms)    ****    5
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Beamwidth (deg)  ****    0.5
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Power (dB re max)    ****    0
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    RX Beamwidth (deg)  ****    1
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    RX Bandwidth (kHz)  ****    8
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    RX Fixed Gain (dB)  ****    0
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    RX Beam Spacing     ****    HD Equidistant
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Pitch Stab. Mode    ****    On
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Heading Filter  ****    Medium
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Yaw Stab. Ref.  ****    Mean Vessel Heading
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Range Gate Filter   ****    Normal
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Interference Filter     ****    On
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Aeration Filter     ****    Off
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Sector Tracking     ****    On
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Slope Filter    ****    Off
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Spike Filter    ****    Medium
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Special TVG (3002/2040)     ****    Normal
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Phase Ramp  ****    Normal
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Detect Mode (3002/2040)     ****    Normal
INITIAL SETTING     2016-03-10 05:29:44.699    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    Penetration Filter  ****    Off
SETTING CHANGE      2016-03-10 05:34:09.743    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Depth Mode   Deep    Medium
SETTING CHANGE      2016-03-10 05:34:09.743    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Pulse Length (ms)    5   2
SETTING CHANGE      2016-03-10 05:37:41.490    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Depth Mode   Medium  Deep
SETTING CHANGE      2016-03-10 05:37:41.490    0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all    TX Pulse Length (ms)    2   5

****NEW FILE****    2016-03-10 05:58:33.243    0014_20160310_055400_Sikuliaq_EM302_pitch_line_2.all    **********  **********  **********

SETTING CHANGE      2016-03-10 05:58:33.243    0014_20160310_055400_Sikuliaq_EM302_pitch_line_2.all    TX Depth Mode   Deep    Medium
SETTING CHANGE      2016-03-10 05:58:33.243    0014_20160310_055400_Sikuliaq_EM302_pitch_line_2.all    TX Pulse Length (ms)    5   2
SETTING CHANGE      2016-03-10 06:01:48.060    0014_20160310_055400_Sikuliaq_EM302_pitch_line_2.all    TX Depth Mode   Medium  Deep
SETTING CHANGE      2016-03-10 06:01:48.060    0014_20160310_055400_Sikuliaq_EM302_pitch_line_2.all    TX Pulse Length (ms)    2   5
```

Multibeam Assessment Tools: RTP Tracker

- Query RTP logs
- All RTP at specific time in log
  - Confirm settings, track artifacts
- Specific RTP history throughout log
  - Monitor 'automatic' settings, detect user-initiated changes

```
>> queryEMparams


Select runtime parameter logs covering the time period of interest.
Logs are .mat files created with script 'logEMparams'.

*** NEW EM LOG QUERY ***

Enter 'P' to search for a parameter
      'T' to search for a time
      'L' to select new logs
   or 'Q' to quit query: p

*** NEW PARAMETER QUERY ***

List of parameters in log:

    1 - TX Swath Mode
    2 - TX Pulse Form
    3 - TX Depth Mode
    4 - TX Along. Tilt (deg)
    5 - TX Pulse Length (ms)
    6 - TX Beamwidth (deg)
    7 - TX Power (dB re max)
    8 - RX Beamwidth (deg)
    9 - RX Bandwidth (kHz)
    10 - RX Fixed Gain (dB)
    11 - RX Beam Spacing
    12 - Pitch Stab. Mode
    13 - Heading Filter
    14 - Yaw Stab. Ref.
    15 - Range Gate Filter
    16 - Interference Filter
    17 - Aeration Filter
    18 - Sector Tracking
    19 - Slope Filter
    20 - Spike Filter
    21 - Special TVG (3002/2040)
    22 - Phase Ramp
    23 - Detect Mode (3002/2040)
    24 - Penetration Filter

Enter the number for the parameter of interest
or 'Q' and ENTER to quit parameter query: 14

*** PARAMETER QUERY RESULTS ***

2016-03-10 05:29:44.699 EM_RUNTIME_PARAM_LOG_20160310_052944_to_20160
2016-03-10 05:29:44.699 Yaw Stab. Ref.: Mean Vessel Heading

End of log list.
```

```
*** NEW EM LOG QUERY ***

Enter 'P' to search for a parameter
      'T' to search for a time
      'L' to select new logs
   or 'Q' to quit query: t

*** NEW TIME QUERY ***

Enter the UTC time of interest (YYYYMMDDhhmmss)
or 'Q' and ENTER to quit time query: 20160310053000

Finding .mat log file with parameters for 2016-03-10 05:30:00.000
Log found. Querying log for parameters at 2016-03-10 05:30:00.000

*** TIME QUERY RESULTS ***

Query time:                          2016-03-10 05:30:00.000
Raw file containing query time:      0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all
Raw file containing last change(s):  0012_20160310_052944_Sikuliaq_EM302_pitch_line_1.all
Log file containing query time:      EM_RUNTIME_PARAM_LOG_20160310_052944_to_20160310_060408.mat
Time of first entry in log:          2016-03-10 05:29:44.699
Time of most recent change(s):       2016-03-10 05:29:44.699

          TX Swath Mode: Dual Swath - Dynamic (unchanged since start of log file)
          TX Pulse Form: CW (unchanged since start of log file)
          TX Depth Mode: Deep (unchanged since start of log file)
   TX Along. Tilt (deg): 0 (unchanged since start of log file)
   TX Pulse Length (ms): 5 (unchanged since start of log file)
     TX Beamwidth (deg): 0.5 (unchanged since start of log file)
   TX Power (dB re max): 0 (unchanged since start of log file)
     RX Beamwidth (deg): 1 (unchanged since start of log file)
     RX Bandwidth (kHz): 8 (unchanged since start of log file)
     RX Fixed Gain (dB): 0 (unchanged since start of log file)
        RX Beam Spacing: HD Equidistant (unchanged since start of log file)
       Pitch Stab. Mode: On (unchanged since start of log file)
         Heading Filter: Medium (unchanged since start of log file)
         Yaw Stab. Ref.: Mean Vessel Heading (unchanged since start of log file)
      Range Gate Filter: Normal (unchanged since start of log file)
    Interference Filter: On (unchanged since start of log file)
        Aeration Filter: Off (unchanged since start of log file)
        Sector Tracking: On (unchanged since start of log file)
           Slope Filter: Off (unchanged since start of log file)
           Spike Filter: Medium (unchanged since start of log file)
Special TVG (3002/2040): Normal (unchanged since start of log file)
             Phase Ramp: Normal (unchanged since start of log file)
Detect Mode (3002/2040): Normal (unchanged since start of log file)
     Penetration Filter: Off (unchanged since start of log file)

End of log list.
```

Multibeam Assessment Tools: In Development

- **Swath coverage**
- Swath accuracy
- RX noise and spectrum
  - vs. speed, heading, other conditions
- TX and RX channels impedance
- **Datagram stripper for file transfer**
- BIST and PU Parameter tracker
- System geometry visualizer
- Runtime Parameter tracker
- Patch test planner
- **Others? Open for suggestions!**

v0

Sound Speed Manager

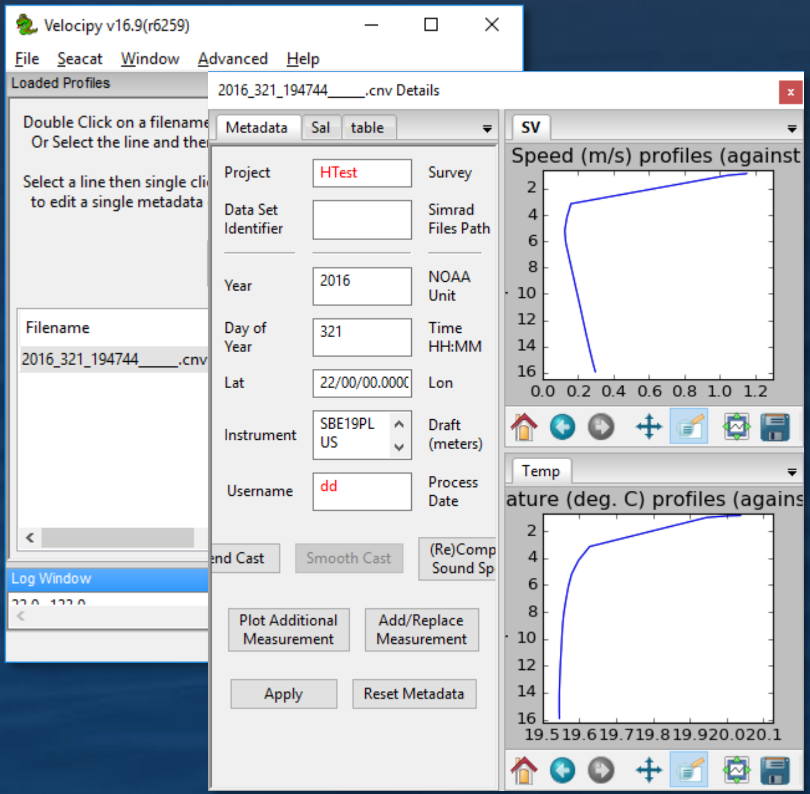
G. Masetti

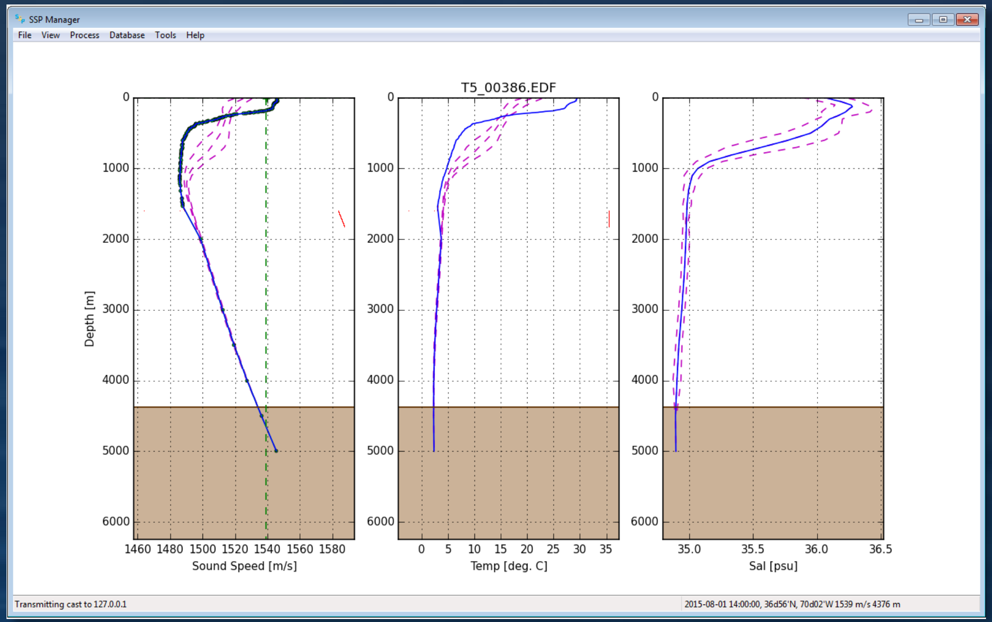
Sound Speed Manager

- A **ready-to-go** and **free** solution to ease the **management of sound speed profiles** for ocean mapping

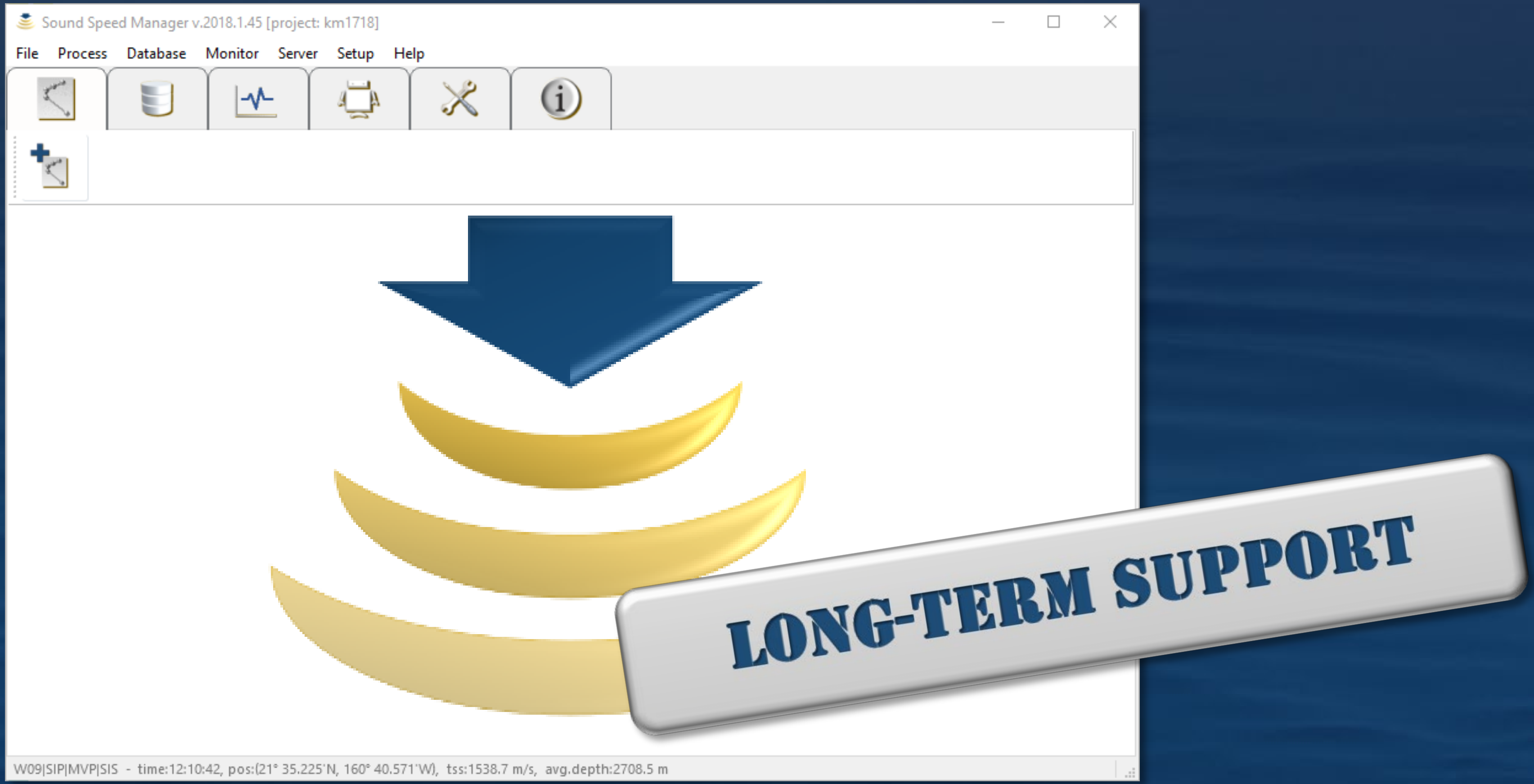
Ref.: Masetti, G. et al., *Sound Speed Manager: An open-source application to manage sound speed profiles*, International Hydrographic Review, vol. 17, pp. 31-40, 2017.

Collaborative Effort

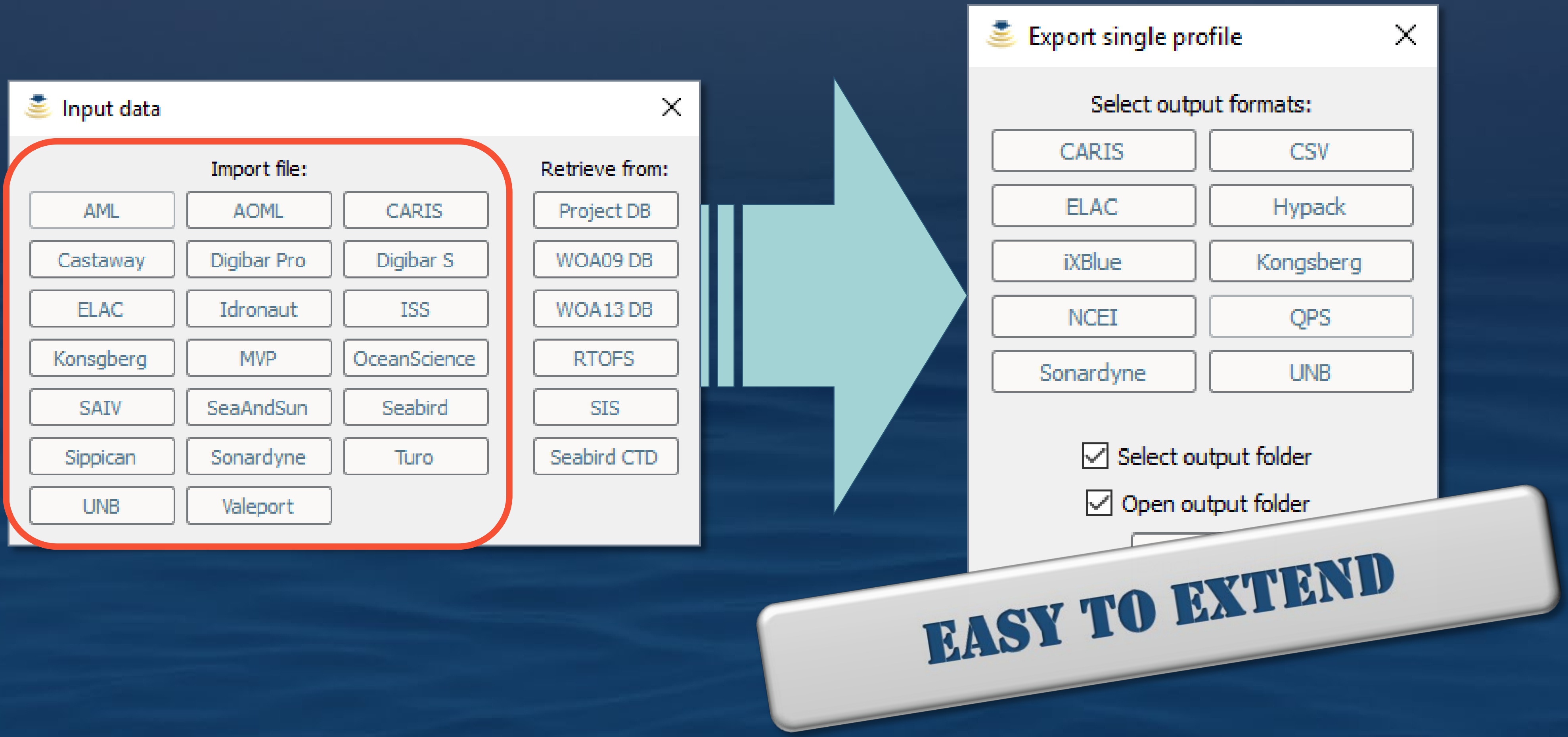


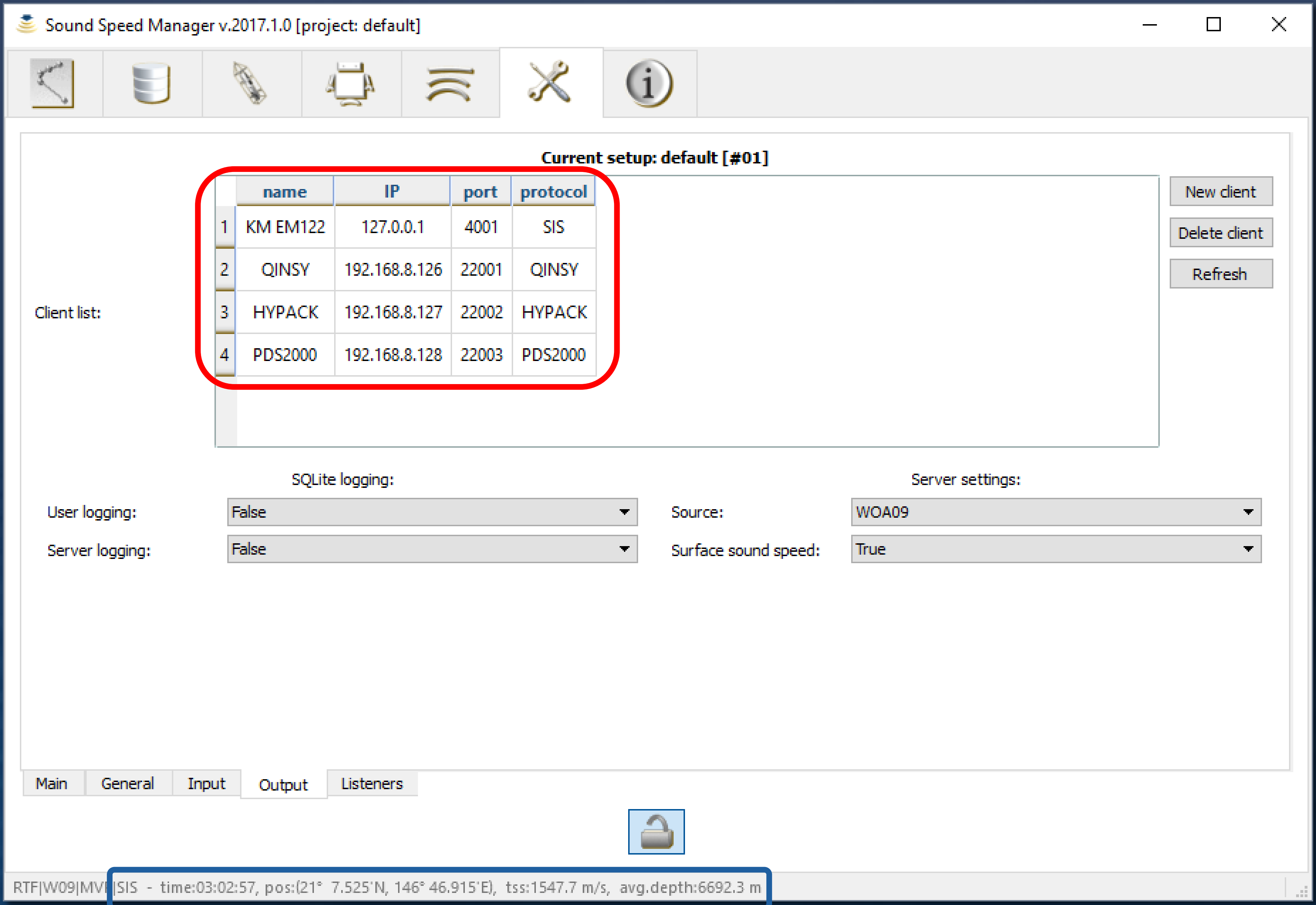


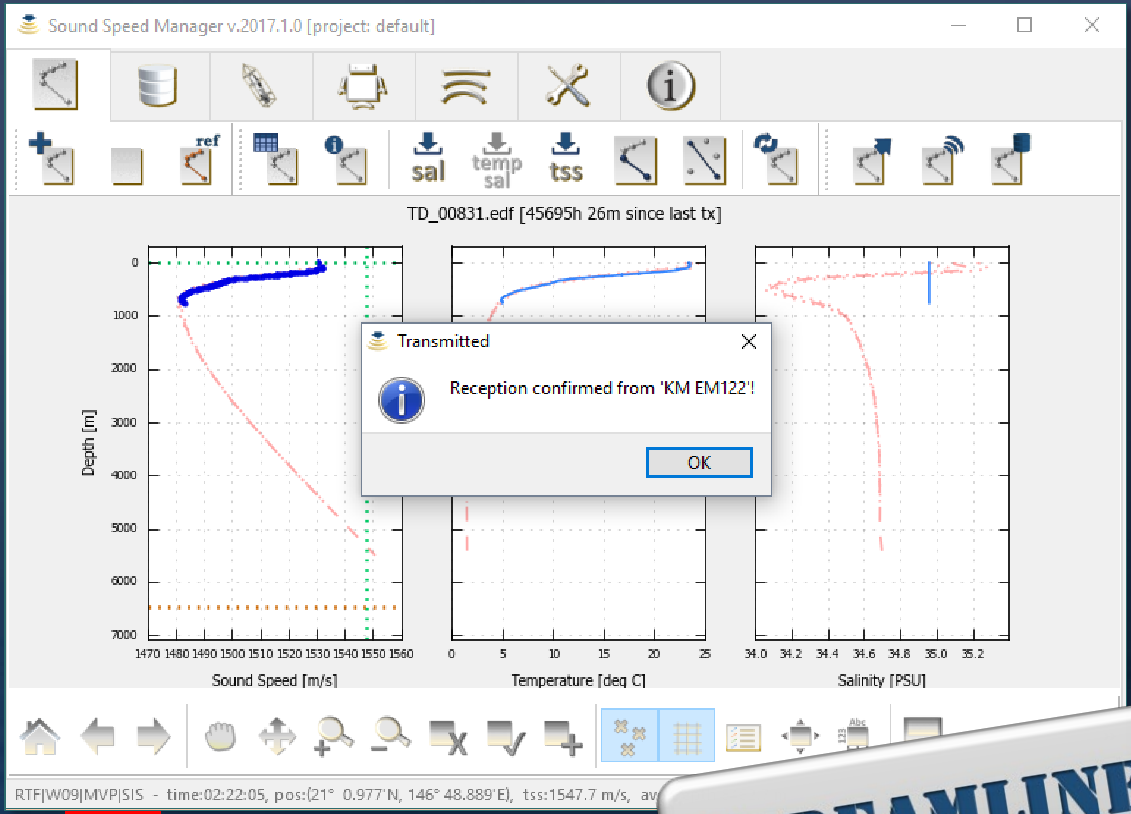
Collaborative Effort



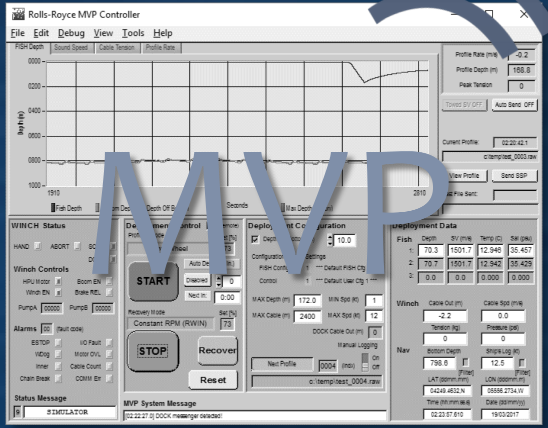
Format Converter

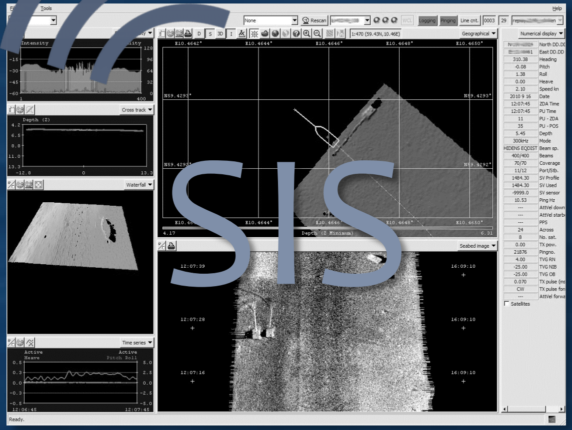


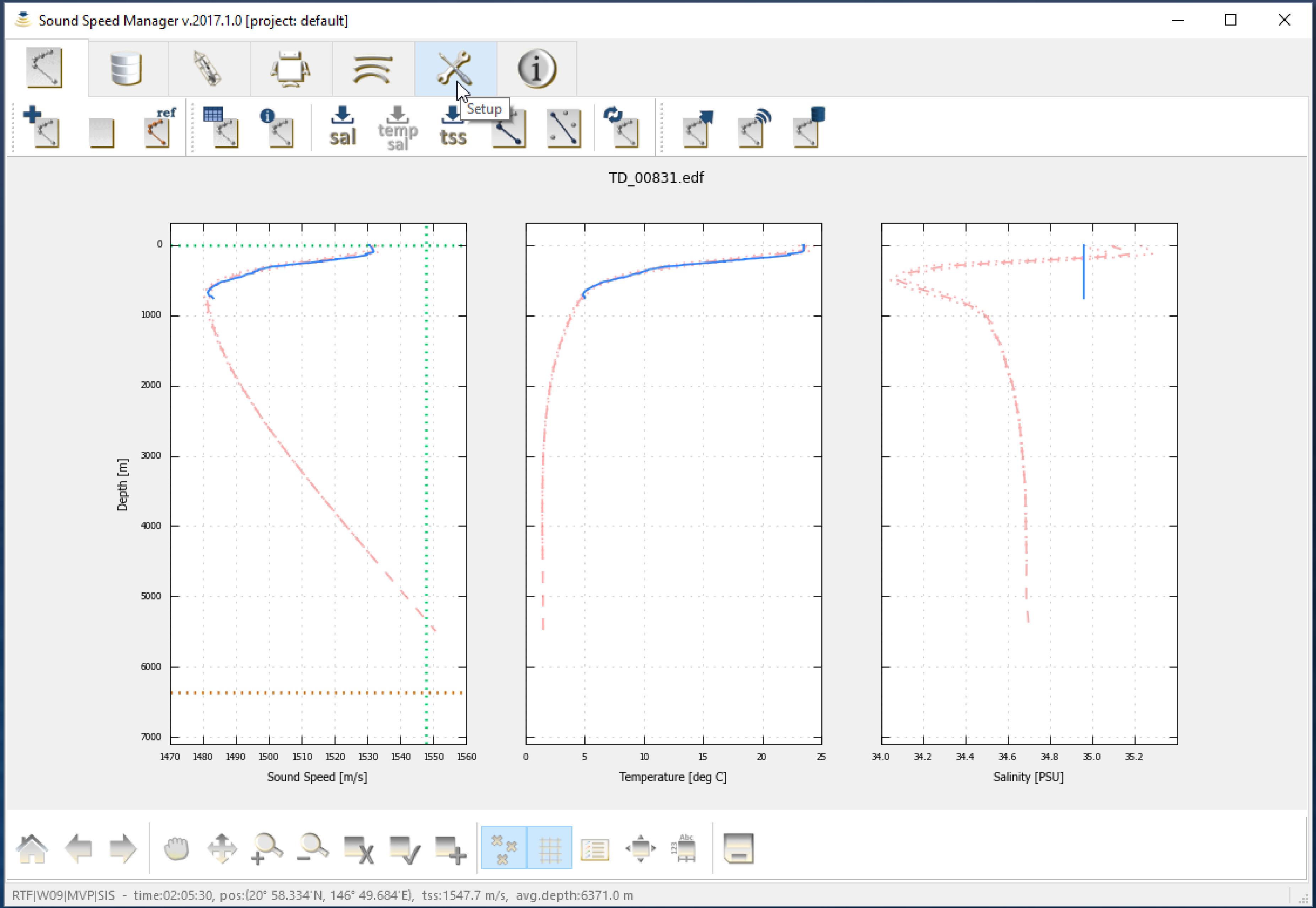

Sound Speed Manager v.2017.1.0 [project: default]
Current setup: default [#01]
Client list:
name | IP | port | protocol
1 KM EM122 | 127.0.0.1 | 4001 | SIS
2 QINSY | 192.168.8.126 | 22001 | QINSY
3 HYPACK | 192.168.8.127 | 22002 | HYPACK
4 PDS2000 | 192.168.8.128 | 22003 | PDS2000
New client
Delete client
Refresh
SQLite logging:
User logging: False
Server logging: False
Server settings:
Source: WOA09
Surface sound speed: True
Main
General
Input
Output
Listeners
RTF|W09|MVP|SIS - time:03:02:57, pos:(21° 7.525'N, 146° 46.915'E), tss:1547.7 m/s, avg.depth:6692.3 m



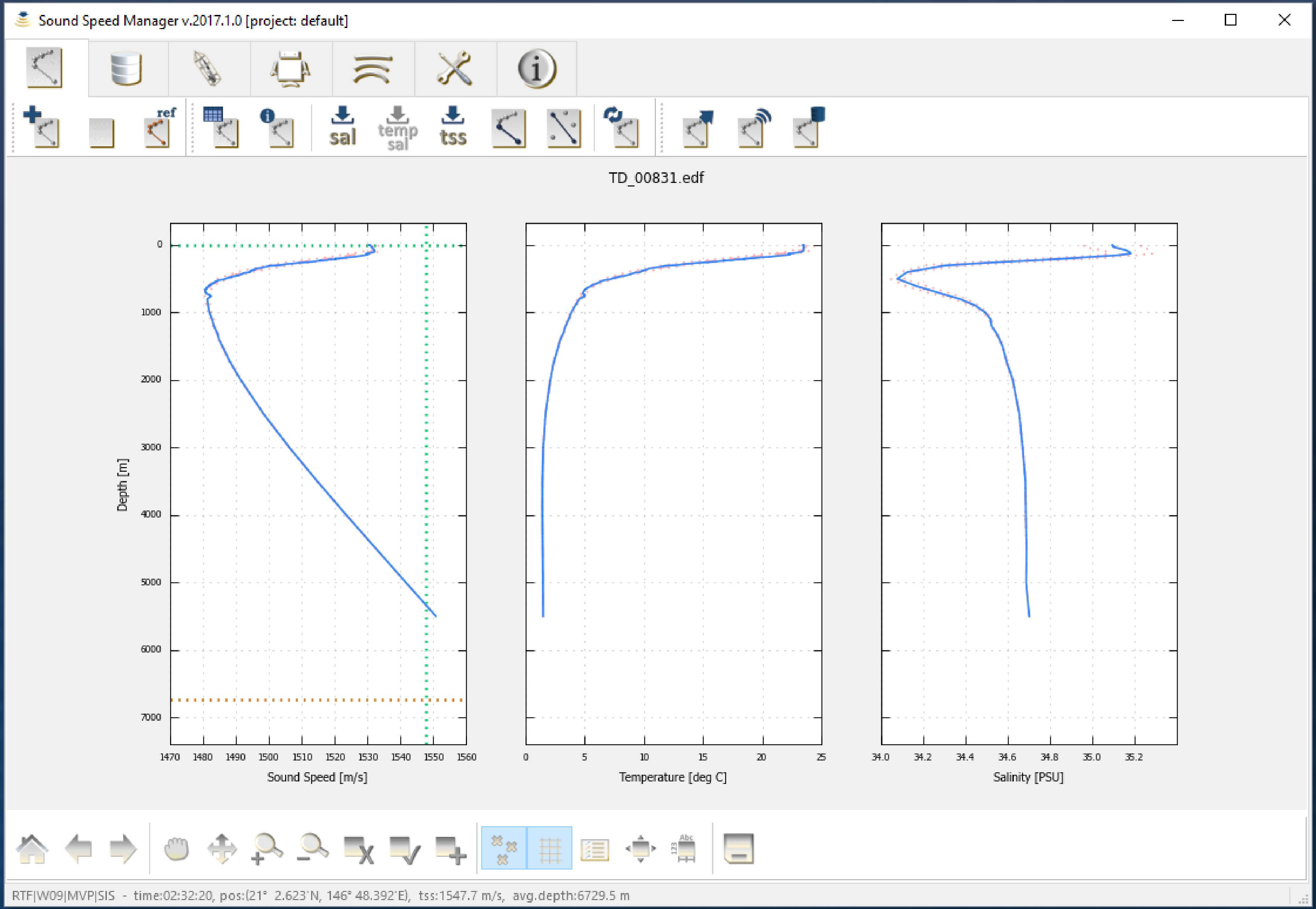
STREAMLINE WORKFLOWS



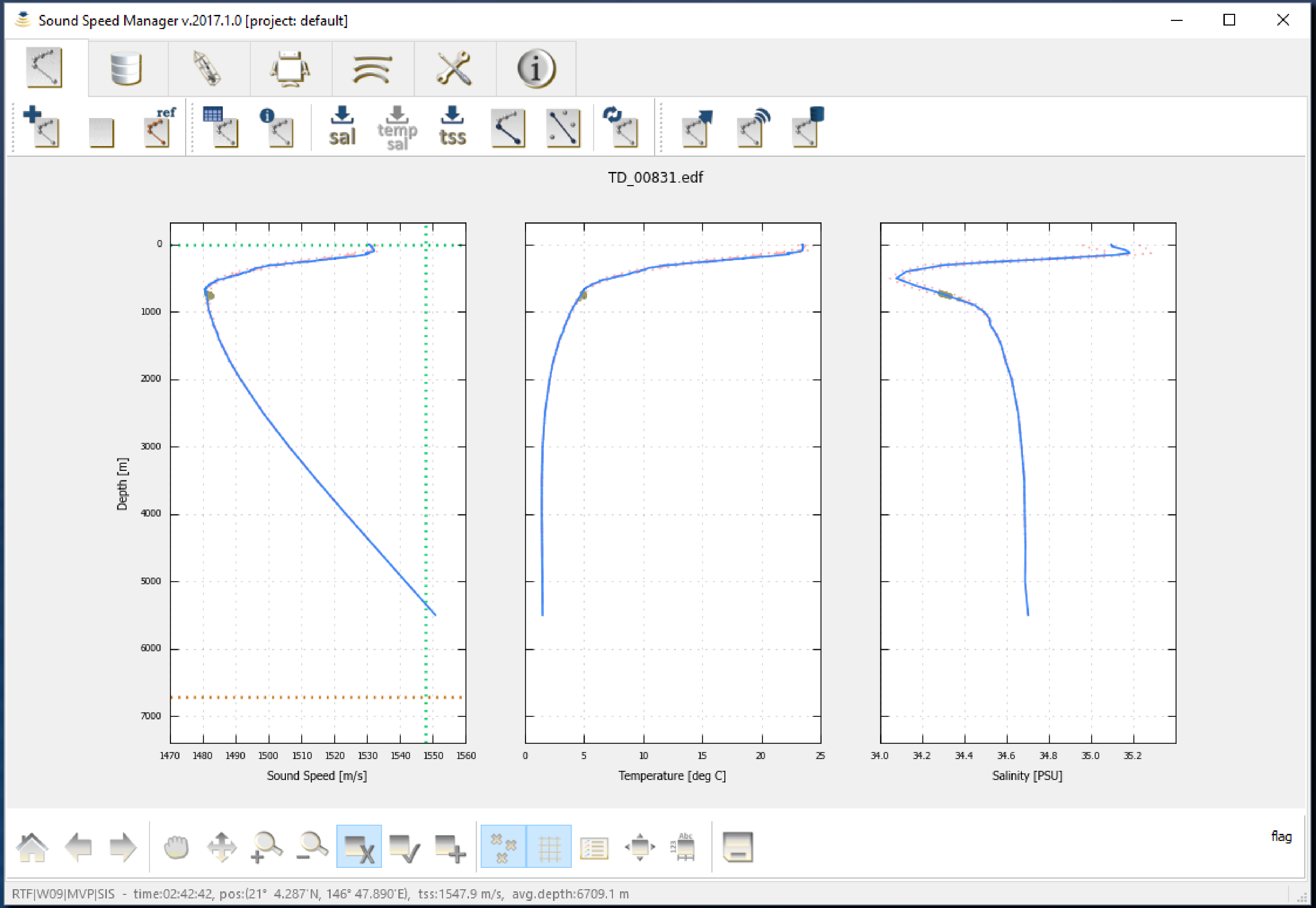


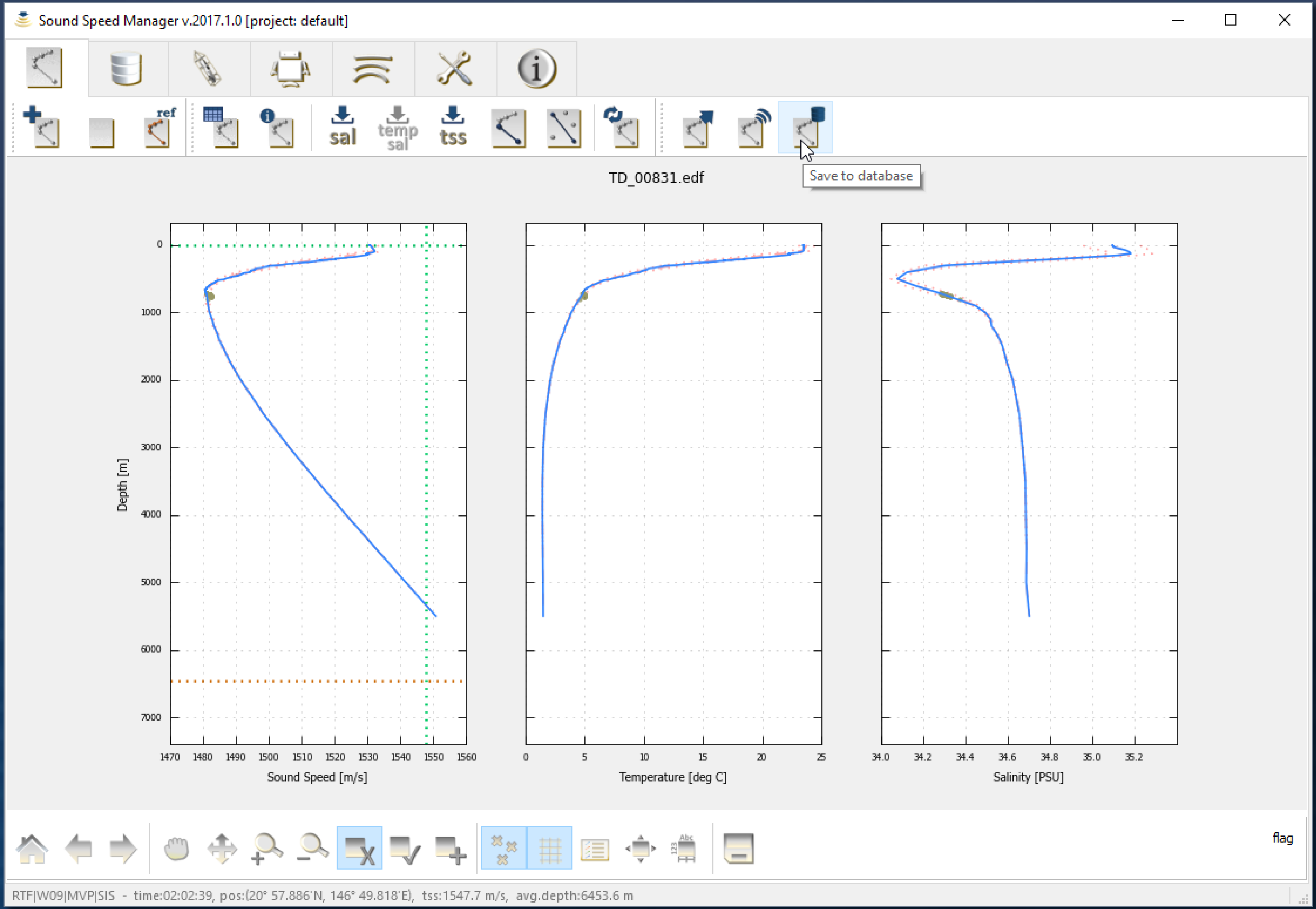


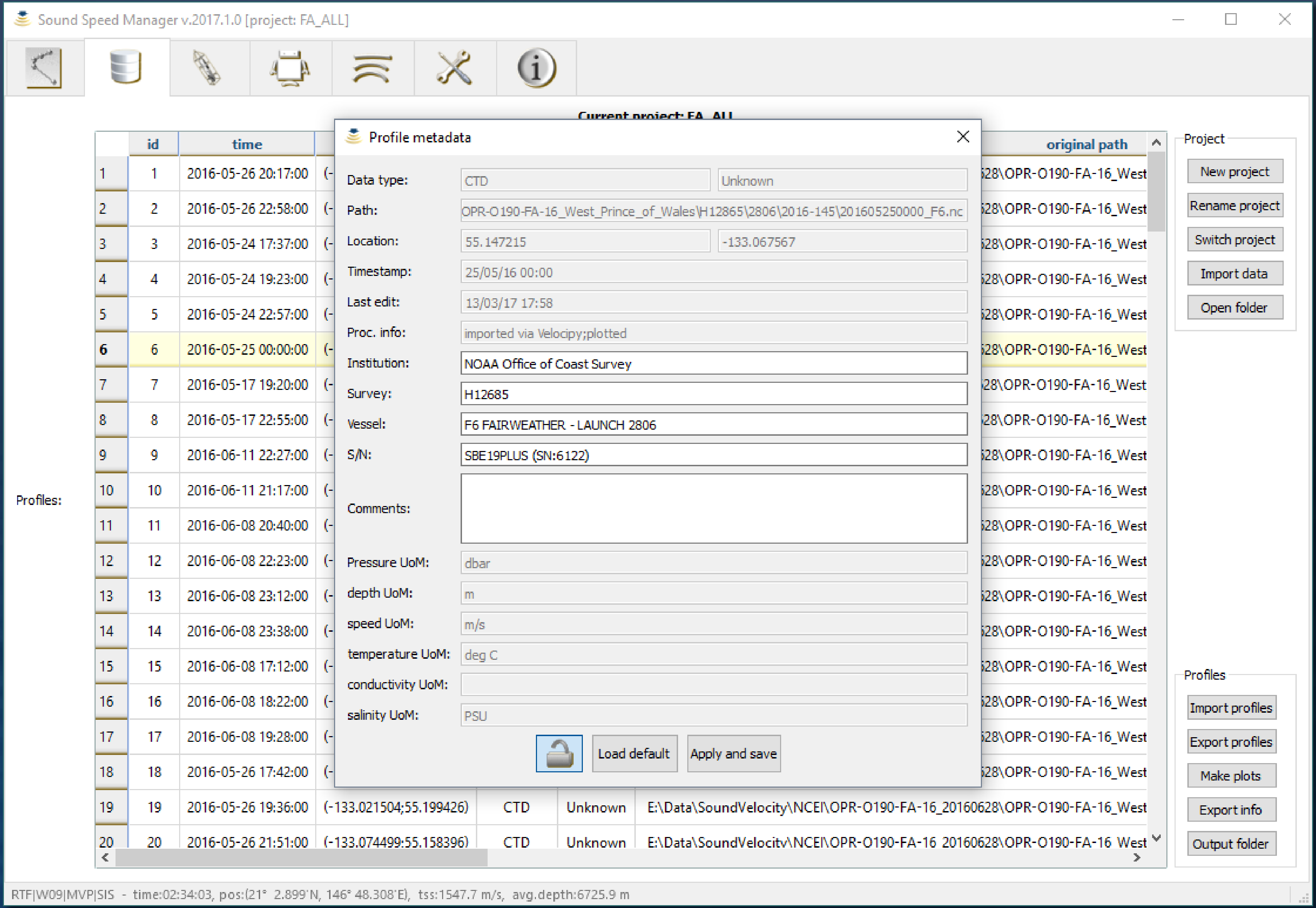
MULTIBEAM ADVISORY COMMITEE

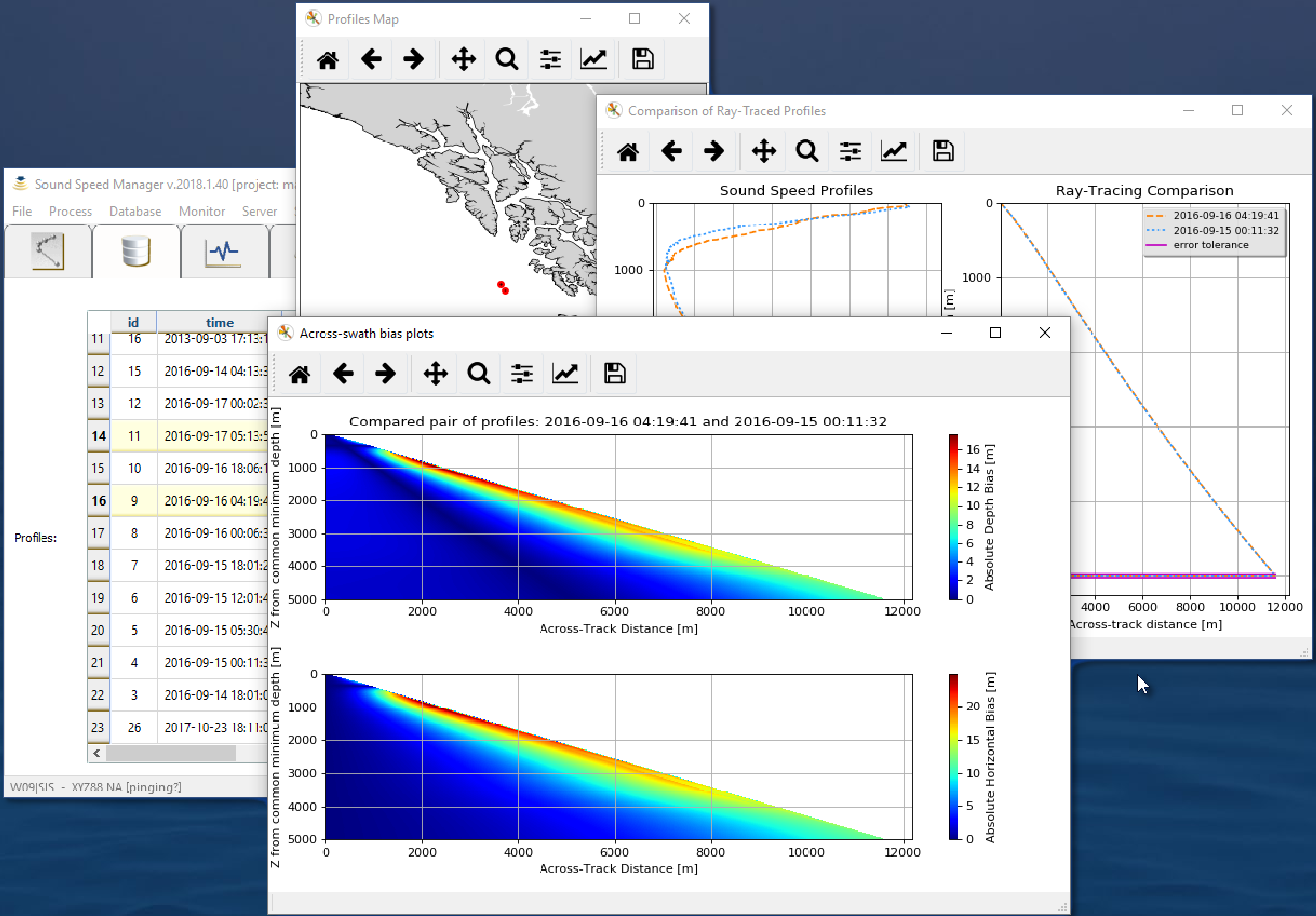


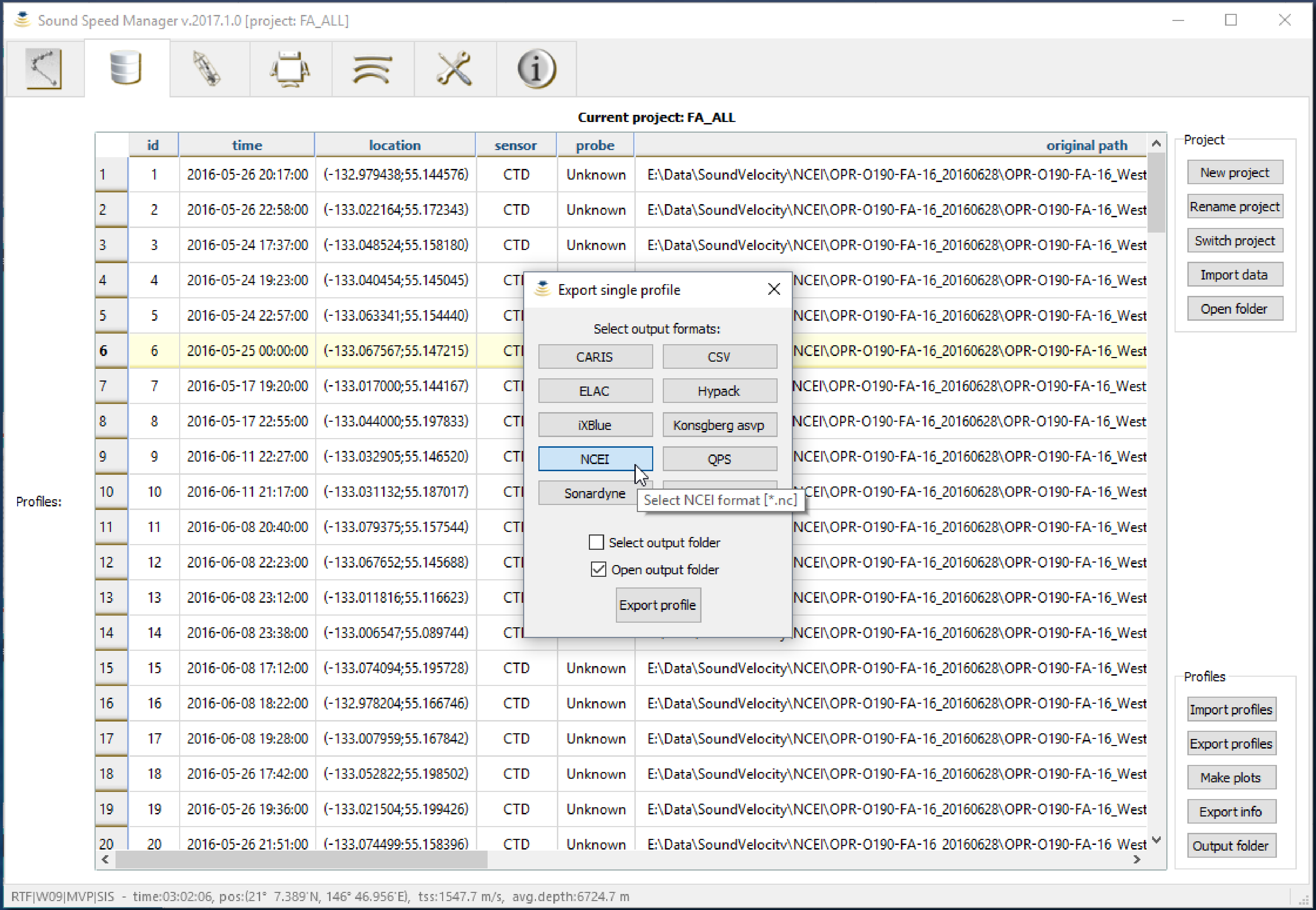
Sound Speed Manager v.2017.1.0 [project: default]
ref
sal
temp sal
tss
TD_00831.edf
Depth [m]
0
1000
2000
3000
4000
5000
6000
7000
1470 1480 1490 1500 1510 1520 1530 1540 1550 1560
Sound Speed [m/s]
0 5 10 15 20 25
Temperature [deg C]
34.0 34.2 34.4 34.6 34.8 35.0 35.2
Salinity [PSU]
RTF|W09|MVP|SIS - time:02:32:20, pos:(21° 2.623'N, 146° 48.392'E), tss:1547.7 m/s, avg.depth:6729.5 m


Sound Speed Manager v.2017.1.0 [project: default]
TD_00831.edf
Depth [m]
Sound Speed [m/s]
Temperature [deg C]
Salinity [PSU]
flag
RTF|W09|MVP|SIS - time:02:42:42, pos:(21° 4.287'N, 146° 47.890'E), tss:1547.9 m/s, avg.depth:6709.1 m

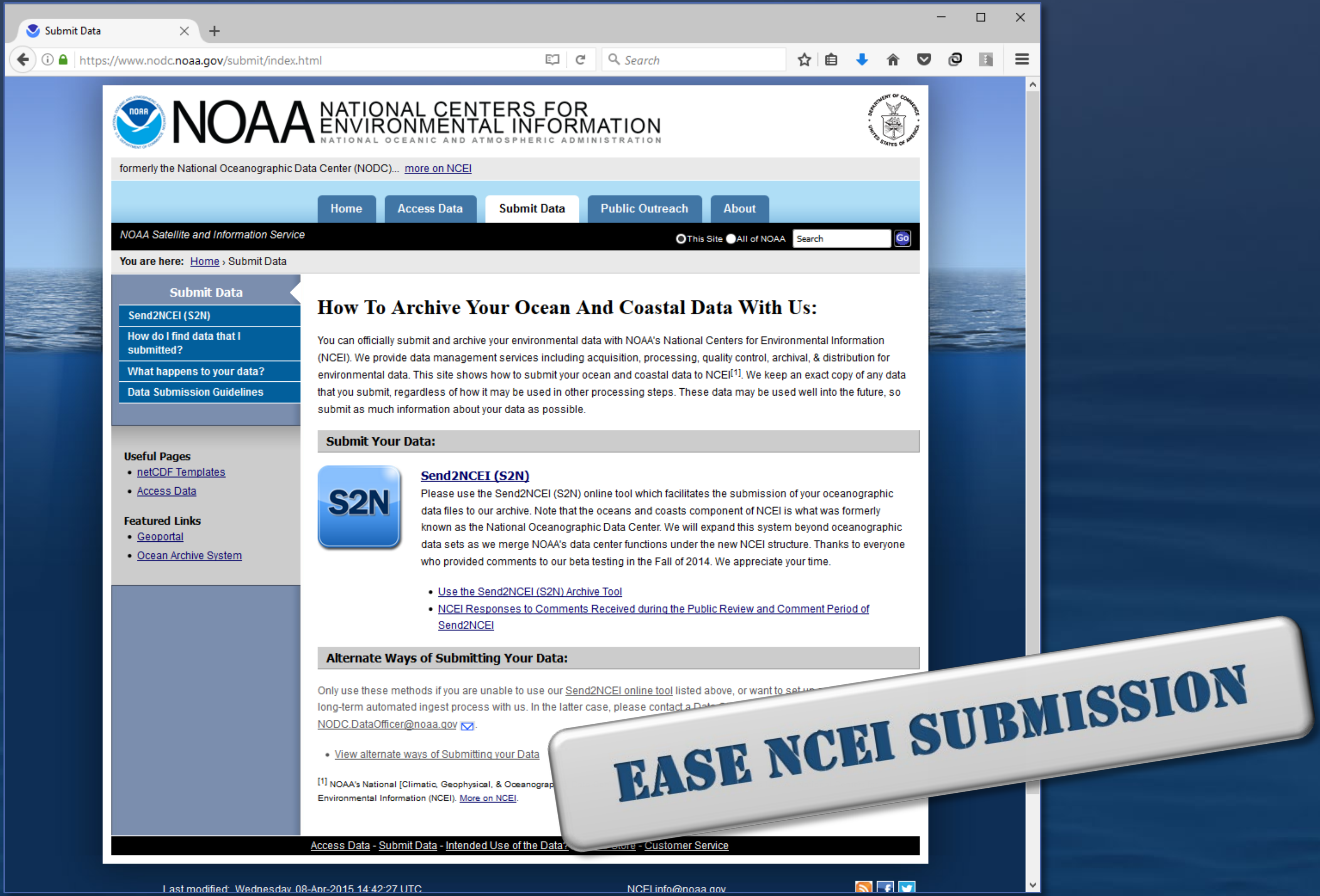

Sound Speed Manager v.2017.1.0 [project: default]
ref
sal
temp sal
tss
Save to database
TD_00831.edf
Depth [m]
Sound Speed [m/s]
Temperature [deg C]
Salinity [PSU]
flag
RTF|W09|MVP|SIS - time:02:02:39, pos:(20° 57.886'N, 146° 49.818'E), tss:1547.7 m/s, avg.depth:6453.6 m

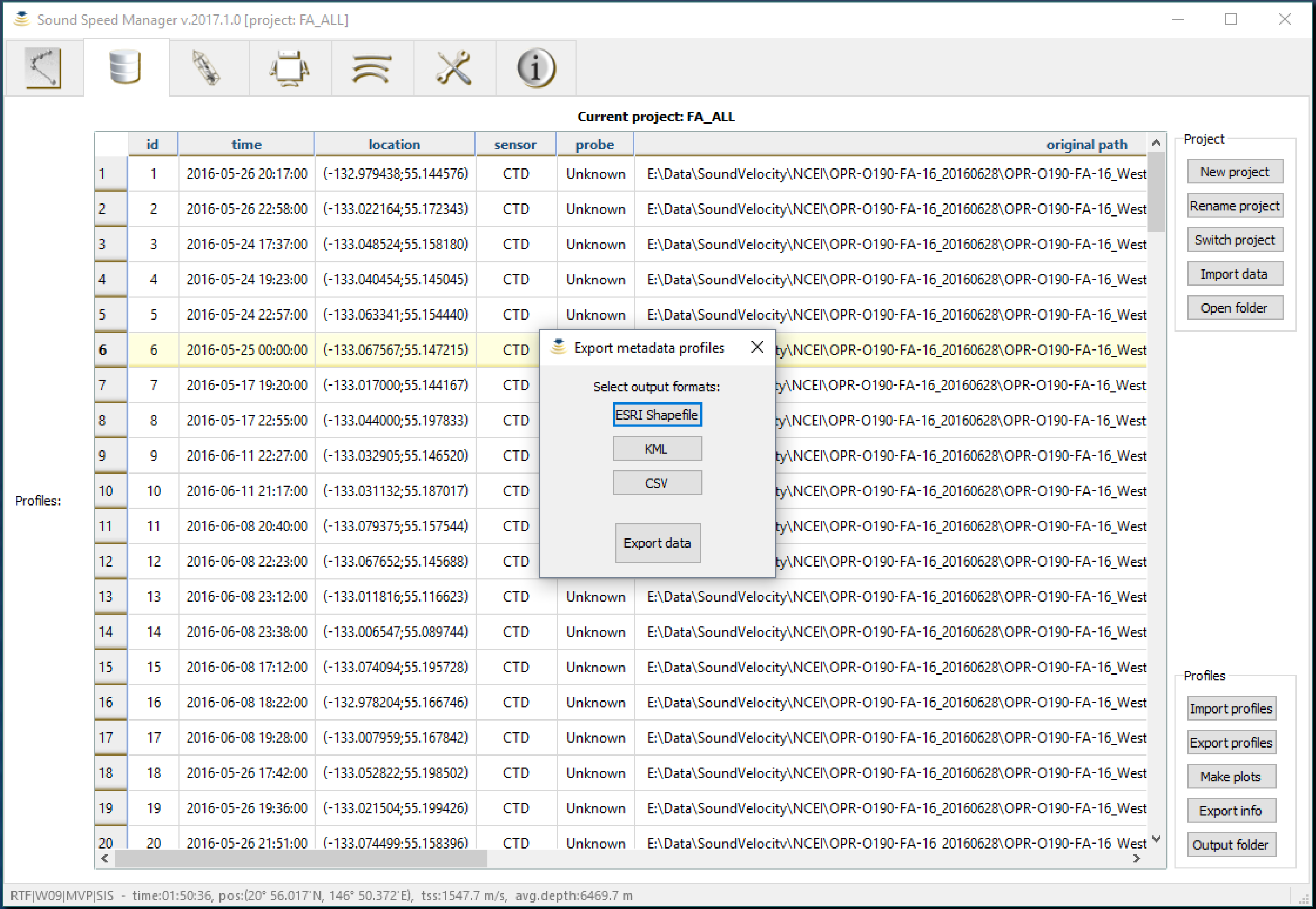

Sound Speed Manager v.2017.1.0 [project: FA_ALL]
Current project: FA_ALL
Profile metadata
Data type: CTD Unknown
Path: OPR-O190-FA-16_West_Prince_of_Wales\H12865\2806\2016-145\201605250000_F6.nc
Location: 55.147215 -133.067567
Timestamp: 25/05/16 00:00
Last edit: 13/03/17 17:58
Proc. info: imported via Velocipy;plotted
Institution: NOAA Office of Coast Survey
Survey: H12685
Vessel: F6 FAIRWEATHER - LAUNCH 2806
S/N: SBE19PLUS (SN:6122)
Comments:
Pressure UoM: dbar
depth UoM: m
speed UoM: m/s
temperature UoM: deg C
conductivity UoM:
salinity UoM: PSU
Load default
Apply and save
Profiles:
id
time
original path
1 1 2016-05-26 20:17:00
2 2 2016-05-26 22:58:00
3 3 2016-05-24 17:37:00
4 4 2016-05-24 19:23:00
5 5 2016-05-24 22:57:00
6 6 2016-05-25 00:00:00
7 7 2016-05-17 19:20:00
8 8 2016-05-17 22:55:00
9 9 2016-06-11 22:27:00
10 10 2016-06-11 21:17:00
11 11 2016-06-08 20:40:00
12 12 2016-06-08 22:23:00
13 13 2016-06-08 23:12:00
14 14 2016-06-08 23:38:00
15 15 2016-06-08 17:12:00
16 16 2016-06-08 18:22:00
17 17 2016-06-08 19:28:00
18 18 2016-05-26 17:42:00
19 19 2016-05-26 19:36:00 (-133.021504;55.199426) CTD Unknown E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
20 20 2016-05-26 21:51:00 (-133.074499;55.158396) CTD Unknown E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
Project
New project
Rename project
Switch project
Import data
Open folder
Profiles
Import profiles
Export profiles
Make plots
Export info
Output folder
RTF|W09|MVP|SIS - time:02:34:03, pos:(21° 2.899'N, 146° 48.308'E), tss:1547.7 m/s, avg.depth:6725.9 m

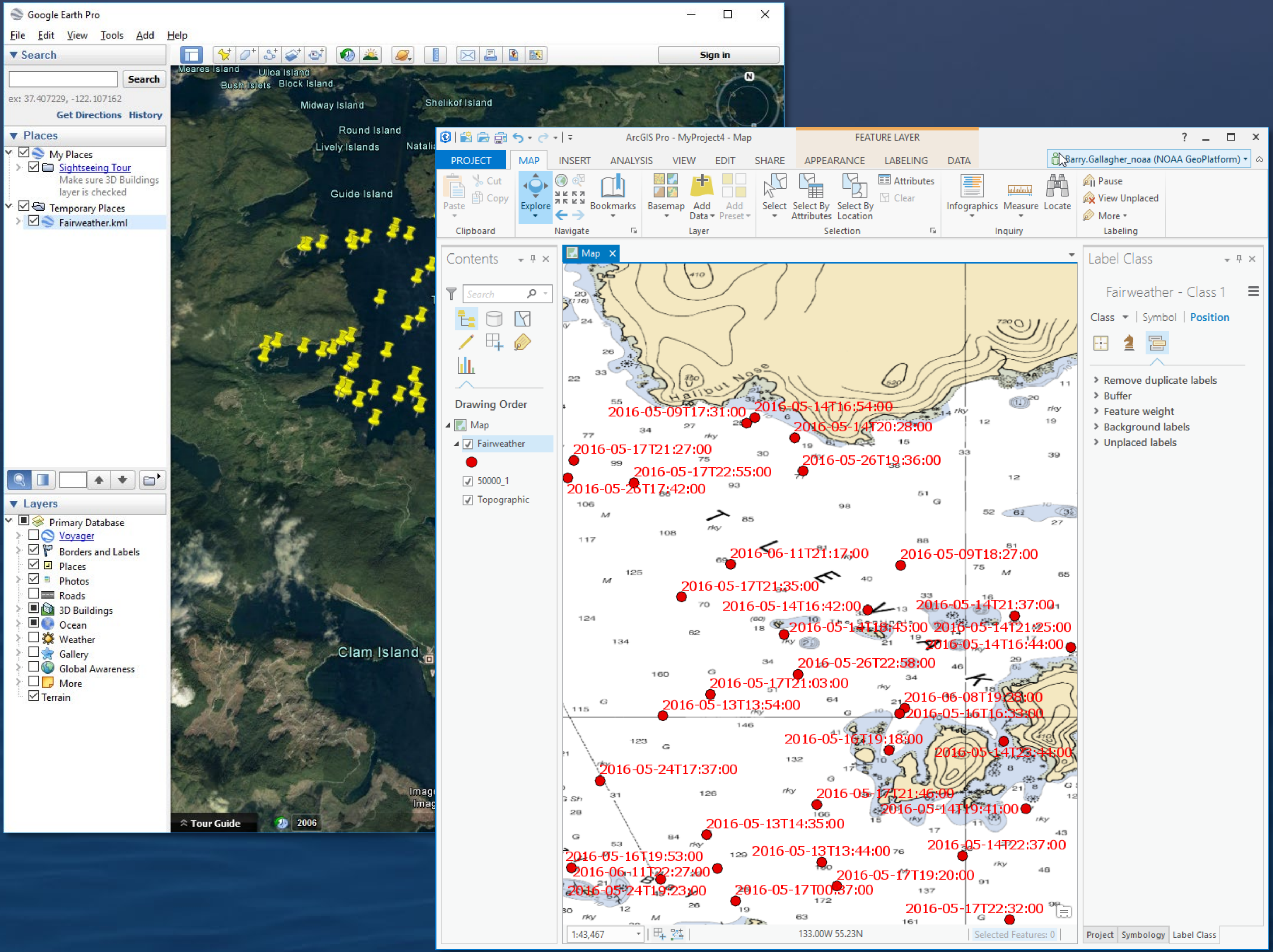

Profiles Map
Comparison of Ray-Traced Profiles
Sound Speed Profiles
Ray-Tracing Comparison
2016-09-16 04:19:41
2016-09-15 00:11:32
error tolerance
Across-track distance [m]
Sound Speed Manager v.2018.1.40 [project: m
File
Process
Database
Monitor
Server
Profiles:
id
time
11 16 2013-09-03 17:13:1
12 15 2016-09-14 04:13:3
13 12 2016-09-17 00:02:3
14 11 2016-09-17 05:13:5
15 10 2016-09-16 18:06:1
16 9 2016-09-16 04:19:4
17 8 2016-09-16 00:06:3
18 7 2016-09-15 18:01:2
19 6 2016-09-15 12:01:4
20 5 2016-09-15 05:30:4
21 4 2016-09-15 00:11:3
22 3 2016-09-14 18:01:0
23 26 2017-10-23 18:11:0
W09|SIS - XYZ88 NA [pinging?]
Across-swath bias plots
Compared pair of profiles: 2016-09-16 04:19:41 and 2016-09-15 00:11:32
Z from common minimum depth [m]
Across-Track Distance [m]
Absolute Depth Bias [m]
Absolute Horizontal Bias [m]


Sound Speed Manager v.2017.1.0 [project: FA_ALL]
Current project: FA_ALL
id | time | location | sensor | probe | original path
1 | 1 | 2016-05-26 20:17:00 | (-132.979438;55.144576) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
2 | 2 | 2016-05-26 22:58:00 | (-133.022164;55.172343) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
3 | 3 | 2016-05-24 17:37:00 | (-133.048524;55.158180) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
4 | 4 | 2016-05-24 19:23:00 | (-133.040454;55.145045)
5 | 5 | 2016-05-24 22:57:00 | (-133.063341;55.154440)
6 | 6 | 2016-05-25 00:00:00 | (-133.067567;55.147215)
7 | 7 | 2016-05-17 19:20:00 | (-133.017000;55.144167)
8 | 8 | 2016-05-17 22:55:00 | (-133.044000;55.197833)
9 | 9 | 2016-06-11 22:27:00 | (-133.032905;55.146520)
10 | 10 | 2016-06-11 21:17:00 | (-133.031132;55.187017)
11 | 11 | 2016-06-08 20:40:00 | (-133.079375;55.157544)
12 | 12 | 2016-06-08 22:23:00 | (-133.067652;55.145688)
13 | 13 | 2016-06-08 23:12:00 | (-133.011816;55.116623)
14 | 14 | 2016-06-08 23:38:00 | (-133.006547;55.089744)
15 | 15 | 2016-06-08 17:12:00 | (-133.074094;55.195728) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
16 | 16 | 2016-06-08 18:22:00 | (-132.978204;55.166746) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
17 | 17 | 2016-06-08 19:28:00 | (-133.007959;55.167842) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
18 | 18 | 2016-05-26 17:42:00 | (-133.052822;55.198502) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
19 | 19 | 2016-05-26 19:36:00 | (-133.021504;55.199426) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
20 | 20 | 2016-05-26 21:51:00 | (-133.074499;55.158396) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
Profiles:
Project
New project
Rename project
Switch project
Import data
Open folder
Profiles
Import profiles
Export profiles
Make plots
Export info
Output folder
Export single profile
Select output formats:
CARIS
CSV
ELAC
Hypack
iXBlue
Konsgberg asvp
NCEI
QPS
Sonardyne
Select NCEI format [*.nc]
Select output folder
Open output folder
Export profile
RTF|W09|MVP|SIS - time:03:02:06, pos:(21° 7.389'N, 146° 46.956'E), tss:1547.7 m/s, avg.depth:6724.7 m

Data Dissemination




Sound Speed Manager v.2017.1.0 [project: FA_ALL]
Current project: FA_ALL
Profiles:
id | time | location | sensor | probe | original path
1 | 1 | 2016-05-26 20:17:00 | (-132.979438;55.144576) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
2 | 2 | 2016-05-26 22:58:00 | (-133.022164;55.172343) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
3 | 3 | 2016-05-24 17:37:00 | (-133.048524;55.158180) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
4 | 4 | 2016-05-24 19:23:00 | (-133.040454;55.145045) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
5 | 5 | 2016-05-24 22:57:00 | (-133.063341;55.154440) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
6 | 6 | 2016-05-25 00:00:00 | (-133.067567;55.147215) | CTD | ty\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
7 | 7 | 2016-05-17 19:20:00 | (-133.017000;55.144167) | CTD | ty\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
8 | 8 | 2016-05-17 22:55:00 | (-133.044000;55.197833) | CTD | ty\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
9 | 9 | 2016-06-11 22:27:00 | (-133.032905;55.146520) | CTD | ty\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
10 | 10 | 2016-06-11 21:17:00 | (-133.031132;55.187017) | CTD | ty\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
11 | 11 | 2016-06-08 20:40:00 | (-133.079375;55.157544) | CTD | ty\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
12 | 12 | 2016-06-08 22:23:00 | (-133.067652;55.145688) | CTD | ty\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
13 | 13 | 2016-06-08 23:12:00 | (-133.011816;55.116623) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
14 | 14 | 2016-06-08 23:38:00 | (-133.006547;55.089744) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
15 | 15 | 2016-06-08 17:12:00 | (-133.074094;55.195728) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
16 | 16 | 2016-06-08 18:22:00 | (-132.978204;55.166746) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
17 | 17 | 2016-06-08 19:28:00 | (-133.007959;55.167842) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
18 | 18 | 2016-05-26 17:42:00 | (-133.052822;55.198502) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
19 | 19 | 2016-05-26 19:36:00 | (-133.021504;55.199426) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
20 | 20 | 2016-05-26 21:51:00 | (-133.074499;55.158396) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
Export metadata profiles
Select output formats:
ESRI Shapefile
KML
CSV
Export data
Project
New project
Rename project
Switch project
Import data
Open folder
Profiles
Import profiles
Export profiles
Make plots
Export info
Output folder
RTF|W09|MVP|SIS - time:01:50:36, pos:(20° 56.017'N, 146° 50.372'E), tss:1547.7 m/s, avg.depth:6469.7 m



Google Earth Pro
File Edit View Tools Add Help
Search
Search
ex: 37.407229, -122.107162
Get Directions History
Places
My Places
Sightseeing Tour
Make sure 3D Buildings layer is checked
Temporary Places
Fairweather.kml
Layers
Primary Database
Voyager
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
Terrain
Sign in
Meares Island
Ulloa Island
Bush Islets
Block Island
Midway Island
Shelikof Island
Round Island
Lively Islands
Guide Island
Clam Island
Tour Guide
2006
ArcGIS Pro - MyProject4 - Map
FEATURE LAYER
PROJECT MAP INSERT ANALYSIS VIEW EDIT SHARE APPEARANCE LABELING DATA
Barry.Gallagher_noaa (NOAA GeoPlatform)
Paste Cut Copy
Clipboard
Explore
Bookmarks
Navigate
Basemap
Add Data
Add Preset
Layer
Select
Select By Attributes
Select By Location
Attributes
Clear
Selection
Infographics
Measure
Locate
Inquiry
Pause
View Unplaced
More
Labeling
Contents
Drawing Order
Map
Fairweather
50000_1
Topographic
Map
Label Class
Fairweather - Class 1
Class Symbol Position
Remove duplicate labels
Buffer
Feature weight
Background labels
Unplaced labels
2016-05-09T17:31:00
2016-05-14T16:54:00
2016-05-14T20:28:00
2016-05-17T21:27:00
2016-05-26T19:36:00
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2016-05-26T17:42:00
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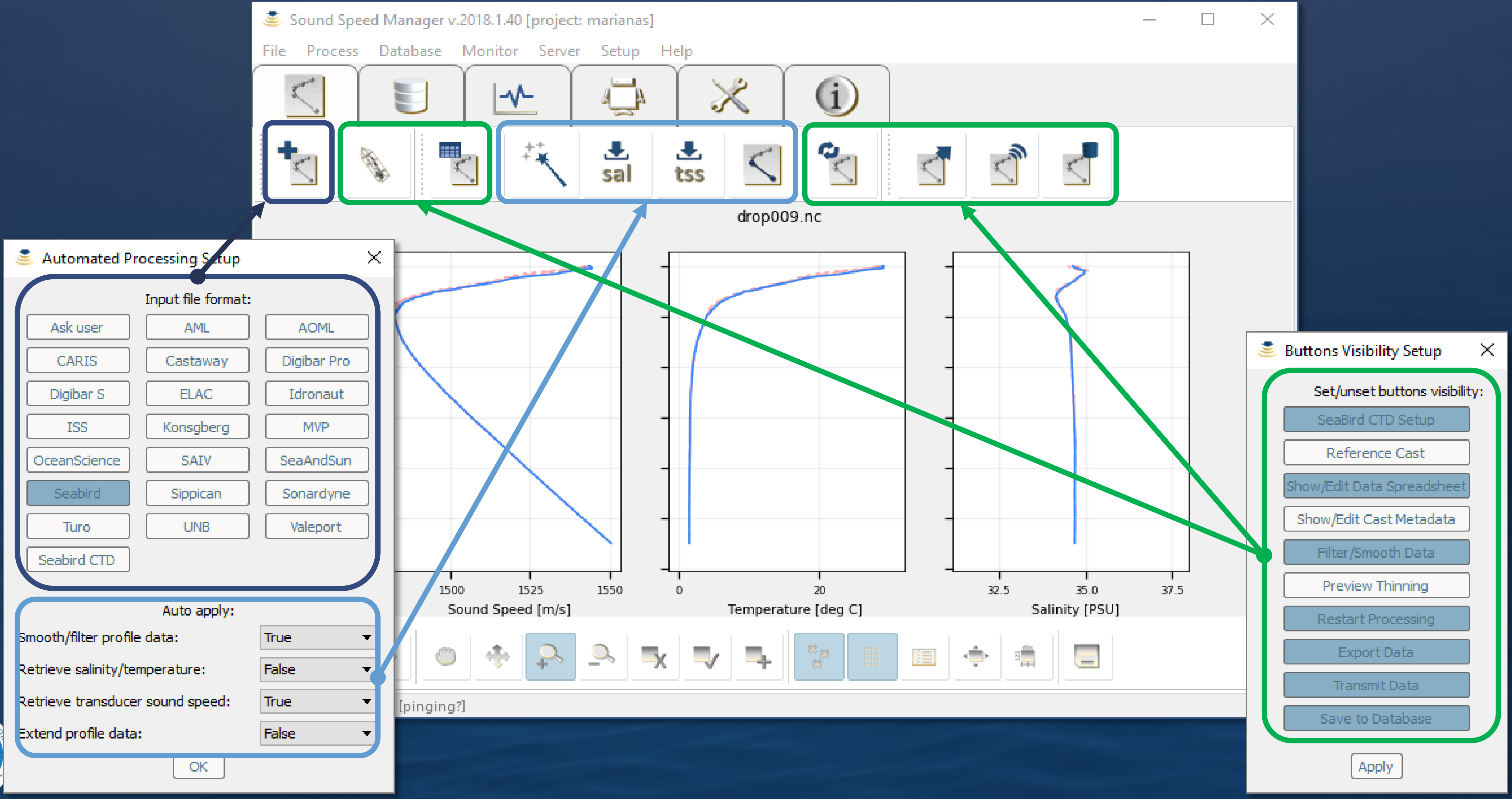
2016-05-24T19:23:00
2016-05-17T00:37:00
2016-05-17T22:32:00
1:43,467
133.00W 55.23N
Selected Features: 0
Project Symbology Label Class

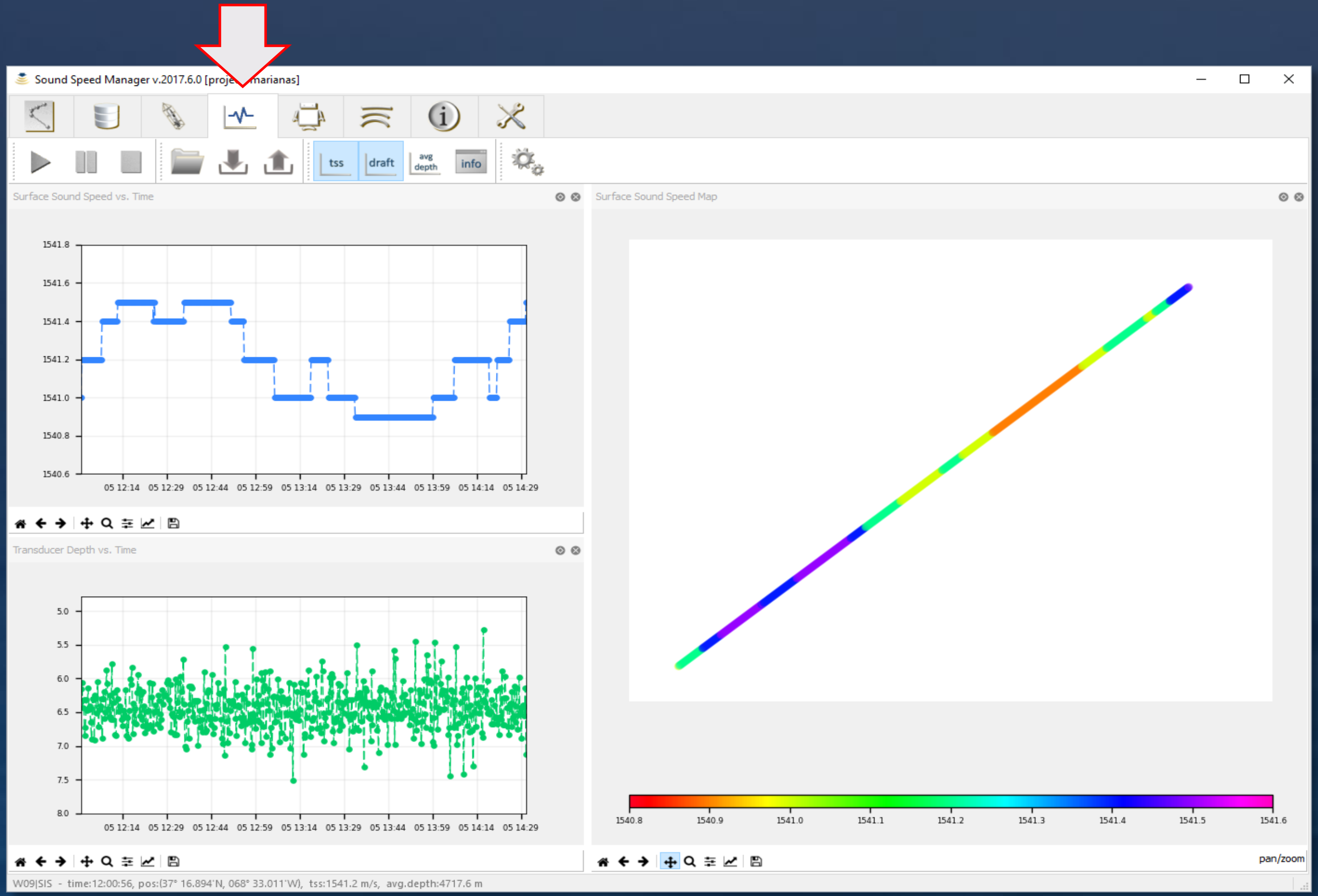
Recent Improvements



Data Monitor

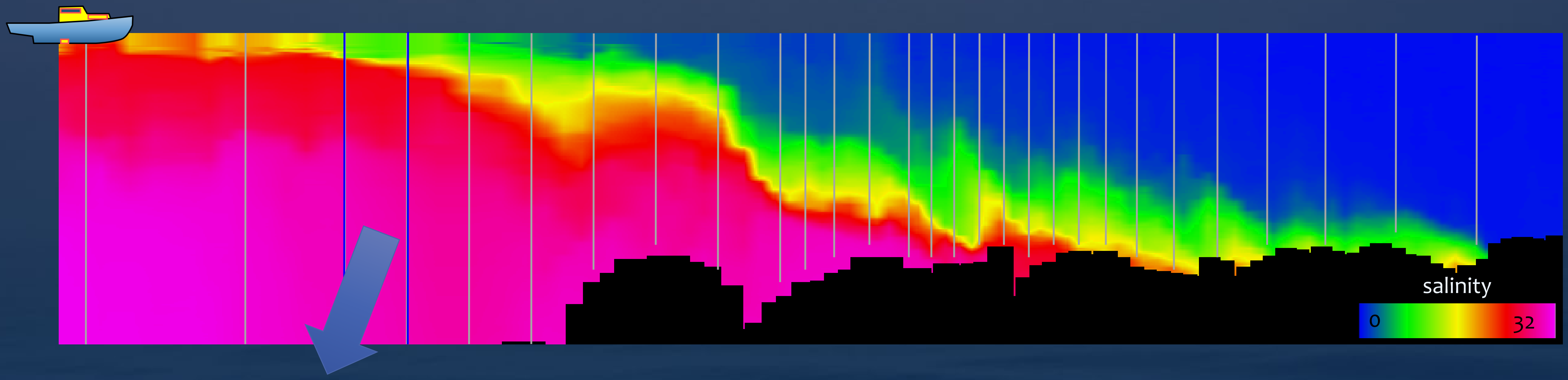
- An extension of Sound Speed Manager to:
  - Monitor survey data
  - Predict cast time

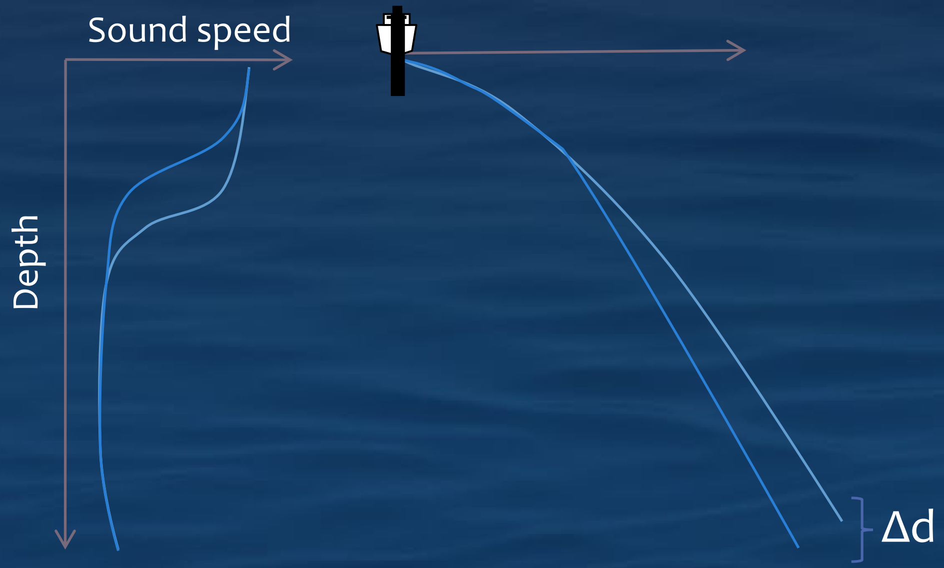
Data Monitor



- Merge ideas from:
  - Manda's svplot
  - Wilson's CastTime
- Leverage:
  - SSM database
  - SSM-SIS interaction

CastTime

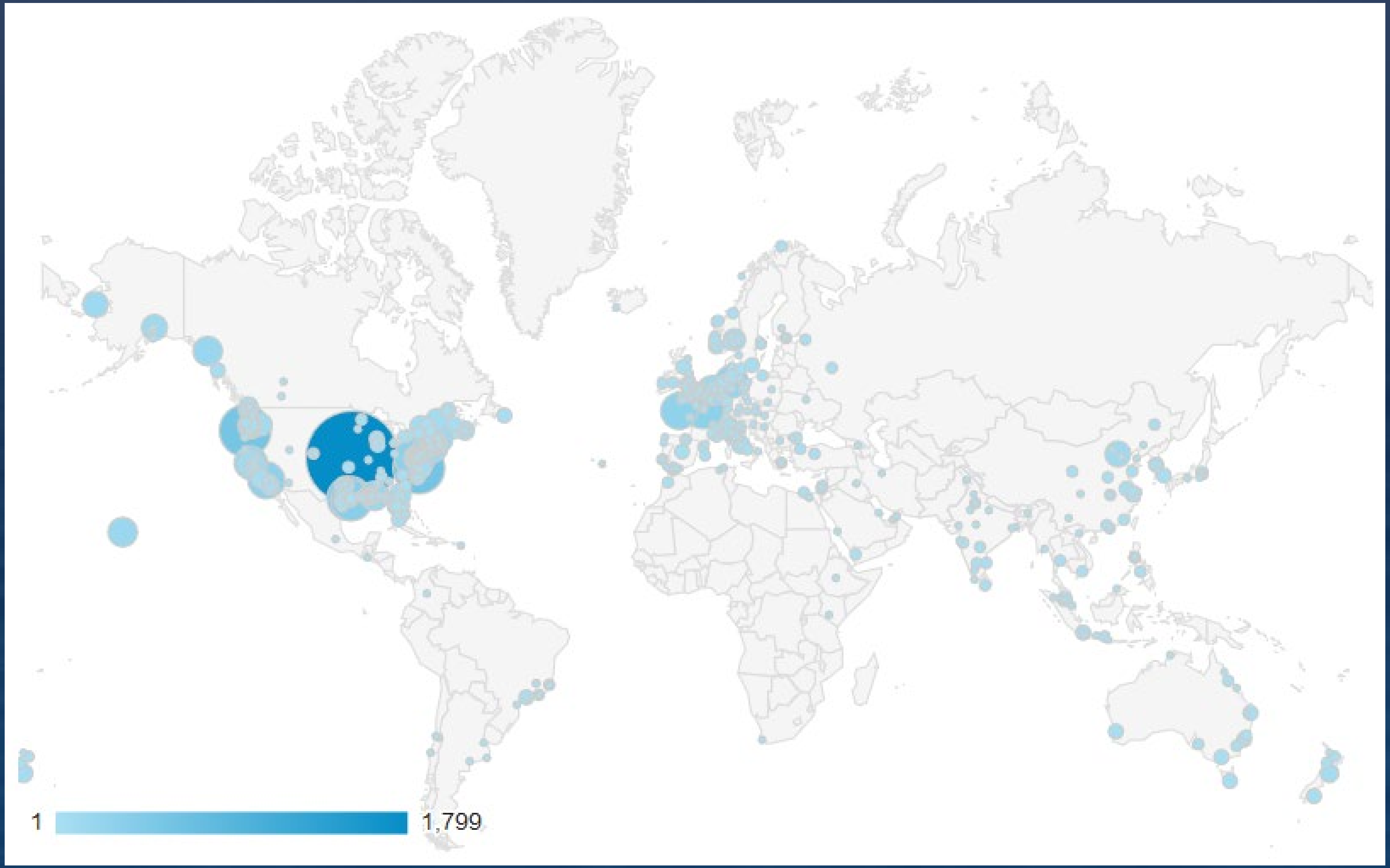




In a nutshell:

- If **Δd** is bigger than you wish, sample more often.
- If **Δd** is smaller than you care about, sample less often.
- If **Δd** is just about right, keep the same interval.

Sound Speed Manager Usage



(*) Google Analytics, Number of Sessions, January 2018, location filtered: Durham, Silver Spring, Seattle, unset.

Sound Speed Manager DEMO

www.hydroffice.org/soundspeed

v0

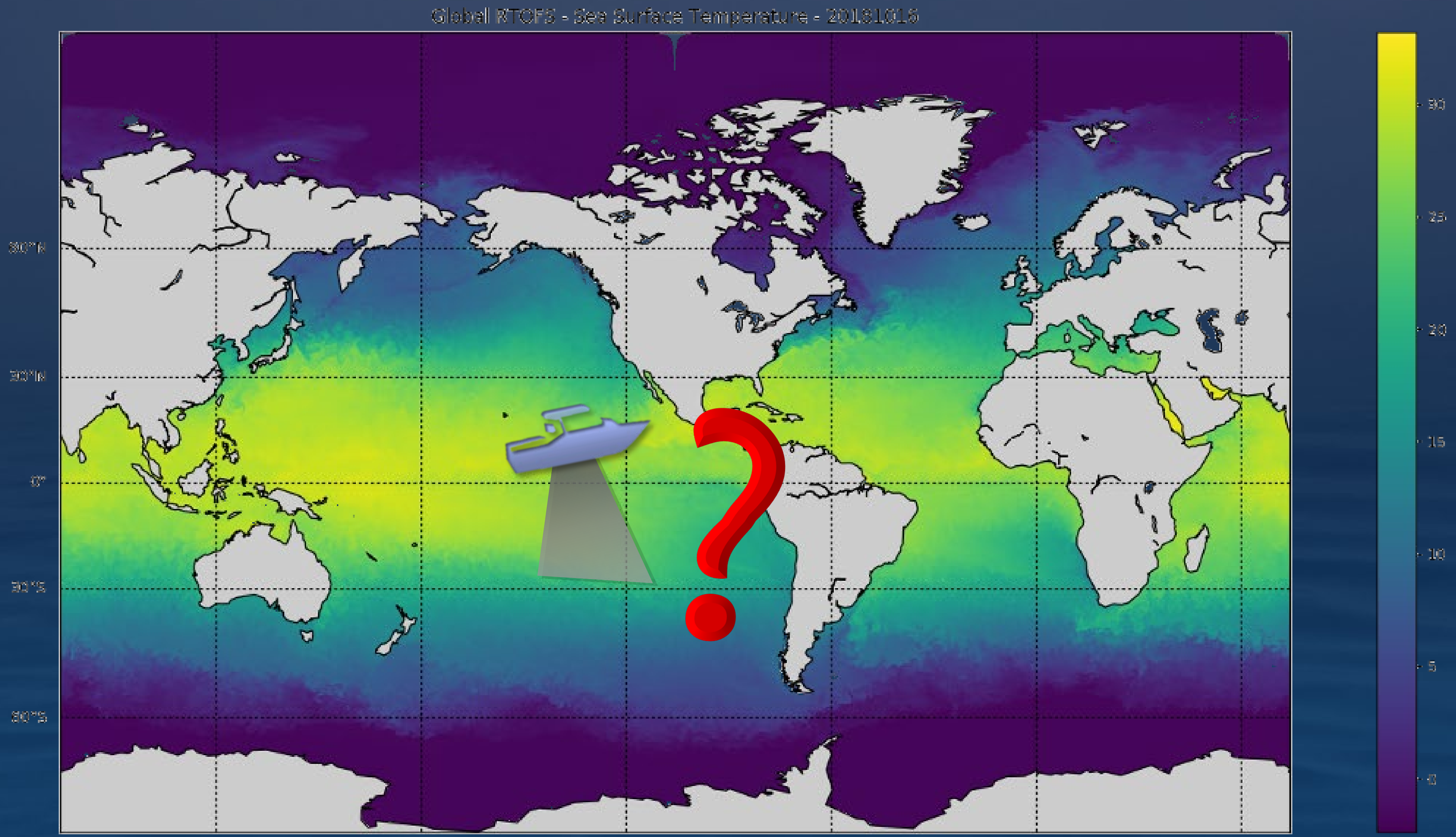
SmartMap

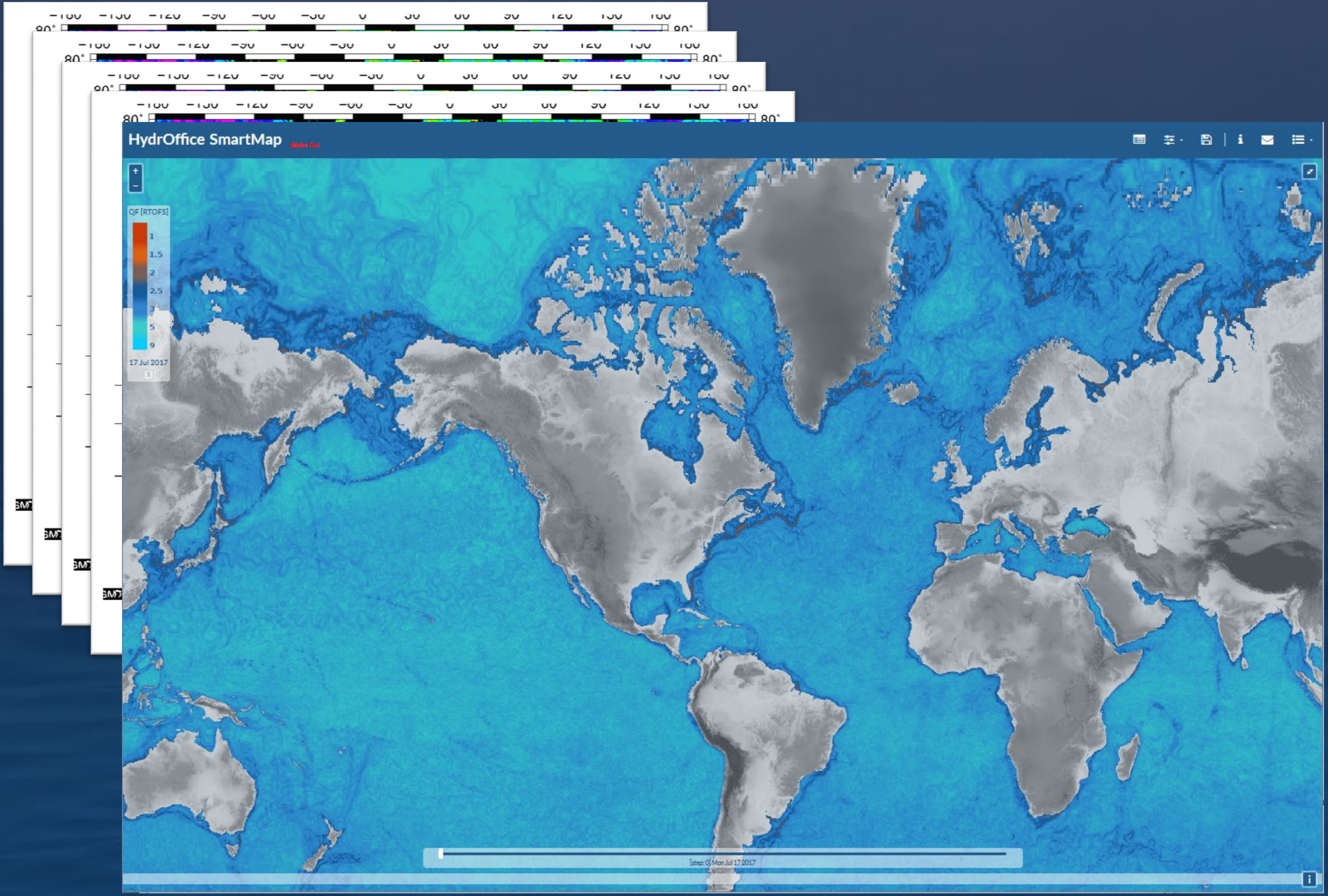
G. Masetti

SmartMap

- A tool to evaluate
- the **effects** of **oceanographic variability on mapping surveys**

Ref.: Masetti,, G., Kelley, J., Johnson, P., and Beaudoin, J., *A Ray-Tracing Uncertainty Estimation Tool for Ocean Mapping*, IEEE Access. IEEE, pp. 1-9, 2017.

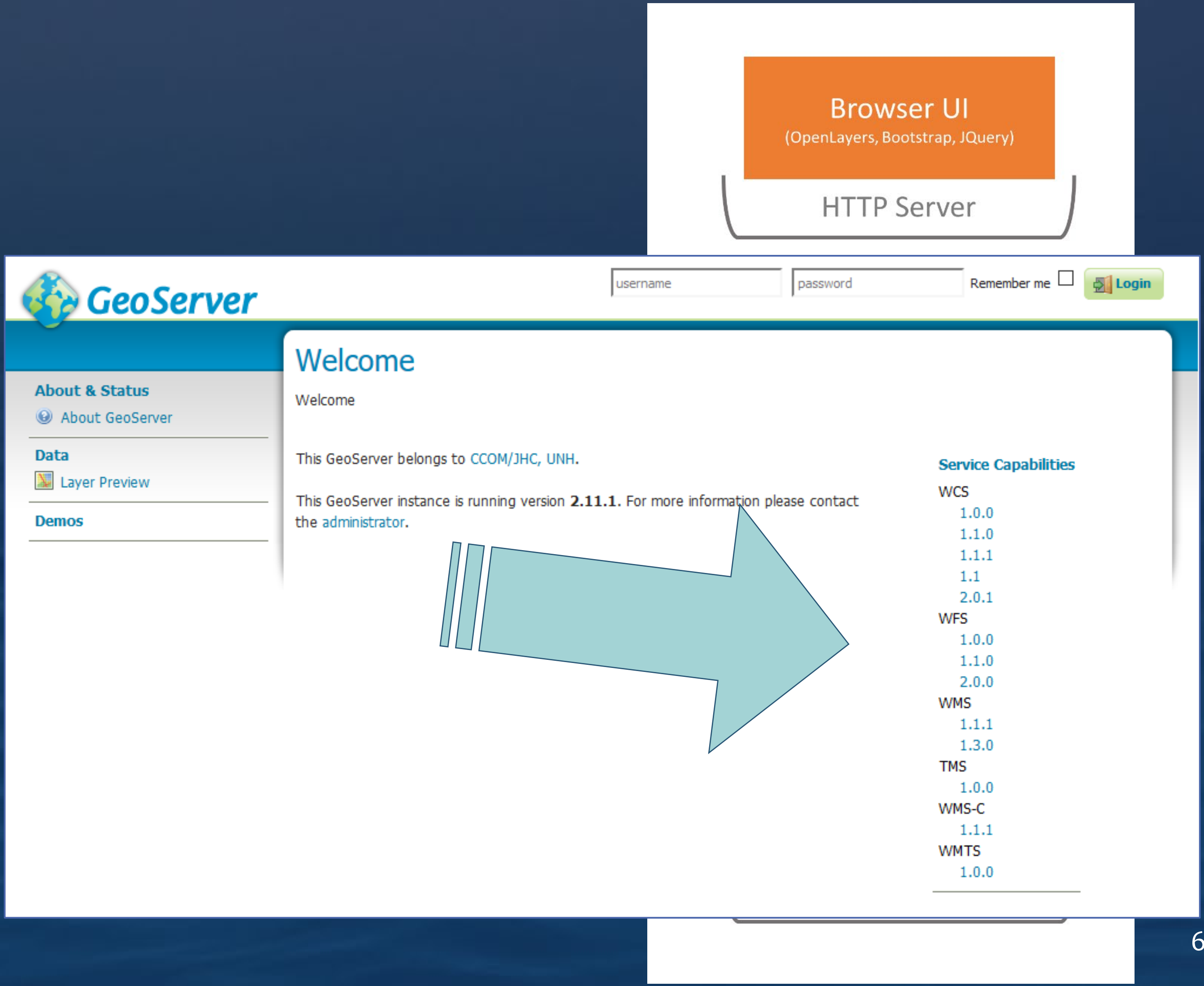

Global RTOFS - Sea Surface Temperature - 20181016
60°N
30°N
0°
30°S
60°S
30
25
20
15
10
5
0



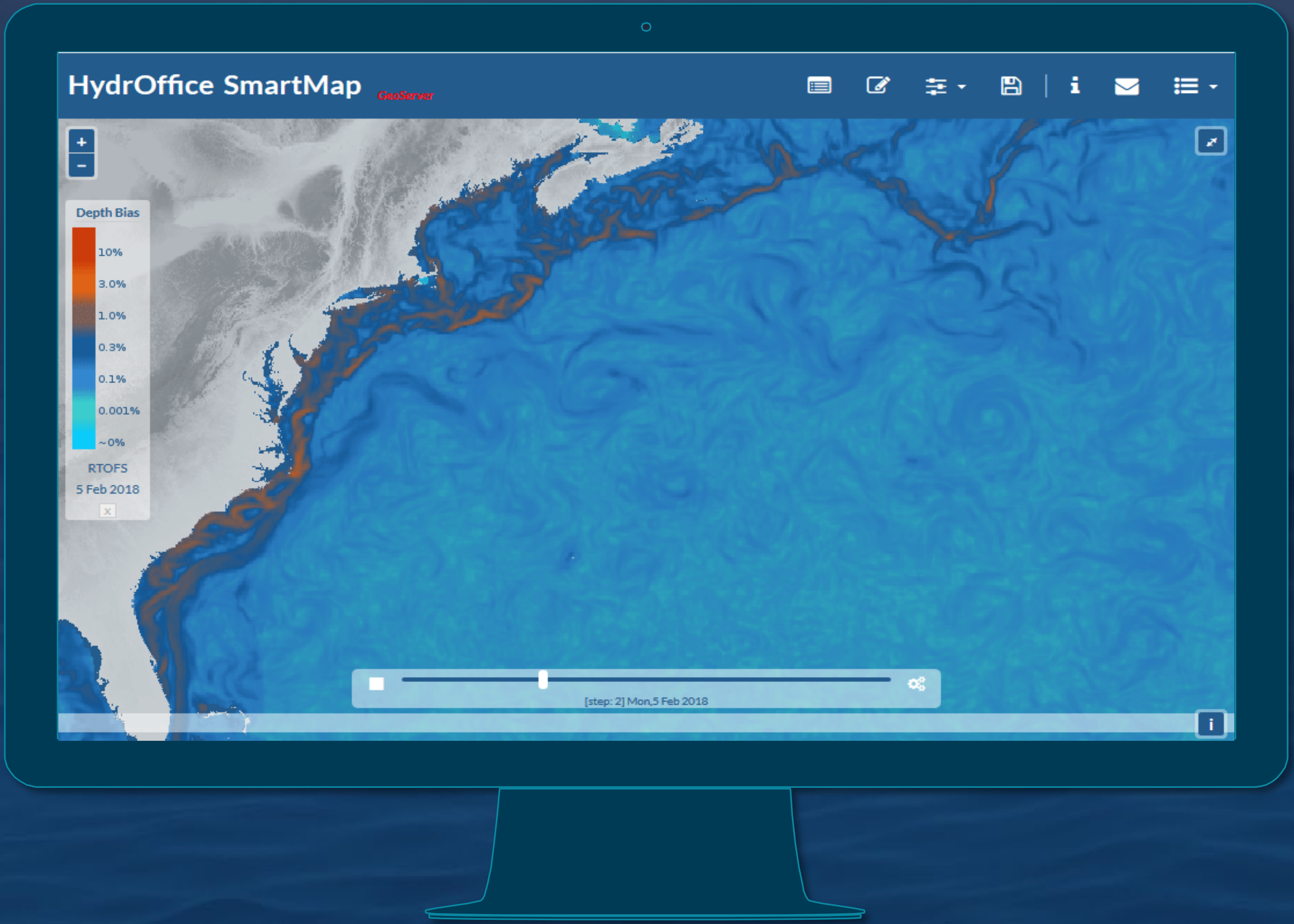
HydrOffice SmartMap
QF [RTOFS]
1
1.5
2
2.5
3
5
9
17 Jul 2017

SmartMap components

- Backend
  - C++
  - Python
- Frontend
  - GeoServer
  - OGC services
- WebGIS
  - *hydroffice.org/smartmap/*

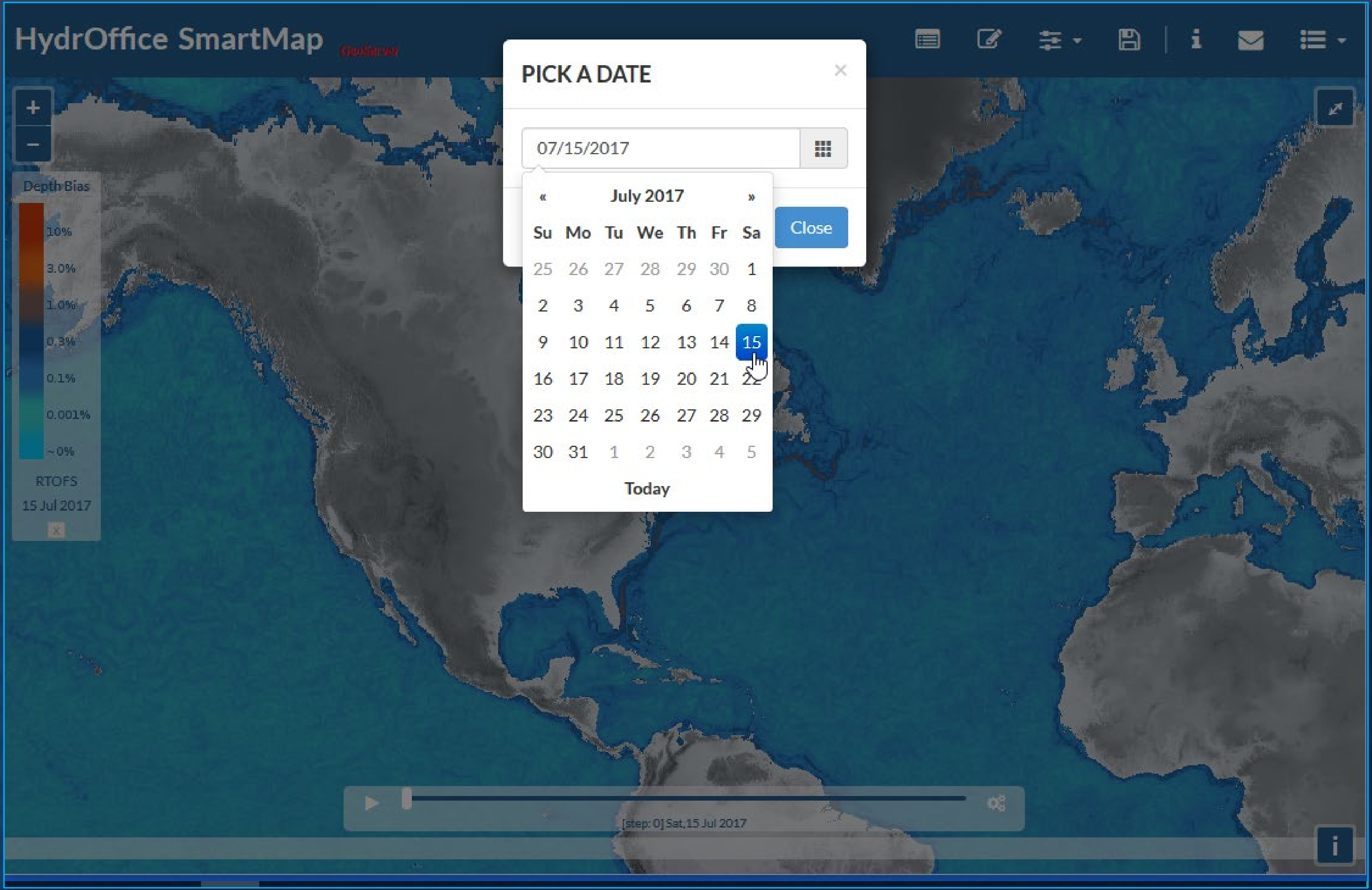


SmartMap WebGIS

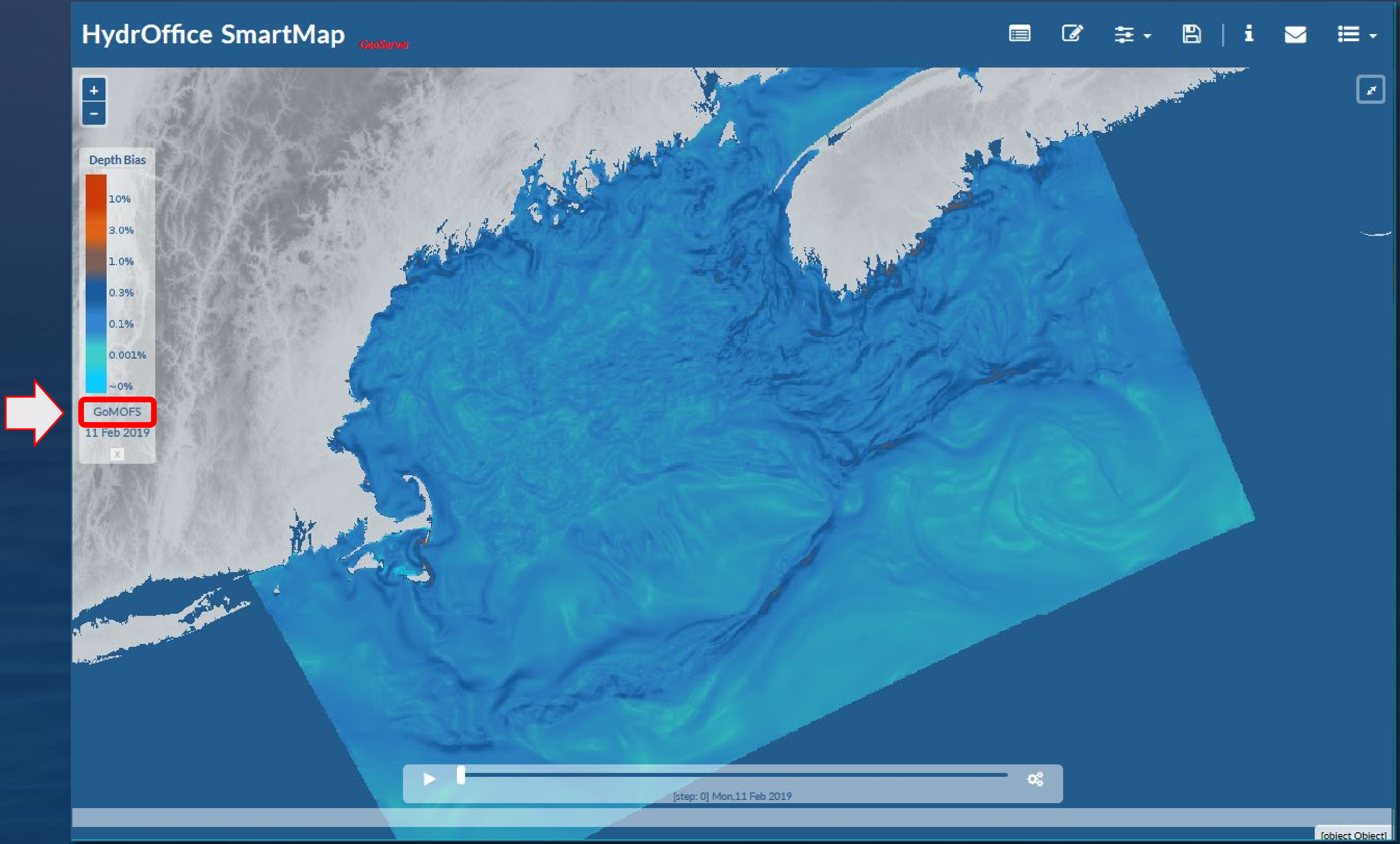


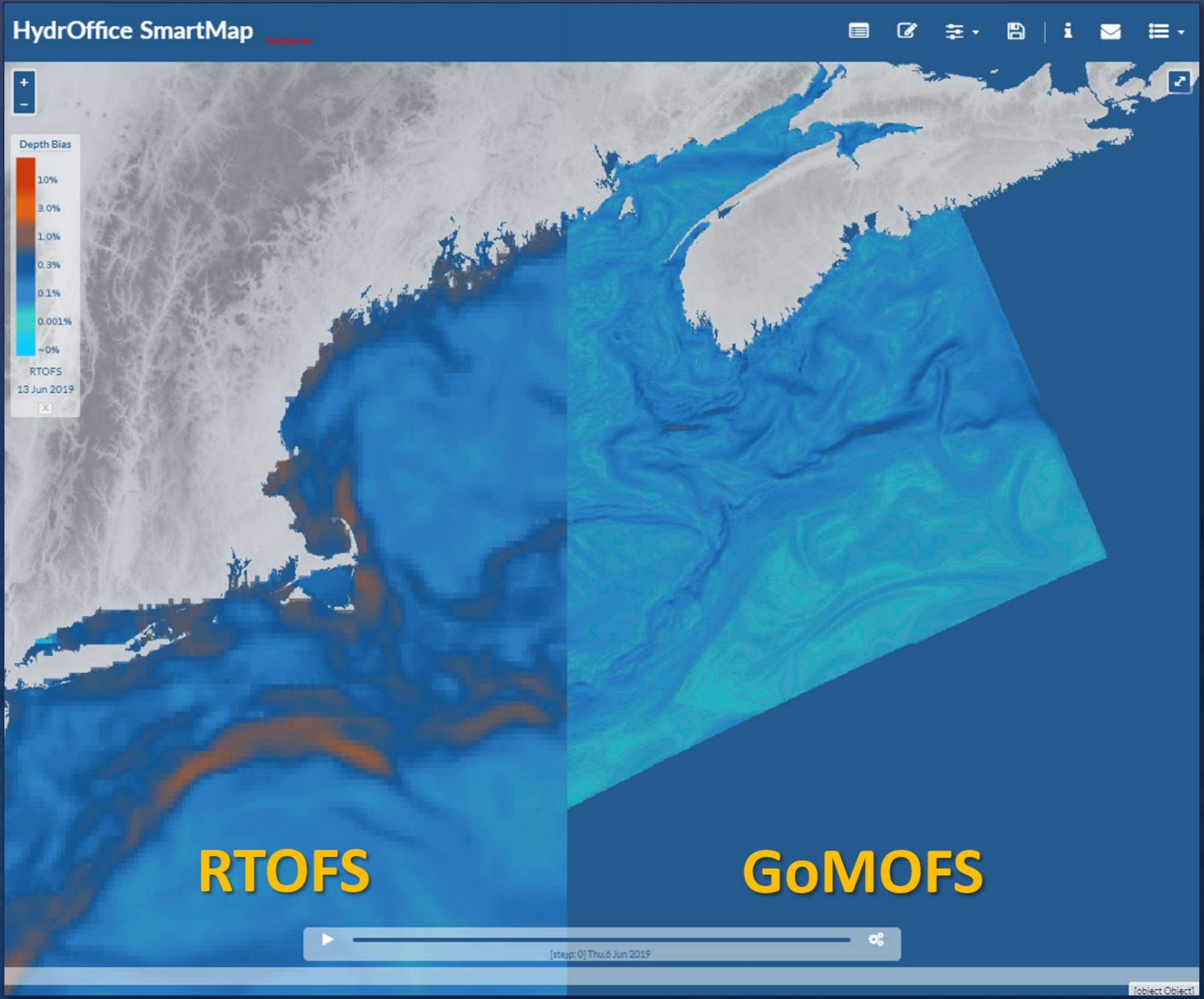
- RTOFS + WOA13 + GoMOFS
- Nowcasts + Forecasts

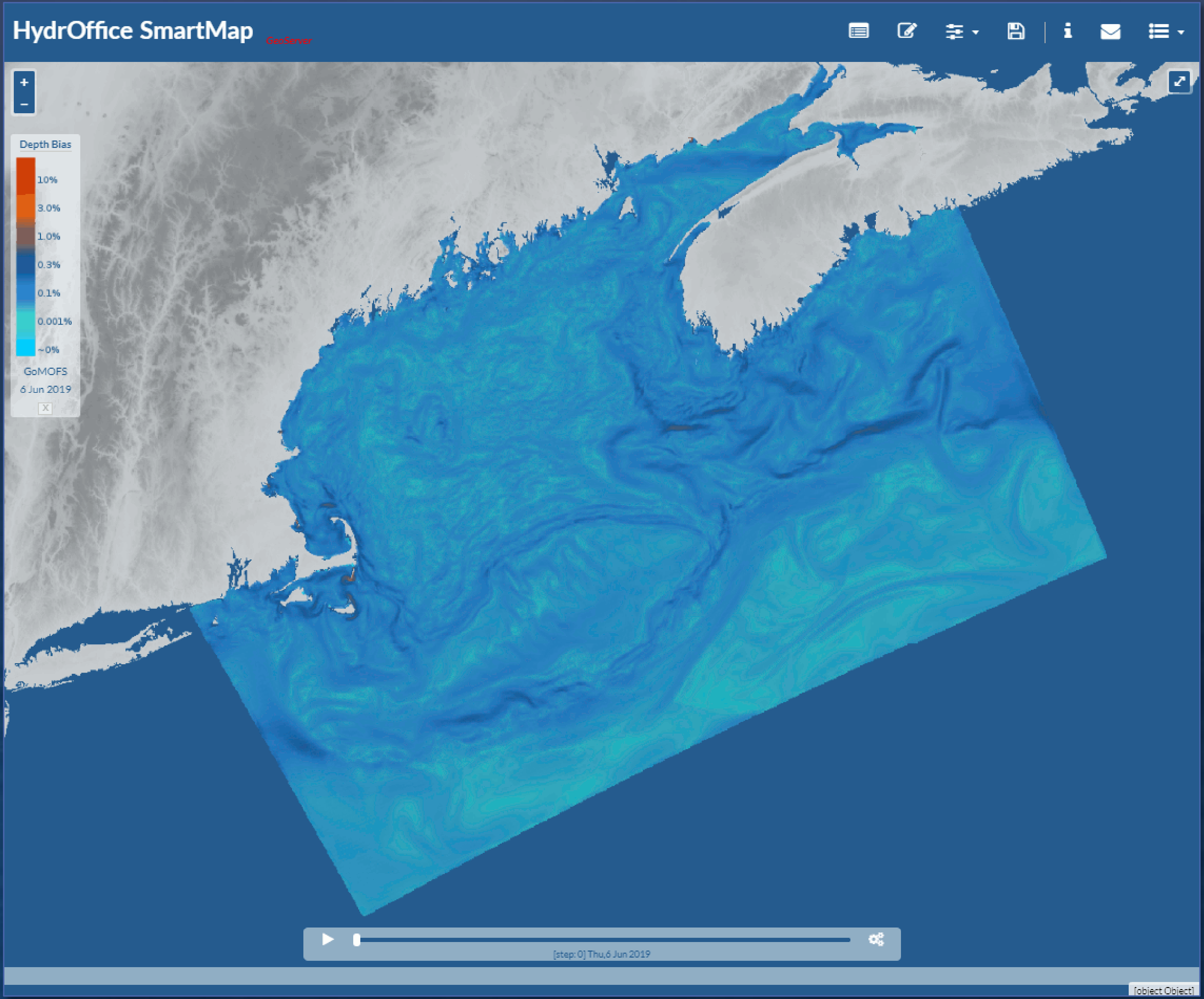
Past Analyses



Gulf of Maine OFS → beta




HydrOffice SmartMap
Depth Bias
10%
3.0%
1.0%
0.3%
0.1%
0.001%
~0%
RTOFS
13 Jun 2019
RTOFS
GoMOFS
[step: 0] Thu,6 Jun 2019
[object Object]


HydrOffice SmartMap
Depth Bias
10%
3.0%
1.0%
0.3%
0.1%
0.001%
~0%
GoMOFS
6 Jun 2019
[step: 0] Thu,6 Jun 2019
[object Object]

Patch Test Site Selector