W00649

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

DESCRIPTIVE REPORT

Type of Survey:	Basic Hydrographic Survey
Registry Number:	W00649

LOCALITY

State(s):	Maine
General Locality:	East of Casco Bay
Sub-locality:	Murray Hole

2022

CHIEF OF PARTY
Peyton Benson

LIBRARY & ARCHIVES

Date:

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY NUMBER:

HYDROGRAPHIC TITLE SHEET

W00649

INSTRUCTIONS: The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State(s):	**Maine**
General Locality:	**East of Casco Bay**
Sub-Locality:	**Murray Hole**
Scale:	**40000**
Dates of Survey:	**06/14/2022 to 04/14/2023**
Instructions Dated:	**N/A**
Project Number:	**ESD-AHB-22**
Field Unit:	**State of Maine**
Chief of Party:	**Peyton Benson**
Soundings by:	**Kongsberg Maritime EM 2040C (MBES)**
Imagery by:	**Kongsberg Maritime EM 2040C (MBES Backscatter)**
Verification by:	**Atlantic Hydrographic Branch**
Soundings Acquired in:	**meters at Mean Lower Low Water**

Remarks:

Any revisions to the Descriptive Report (DR) applied during office processing are shown in red italic text. The DR is maintained as a field unit product, therefore all information and recommendations within this report are considered preliminary unless otherwise noted. The final disposition of survey data is represented in the NOAA nautical chart products. All pertinent records for this survey are archived at the National Centers for Environmental Information (NCEI) and can be retrieved via https://www.ncei.noaa.gov/. Products created during office processing were generated in NAD83 UTM 19N, MLLW. All references to other horizontal or vertical datums in this report are applicable to the processed hydrographic data provided by the field unit.

DESCRIPTIVE REPORT MEMO

April 18, 2023

MEMORANDUM FOR: Atlantic Hydrographic Branch

FROM: Report prepared by AHB on behalf of field unit
Peyton Benson
Maine Coastal Mapping Initiative Program Coordinator, State of Maine

SUBJECT: Submission of Survey W00649

This survey was a part of a large data set provided by the State of Maine Coastal Mapping Initiative program.

Survey products were created by the Atlantic Hydrographic Branch.

All soundings were reduced to Mean Lower Low Water using Discrete Zoning. The horizontal datum for this project is North American Datum of 1983 (NAD 83). The projection used for this project is Universal Transverse Mercator (UTM) Zone 19.

This survey does not include a data acquisition and processing report.

All data were reviewed for DTONs and none were identified in this survey.

The State of Maine Coastal Mapping Initiative Program acquired the data outlined in this report. Data are available at https://www.maine.gov/dmr/programs/maine-coastal-program/coastal-science-and-research/maine-coastal-mapping-initiative/. Additional documentation from the data provider may be attached to this report.

This survey does meet charting specifications and is adequate to supersede prior data. This survey will be used to update NOAA navigational products.

2022 Descriptive Report of Seafloor Mapping: Vicinity of Monhegan Island

Chief of Party – Peyton Benson, Project Hydrographer, Contractor to the Maine Coastal Program

Program Manager – Claire Enterline, Research Coordinator, Maine Coastal Program

Maine Coastal Mapping Initiative, June 2023

Disclaimer

These data and information published herein are accurate to the best of our knowledge. Data synthesis, summaries and related conclusions may be subject to change as additional data are collected and evaluated. While the Maine Coastal Program makes every effort to provide useful and accurate information, investigations are site-specific and (where relevant) results and/or conclusions do not necessarily apply to other regions. The Maine Coastal Program does not endorse conclusions based on subsequent use of the data by individuals not under their employment. The Maine Coastal Program disclaims any liability, incurred as a consequence, directly or indirectly, resulting from the use and application of any of the data and reports produced by staff. Any use of trade names is for descriptive purposes only and does not imply endorsement by The State of Maine.

For an overview of the Maine Coastal Mapping Initiative (MCMI) information products, including maps, data, imagery, and reports visit: https://www.maine.gov/dmr/mcp/planning/mcmi/index.htm.

Acknowledgements

The Maine Coastal Mapping Initiative would like to acknowledge the efforts of the University of Maine sediment laboratory personnel, Hodgdon Vessel Services, and Maine Coastal Mapping Initiative team for contributing to the success of the 2022 survey season. The individual contributions made by many were an integral part of sampling, analysis, and synthesis of data collected for this project. Funding for this study was provided by provided by the National Oceanic and Atmospheric Administration Office of Coastal Management (award numbers NA18NOS4190097, NA20NOS4190064, and Project of Special Merit Program NA20NOS4190107) and The Nature Conservancy.

Maine Coastal Mapping Initiative
Maine Coastal Program
Department of Marine Resources

DESCRIPTIVE REPORT

Type of Survey:	Navigable Area
Registry Number:	W00649

LOCALITY

State(s):	Maine
General Locality:	Gulf of Maine
Sub-Localities:	Vicinity of Monhegan Island

2023

CHIEF OF PARTY
Peyton Benson, Hydrographer, Contractor to the State of Maine

LIBRARY & ARCHIVES

Date:

MAINE COASTAL MAPPING INITIATIVE MAINE COASTAL PROGRAM	REGISTRY NUMBER:
HYDROGRAPHIC TITLE SHEET	W00649

INSTRUCTIONS: The hydrographic sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

State(s):	**Maine**
General Locality:	**Gulf of Maine**
Sub-Locality:	**Vicinity of Monhegan Island**
Scale:	
Dates of Survey:	**06/14/2022 to 04/14/2023**
Instructions Dated:	
Project Number:	
Field Unit:	***Amy Gale***
Chief of Party:	**Peyton Benson, Hydrographer, Contractor to the State of Maine**
Soundings by:	**Kongsberg EM2040C (MBES)**
Imagery by:	**Kongsberg EM2040C (MBES Backscatter)**
Verification by:	
Soundings in:	**meters at Mean Lower Low Water**

Remarks:

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Suggested citation:
Benson, P.T., 2022 Descriptive Report of Seafloor Mapping: Vicinity of Monhegan Island. 127 p.

ABSTRACT

From June 14, 2022 through April 14, 2023, the Maine Coastal Mapping Initiative (MCMI) conducted hydrographic surveys using a multibeam echosounder (MBES) in federal marine waters off mid-coast Maine, southwest of Monhegan Island. The surveying efforts were conducted to support endeavors to enhance coastal resiliency through identification and characterization of seafloor habitat to provide information necessary to managing the marine environment and economy. The survey also coincides with state and federal efforts to update coastal data sets and increase high resolution bathymetric coverage for Maine's coastal and marine waters. This report serves as a comprehensive summary of the mainscheme survey efforts conducted by MCMI throughout the 2022 survey season. In total, this survey effort collected approximately 76.18 mi^2 (197.31 km^2) of high-resolution multibeam data in the target area and conducted sediment sampling at 60 sites to aid in seafloor characterization. Throughout the survey period, MCMI also collected water column data and video at all sample locations across the survey area which will contribute to improved classification of substrate and modeling of benthic communities.

1.0 Area Surveyed

The survey area collected throughout the span of the 2022 season is situated in the vicinity of Monhegan Island, Gulf of Maine, as shown in Figure 1. The approximately 76.18 mi^2 survey area consists of all navigable waters from adjoining W00450 and MCMI 2018-2019 Monhegan surveys to the north down to NOAA survey H11347 in the south.

These data were not collected in direct accordance with the *NOS Hydrographic Surveys Specifications and Deliverables* and the *Field Procedures Manual* requirements; however, both documents were referenced during acquisition for guidance.

Prior to data collection, this area was registered with NOAA ESD under pre-registry ID W00649.

Mainscheme survey limits are listed in Table 1. Specific dates of data acquisition for the mainscheme survey are listed in Appendix A.

Table 1 – Survey Limits

2022 Mainscheme Survey Limits

Southwest Limit	**Northeast Limit**
43° 31' 38.59" N 69° 33' 31.54" W	43° 43' 03.13" N 69° 19' 30.86" W

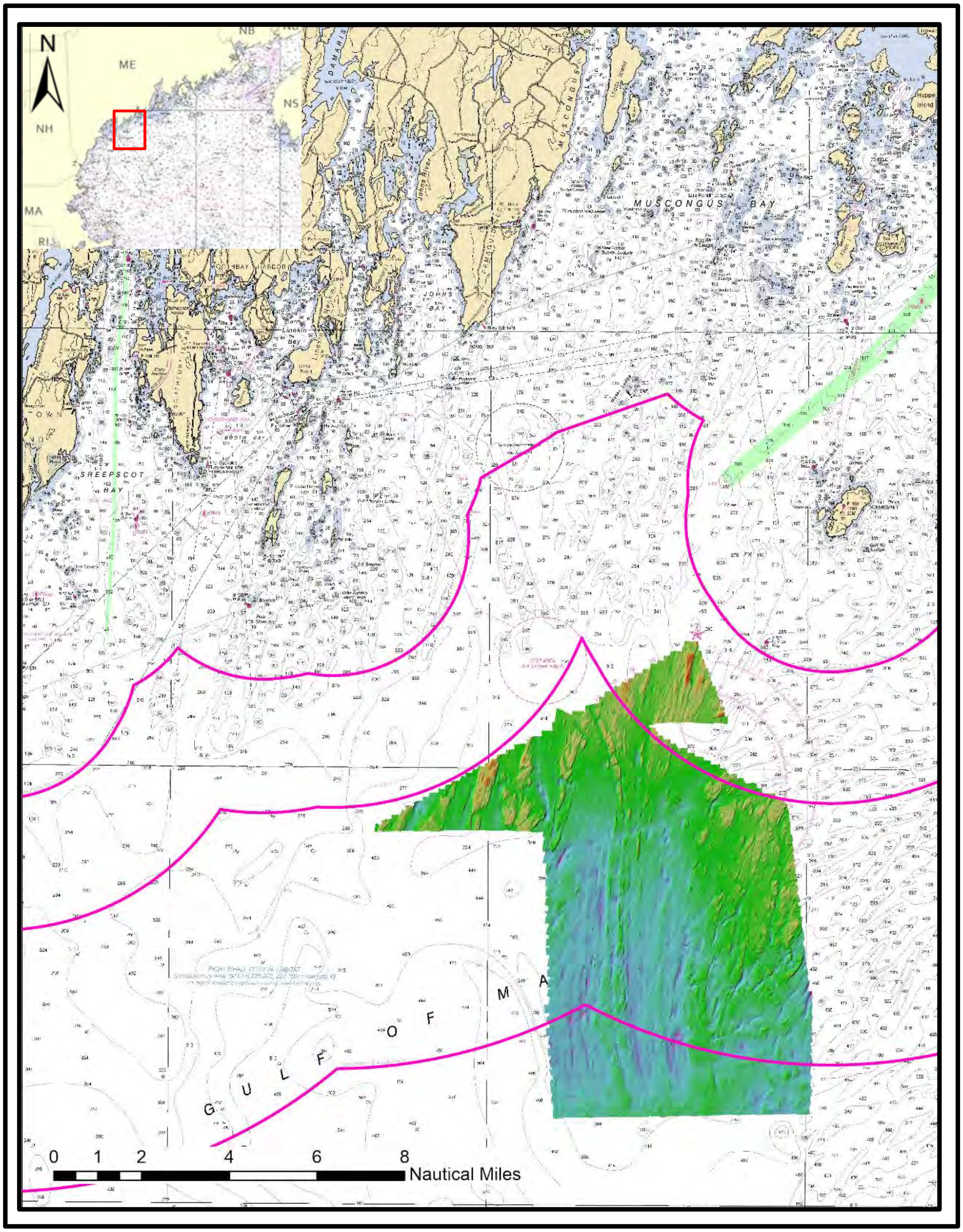


Figure 1 – General locality of mainscheme survey coverage, plotted over NOAA chart 13288. 3-mile, 8-mile, and 12-mile lines shown in magenta

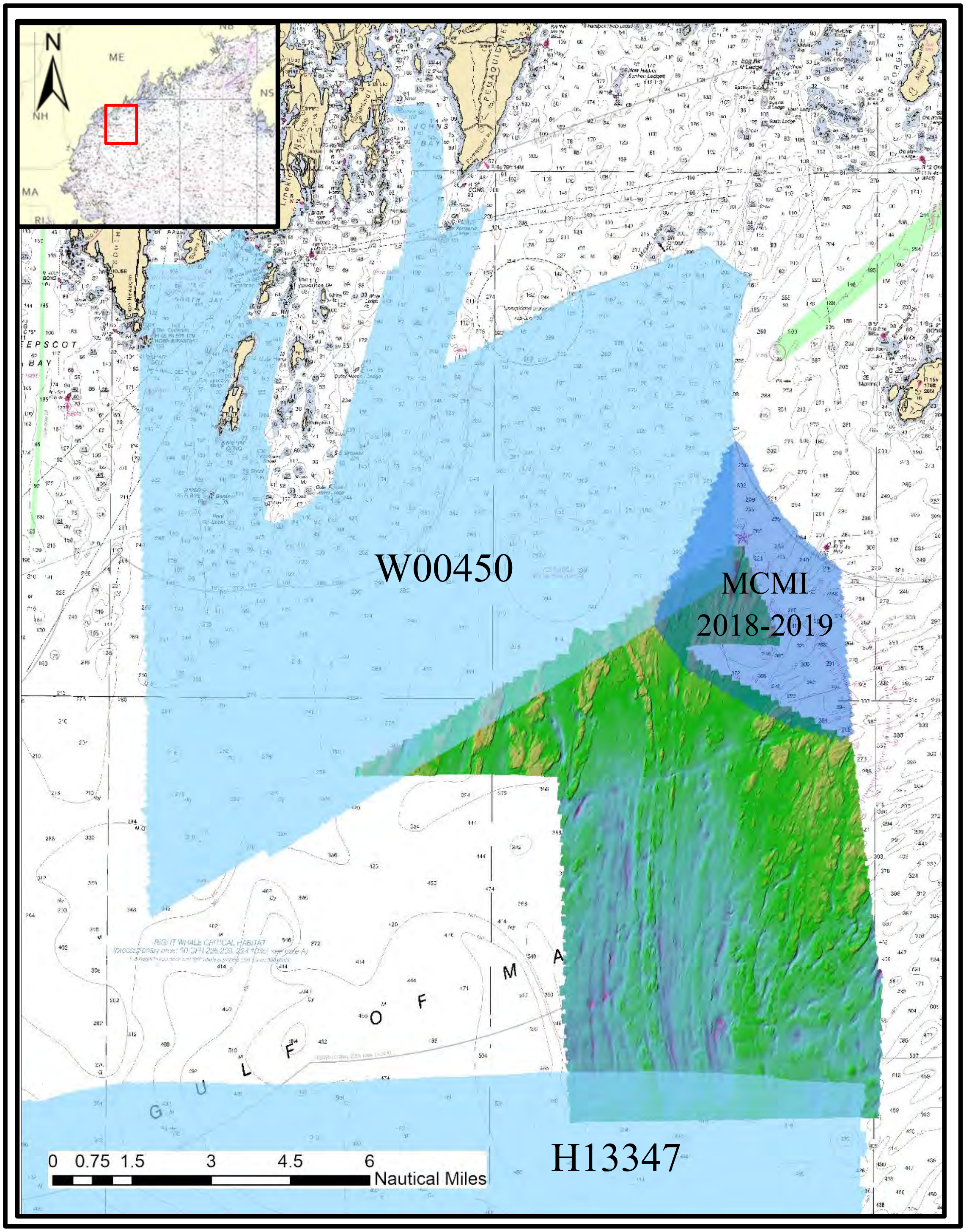


Figure 2 – General locality of mainscheme survey coverage relative to overlapping datasets in the region

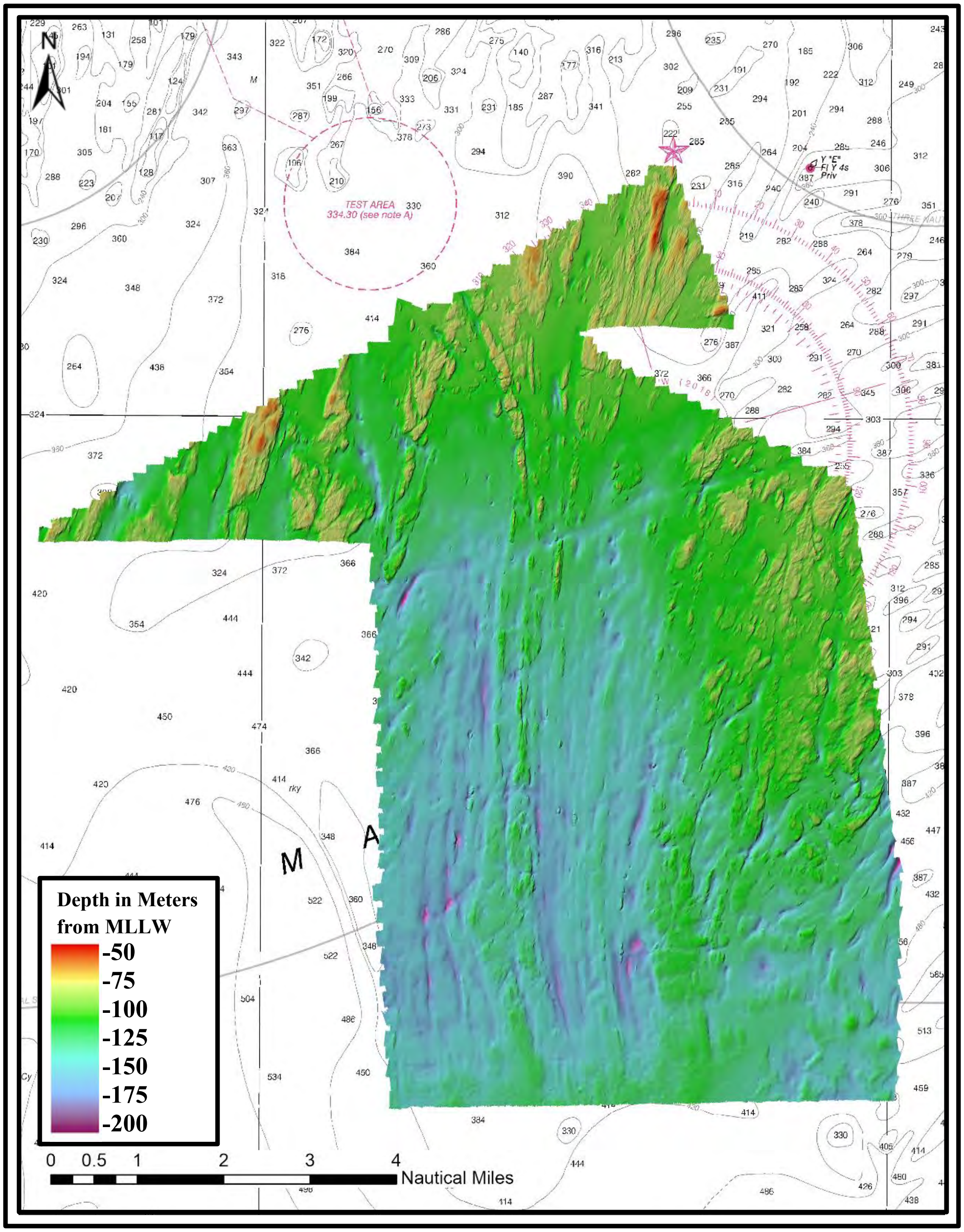


Figure 3 – Shaded relief image of mainscheme bathymetry data gridded at 4-meter resolution and colored by depth. Data is overlain on NOAA chart 13288.

1.1 Survey Purpose

This survey was conducted by the Maine Coastal Program's Maine Coastal Mapping Initiative (MCMI) as part of a multi-agency cooperative agreement partially funded by the National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Management (OCM) and The Nature Conservancy (TNC). The purpose of this project is to help inform policy decision-making related to Maine's coastal waters by increasing the volume of available high-quality bathymetric, benthic habitat, geochemical, and geologic data in the Gulf of Maine. This project also coincides with state and federal efforts to update coastal data sets for Maine's coastal waters and provides new data in the areas covered by National Oceanic and Atmospheric Administration (NOAA) nautical charts 13288, 13260, and 13009 in the vicinity of Monhegan Island. These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and are shared with the NOAA Office of Coast Survey for review.

1.2 Survey Quality

The entire survey should be adequate to supersede previous data.

1.3 Survey Coverage

Select few small holidays (gaps in MBES coverage) exist within the surveyed area, and normally occurred as sonic shadows in areas of locally high relief and/or highly irregular bathymetry. Analyses of bathymetric data show that the least depths were achieved over all features, and that holidays have not compromised data integrity.

2.0 Data Acquisition

The following sub-sections contain a summary of the systems, software, and general operations used for acquisition and preliminary processing throughout the 2022 survey season.

2.1 Survey Vessel

All data were collected aboard the Fishing Vessel (F/V) Amy Gale (length = 10.95 m, width = 3.81 m, draft = 0.93 m) (Figures 4, 5, and 6), a former lobster boat converted to a survey vessel and contracted to the MCMI. The vessel was captained by Caleb Hodgdon of Hodgdon Vessel Services. Surveys were based out of ports in Boothbay Harbor and Portland, ME. The EM2040C transducer, motion reference unit (MRU), AML MicroX surface sound speed probe, and dual GNSS antennas were pole-mounted to the bow; pole raised (for transit) and lowered (for survey) via a pivot point at the edge of the bow. The main cabin of the vessel served as the data collection center and was outfitted with four display monitors for real time visualization of data during acquisition.

Figure 4 – F/V Amy Gale shown with pole-mounted dual GPS antennas, Fugro AD-341 antenna, Kongsberg EM2040C multibeam sonar (not visible), MRU (not visible), and surface sound speed probe (not visible) in acquisition mode.

2.2 Acquisition Systems

The real-time acquisition systems used aboard the F/V Amy Gale during the reported surveys are outlined in Table 2. Data acquisition was performed using the Quality Positioning Services (QPS) Qinsy (Quality Integrated Navigation System; v.9.5.4) acquisition software. The modules within Qinsy integrated all systems and were used for real-time navigation, survey line planning, data time tagging, data logging, and visualization.

Table 2 – Major systems used aboard F/V Amy Gale

Sub-system	Components
Multibeam Sonar	Kongsberg EM2040C and processing unit
Position, Attitude, and Heading Sensor	Seapath 330 processing unit, HMI unit, dual GPS/GLONASS antennas, MRU 5-V motion reference unit (subsea bottle), Fugro 3610 Receiver and AD-341 antenna
Acquisition Software and Workstation	Qinsy software v.9.2.2-9.5.4 and 64-bit Windows 10 PC console
Surface Sound Velocity (SV) Probe	AML Micro X with SV Xchange
Sound Velocity Profiler (SVP)	Teledyne Odom Digibar-S sound speed profiler
Ground-truthing/Sediment Sampling Platform	Ponar grab sampler, GoPro Hero 3+ video camera, GoPro Hero 5 Black video camera, dive light, dive lasers, YSI Exo I sonde

* See Appendix B for a diagram overview of survey systems aboard the Amy Gale.

2.3 Vessel Configuration Parameters

In 2017, the MCMI contracted Doucet Survey, Inc. to perform high-definition (precision ±5mm) 3D laser scanning of the Amy Gale and all external MBES system components (e.g. MRU, GPS antennas, and EM2040C) (Figures 6 and 7). The purpose of the laser scan survey was to refine and or verify the precision of hand-made vessel reference frame measurements for future surveys. All points were referenced to the center point of the base of the MRU (mounted inside the pole and directly atop the EM2040C transducer) (Figure 7), which served as the origin (e.g. 0,0,0), where 'x' was positive forward, 'y' was positive starboard, and 'z' was positive down. The laser scan survey results only differed from hand-made measurements by ≤ 3mm for all nodes of interest. Reference measurements for each component were entered into the Seapath 330 Navigation Engine (Table 3) and converted so all outgoing datagrams would be relative to the location of the EM2040C transducer (e.g. EM2040C was used as the monitoring point for all outgoing datagrams being received by Qinsy during acquisition). Additional configuration and interfacing of all systems were established during the creation of a template database in the Qinsy console.

These offset values were not changed for the reported survey seasons. See appendices for a diagram of survey systems aboard the Amy Gale. specific settings as entered in the Seapath 330 Navigation Engine (Appendix C), for the template database (Appendix D), and the computation settings (Appendix F) used during data acquisition while online in Qinsy. Configuration settings of the EM2040C were assigned in the EM Controller module of Qinsy (Appendix E).

Table 3 – 2017 equipment reference frame measurements for Seapath 330

Equipment	x (m)	y (m)	z (m)
MRU	0.000	0.000	0.00
Antenna 1 (port)	0.158	-1.245	-3.000
Antenna 2 (starboard)	0.158	1.252	-3.035
EM2040C	0.036	0.000	0.133

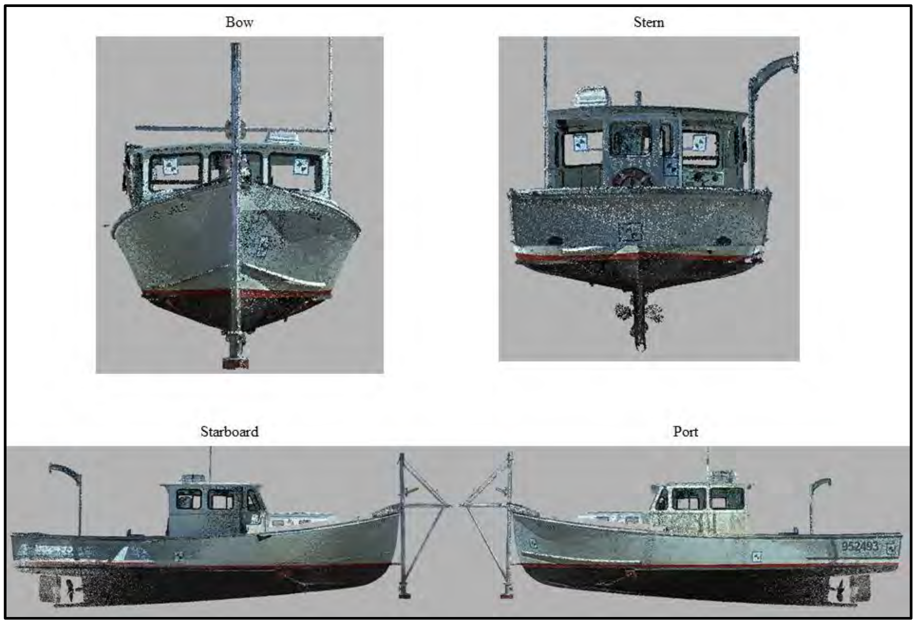


Figure 5 – Amy Gale RGB color images generated from 3D laser scan survey (GPS antennas and external cabling not included in survey) data (.pts file converted to .las for visualization)

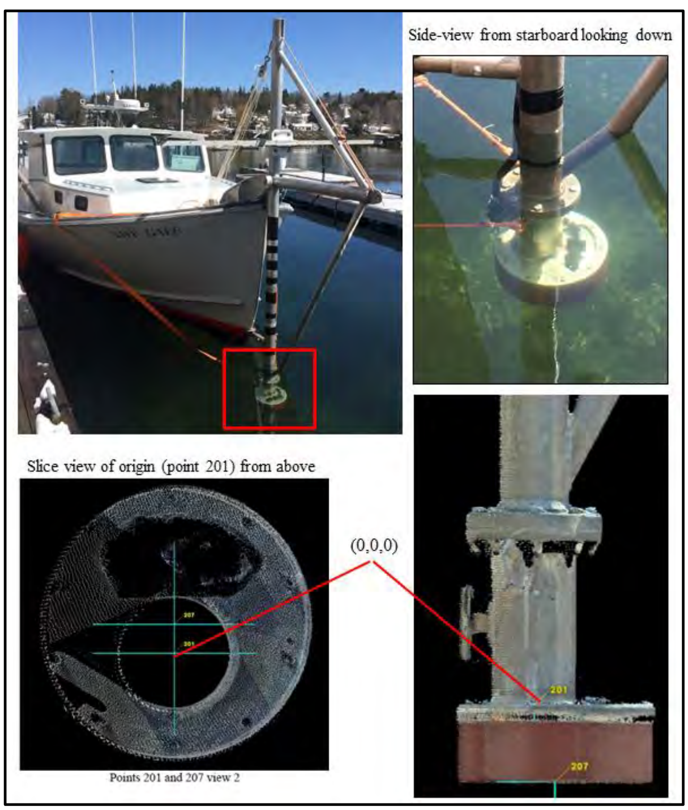


Figure 6 – Amy Gale origin (point 201 in RGB images) for vessel reference frame(s); origin is center point within the base of the pole (center point of base within internally-mounted motion reference unit (MRU) point 201 in images above)

2.4 Survey Operations

The following is a general summary of daily survey operations. Once the survey destination was reached, the sonar pole mount was lowered into survey position and its bracing rods were fastened securely to the hull of the ship via heavy-duty ratchet straps. Electric power to all systems was provided by a 2000-watt Honda *eu2000i* generator. Occasionally two *eu2000i* generators were simultaneously used if any auxiliary equipment needed additional electricity. Immediately following power-up, all interfacing instruments were given time to stabilize (e.g. approximately 30-45 minutes for Seapath to acquire accurate positioning). Next, the desired Qinsy project was selected for data acquisition. All files (e.g. raw sonar files, sound speed profiles, grid files, etc.) were recorded and stored within their respective project subfolders on a local drive. Prior to surveying each day, a sound speed cast was taken and imported into the 'imports' folder of the current project. After confirming agreement between the surface probe reading and the downcast data and inspecting cast values for abnormal profile/readings, the profile was applied to the sonar (EM2040C) in the Qinsy Controller module. Regular sound speed casts were collected throughout the survey day when necessitated by changing tide, location, or upon disagreement with the surface probe measurement (exceeding +/-2.0 m/s difference). Data were gridded at 0.5 to 4 meters for real-time visualization, depending on expected water depth range. Raw sonar files were logged in the Qinsy Controller module in .db format and saved directly onto the hydrographic workstation computer. All data were backed up daily on an external hard drive. At the end of each day's survey, sonar and navigation systems were powered down and the pole mount was raised and fastened for transit back to port. Upon arriving at the dock, all external instruments/hardware were visually inspected and rinsed with freshwater to prevent corrosion.

2.5 Survey Planning

Line planning and coverage requirements were designed to meet requirements for NOAA hydrographic standards and in accordance with IHO S-44 6th Edition Order 1a survey (International Hydrographic Organization, 2020 & NOAA Office of Coast Survey, 2021). Throughout the survey area, parallel lines were planned several days prior to surveying and generally run in an east-west orientation, but variation was necessary for highly dynamic areas such as over ledges and scours. Lines were spaced at consistent intervals to obtain a minimum of 30% overlap between full swaths. Soundings from beam angles outside of ±60 degrees from the nadir were blocked from visualization during acquisition, thus increasing the true minimum full-swath overlap. This online blocking filter was recommended by QPS field engineers with the intent of eliminating noisy outer beams from the final product, thereby increasing the overall contribution of higher quality soundings. All data were acquired at approximately 6.5-7 knots, although some areas required slower speeds to ensure safe operation of the vessel around obstructions, fishing operations, or in especially rough conditions.

2.6 Calibrations

Patch tests were conducted aboard the F/V Amy Gale at the beginning of the survey season as well as throughout data collection periods to correct for alignment offsets. For each patch test, a series of lines were run to determine the latency, pitch, roll, and heading offset following standard protocol (NOAA Office of Coast Survey, 2021). The patch test data were processed using the Qimera (v.2.5.3) patch test tool. After calibration was complete, offsets (Table 4) were entered into the template database in Qinsy. Additional patch tests were conducted any time a system was removed or reinstalled throughout the survey season or if data disagreements were noticed between lines. Full built-in self-tests (BIST) were performed at semiregular intervals throughout the season to determine if any significant deviations in background noise were present at the chosen survey frequency of 300KHz.

Table 4 – 2022 Mainscheme Patch test calibration offsets for EM2040C

Type	Offsets 06/14/22	Offsets 02/07/23
Roll (degrees)	0.081	-0.060
Pitch (degrees)	0.474	0.609
Heading (degrees)	1.254	0.695

3.0 Quality Control

3.1 Crosslines

The majority of crosslines for this region were conducted immediately following completion of the region in August and September of 2022. Due to the decision to append a subset of the survey area to these products some time following initial acquisition, final crosslines were delayed until the beginning of the 2023 survey season for the westernmost portion of the dataset. Final crosslines were collected in April 2023.

Throughout the survey area, crosslines were run at no greater than 900m spacing and intersected with all survey lines between 60° and 90° in accordance with BOEM and NOAA requirements (Figure 7) (U.S. Department of the Interior, 2014 & NOAA Office of Coast Survey, 2021). Crosslines were filtered during post-processing to remove soundings outside 45 degrees from the nadir. After filtering, the two-dimensional surface area totaled approximately 29% of survey area coverage. Crossline sounding agreement with mainscheme data was evaluated by using the crosscheck tool in Qimera version 2.5.3, which performs beam-by-beam statistical analysis.

Results of the statistical analysis showed the mean difference between soundings was 0.051 meters with a standard deviation of 0.389 meters; 95% of all differences were less than 0.829 meters from the mean (Figure 8). Summary statistics for this analysis are shown in Table 5. Additional statistical plots are reported in Appendix G. Raw difference data, reference surfaces, and sonar files used for this analysis were submitted with the data in this survey package.

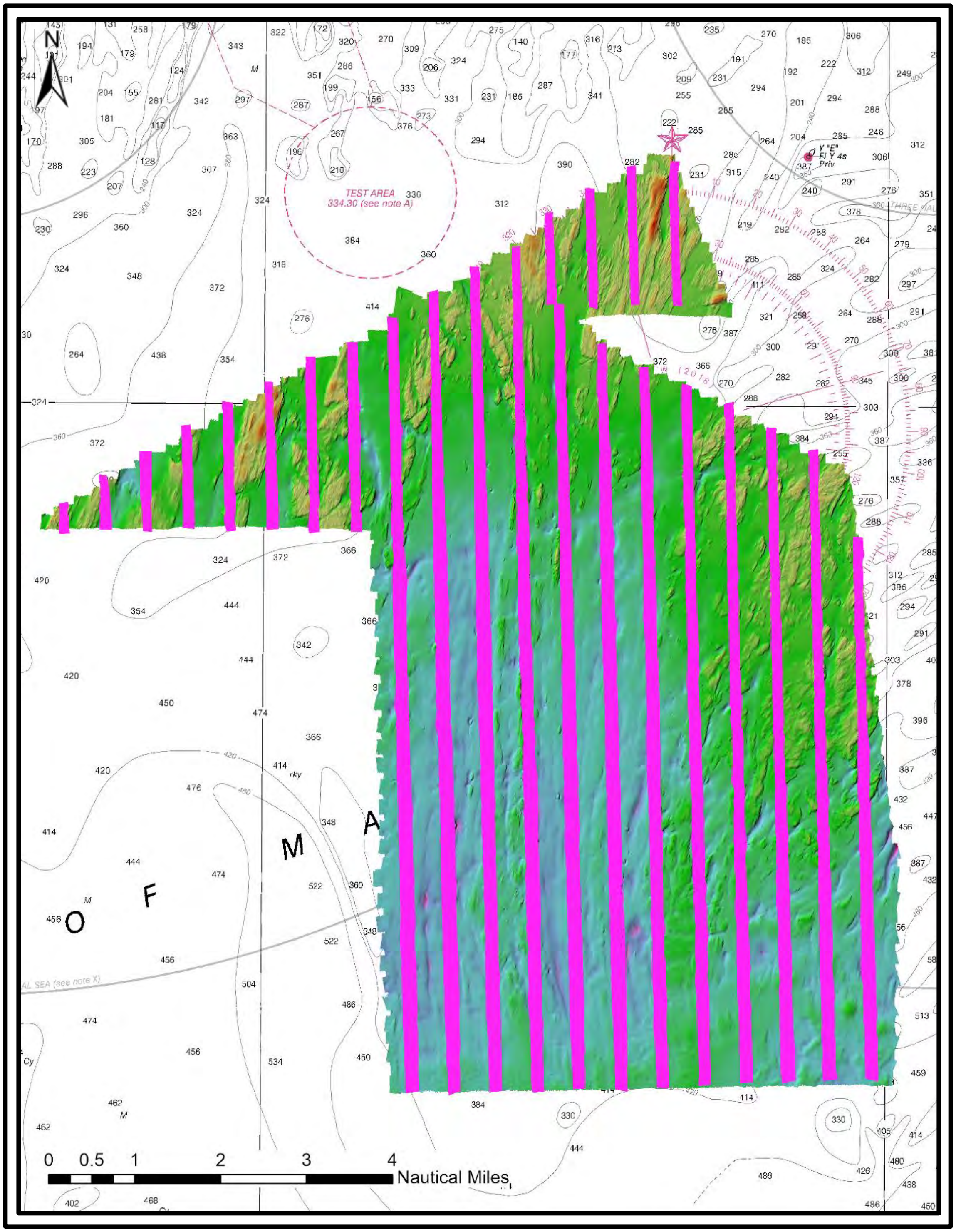


Figure 7 – Location of crosslines (depicted in magenta, with beams filtered outside ±45°) atop bathymetry data

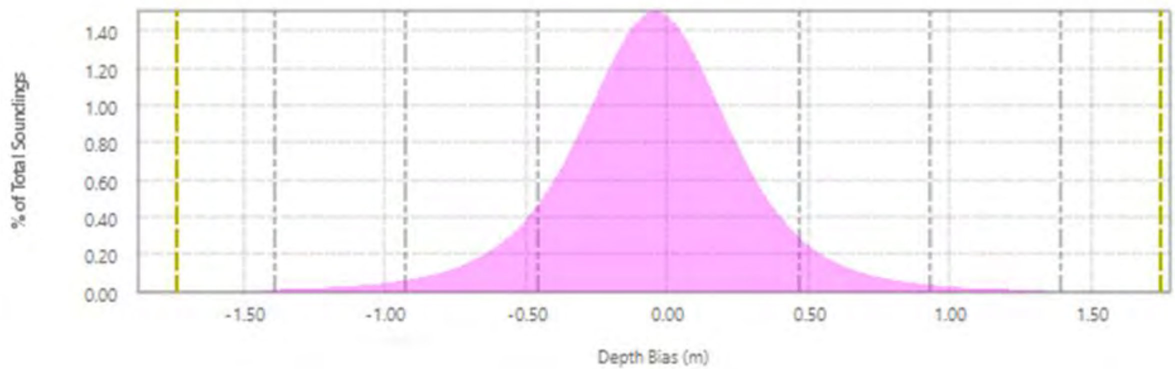


Figure 8 – 2022 mainscheme crosslines difference histogram; pink areas represent the 95% confidence interval based on normal distribution; yellow dashed lines represent limit of IHO Order 1 test vertical tolerance; gray dashed lines on histogram represent ±sigma 1, 2, and 3

Table 5 – 2022 Mainscheme crossline difference (Qimera crosscheck) summary statistics

# of Points of Comparison	40541686
Data Mean	-128.340857 m
Reference Mean	-128.289705 m
Difference Mean	0.051152 m
Difference Median	0.051152 m
Std. Deviation	0.388986 m
Data Z - Range	-194.99 m to -68.08 m
Ref. Z - Range	-193.84 m to -68.89 m
Diff Z - Range	-48.25 m to 48.02 m
Mean + 2*stddev	0.829124 m
Median + 2*stddev	0.829124 m
Order 1a Error Limit	1.741104 m
Order 1a P-Statistic	0.004026
Order 1a - # Rejected	163201
Order 1a Survey	ACCEPTED

*Order 1a parameters: a = 0.25 and b = 0.013

3.2 Junctions

2022 mainscheme survey coverage was planned such that data would sufficiently overlap to the north and to the south with existing surveys in the region. The junctions shown in Table 6 are the result of overlap between the 2022 mainscheme survey and these existing surveys. The areas of overlap between the 2022 mainscheme survey and the junction surfaces (H13347, W00450, and MCMI 2018-2019 Monhegan survey) were evaluated for sounding agreement by performing surface difference tests in Fledermaus (v.8.5.1), where existing surfaces were subtracted from the newly collected 2022 surface. A summary of surface difference test results is shown in Table 6. The extent of overlap between the 2022 base surface and the existing survey areas are illustrated in Figure 9. Detailed junction surfaces can be seen in Figure 10. The surfaces used for these tests are submitted with the data package accompanying this report.

Table 6 – 2022 Mainscheme survey junctions

Registry Number	Resolution (m)	Year	Field Unit	Relative Location(s)
H13347	VR	2020	Ferdinand R. Hassler	S
W00450	4	2017	Amy Gale	NW
Pending	4	2018-2019	Amy Gale	NE

Table 7 – Summary of surface difference test results for overlapping (junction) surveys

Junction Surface ID	New Surface ID	Mean (m)	Median (m)	Std. Dev. (m)
H13347_MB_VR_MLLW	W00649_4m_MLLW	0.03	-0.04	0.78
W00450_4m_MLLW	W00649_4m_MLLW	0.07	0.00	0.54
MCMI_2018_2019_Monhegan_4m_MLLW	W00649_4m_MLLW	0.03	-0.02	0.37

Notable differences between overlapping surveys are likely attributable to poor agreement in rocky areas and motion artifacts resulting from rough survey conditions during acquisition. The greatest disagreement between surfaces is seen in areas of steep, rocky relief where dynamic features and dramatic changes in depth and substrate are present. Additionally, significant wobble caused by excessive motion of the survey vessel are noted throughout both the W00450 and MCMI 2018-2019 Monhegan surveys, which causes greater variability in soundings and slightly lower confidence.

Across all overlapping surfaces, average height agrees by less than 10 centimeters. 95% confidence for all nodes falls within +/- 0.54 meters across both MCMI surveys (W00450 and MCMI 2018-2019), and within +/- 0.78 meters for the extent of overlap with the H13347 survey. These results indicate strong agreement given the depths of survey and verify system accuracy to within desired survey parameters in accordance with Order 1a and NOAA HSSD for this region (International Hydrographic Organization, 2020 & NOAA, 2021).

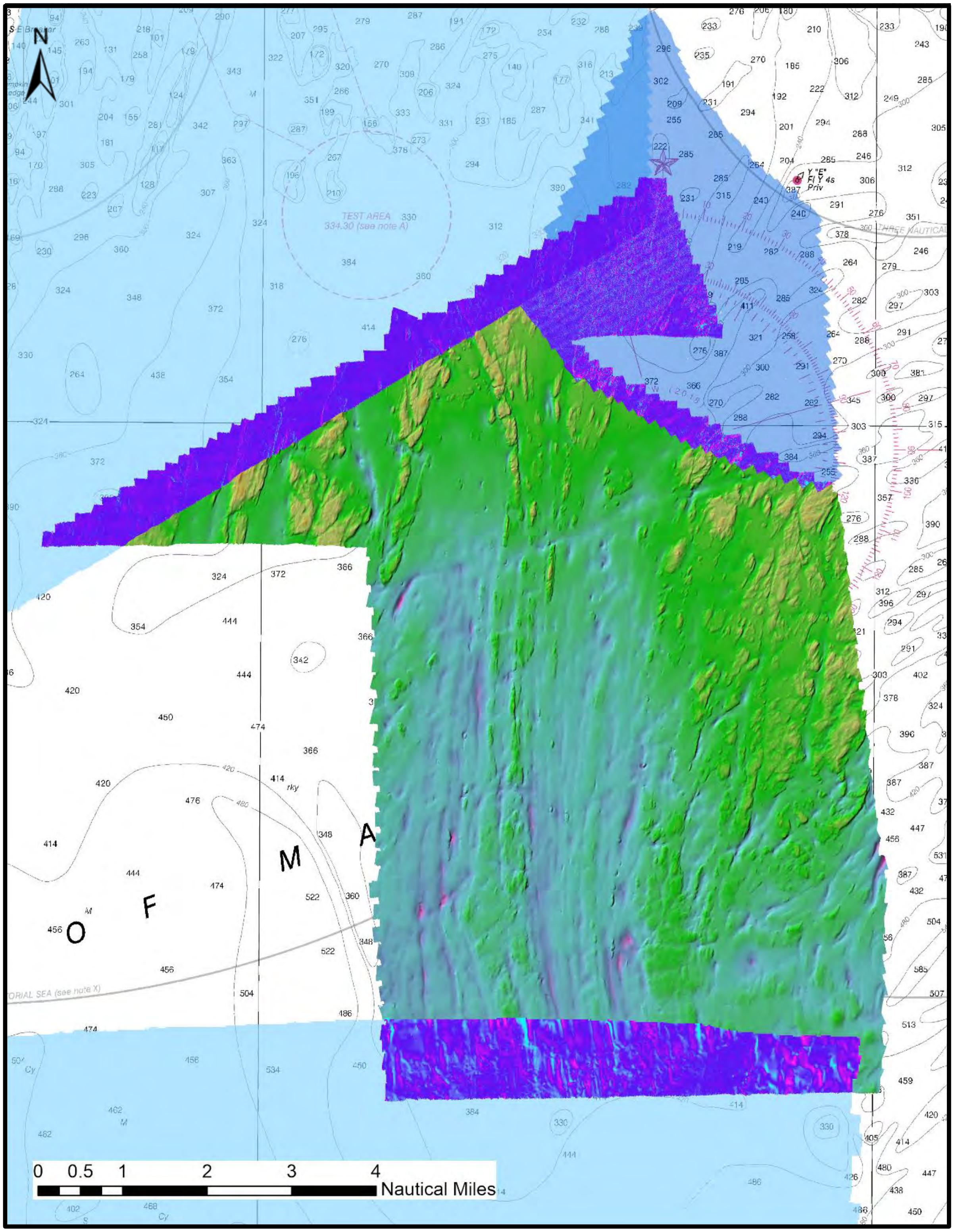


Figure 9 – Overview of resulting junction surfaces atop 2022 mainscheme survey

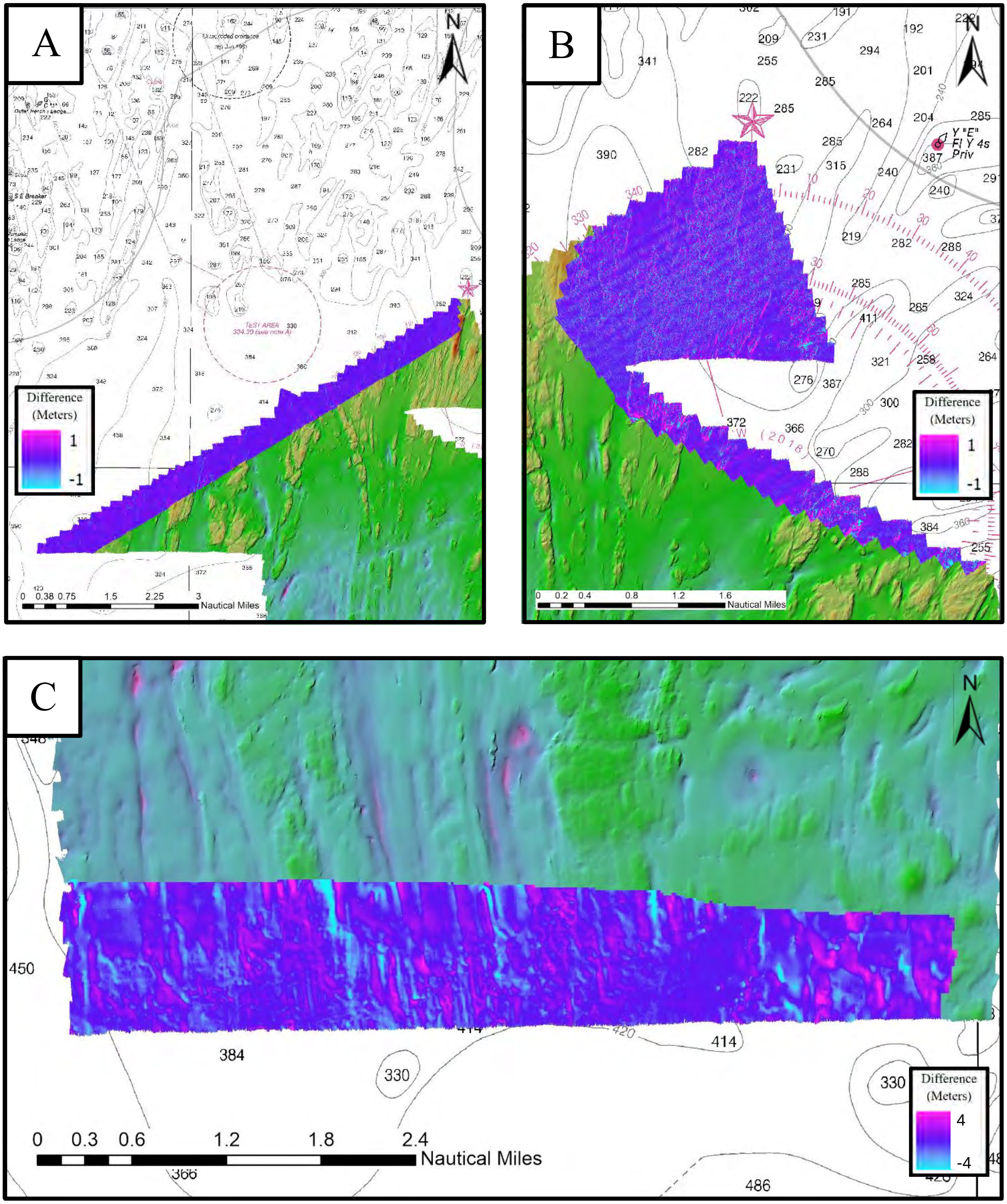


Figure 10 – Junction surfaces created from surface differencing in Fledermaus for A) W00649 with W00450, B) W00649 with MCMI 2018-2019 Monhegan survey, and C) W00649 with H13347

3.3 Uncertainty

HydrOffice QC Tools v.3.9.0 Grid QA feature was used to analyze the highest resolution surface for compliance with NOAA allowable uncertainty standards. 99.97% of all nodes in the surface met uncertainty specifications which passes allowable TVU for the given survey. Detailed results from the analysis are shown in Figure 11 below. Uncertainty surface layers are provided with all BAG files submitted with this report.

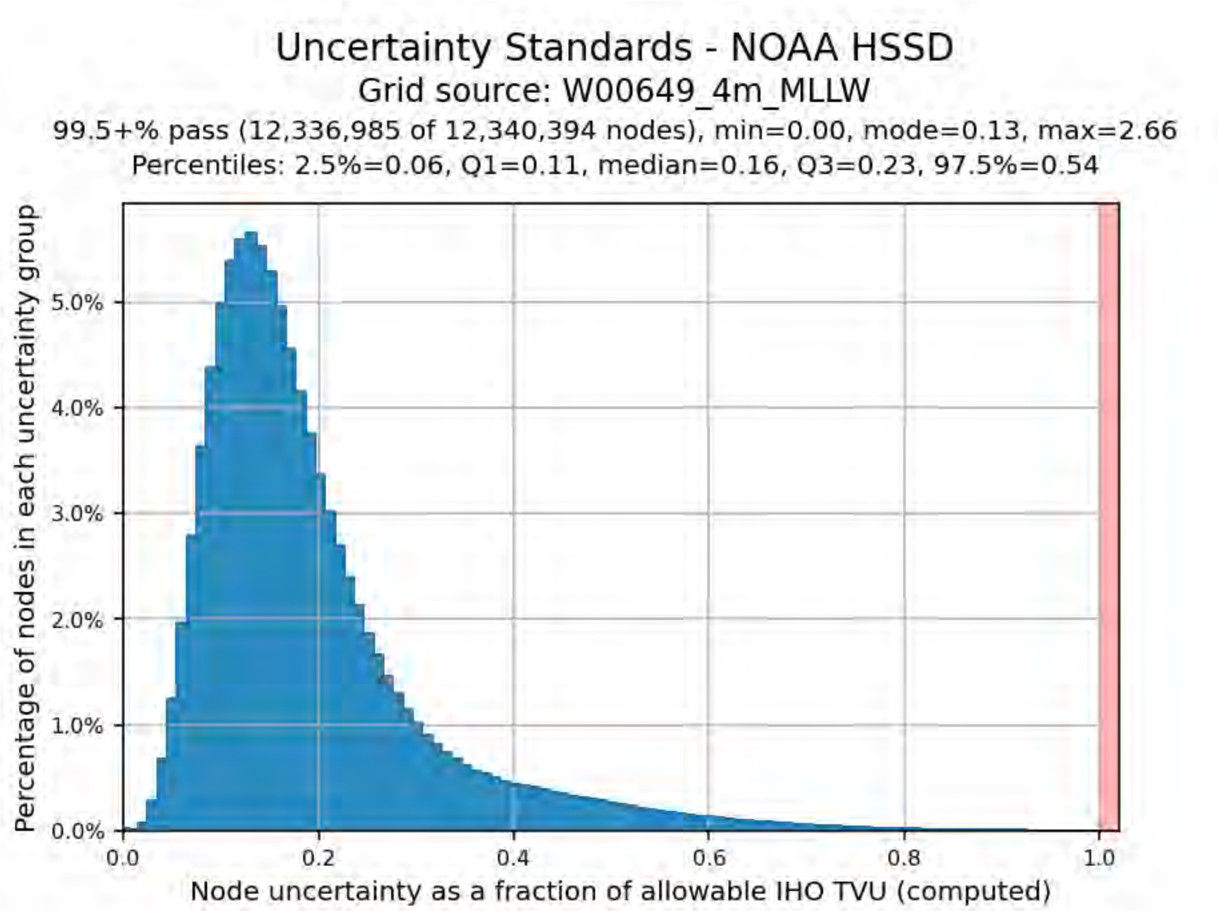


Figure 11 – Allowable uncertainty statistics for 2022 Mainscheme data (W00649)

3.4 Equipment Effectiveness

<u>Sonar</u>

Sonar data were acquired with a Kongsberg EM2040C set to a survey frequency of 300 kHz, high-density beam forming, with 400 beams per ping. Although the EM2040C allowed full swath widths at this frequency, lines from previous years' survey run at comparable depths contained considerable noise in outer beams (> ±60 degrees from the nadir as identified by QPS engineers). As a result (and as per QPS recommendation), soundings greater than ±60 degrees from the nadir were not included in final bathymetric surfaces.

Lambert's Law for Intensity

Prior to January 25, 2023, the setting in EM Controller for Lambert's Law was set to OFF (Default). Following discussions with Kongsberg engineers regarding the mechanics of this setting and after a test comparing data in an area when OFF versus when ON, the setting was changed permanently to ON (Appendix E). This has allowed for more accurate backscatter returns which enables better substrate modeling and more refined sediment characterization efforts. Datasets after changing the setting maintain agreement with older data collected by the program but show improved definition of substrate transitions and throughout regions of uniform substrate. In this data package, only crosslines collected on April 14, 2023 are affected by this change.

All systems performed normally throughout the survey season and no significant failures are worthy of note for the duration of this survey.

3.5 Sound Speed Methods

Sound speed cast frequency: A total of 93 sound speed casts were taken within the boundaries of the W00649 survey area. All sound speed cast measurements were collected using the Teledyne Odom Digibar-S profiler. Sound speed casts were taken as needed throughout the survey, which was generally when the observed surface sound speed (monitored and visualized in real-time using the AML Micro X SV sensor) differed from the surface sound speed in the active profile by more than 2 meters per second. In certain instances, supplemental casts were taken when there was reason to suspect significant changes in the water column (e.g. change in tide, abrupt changes in seafloor relief, etc.). During the collection of sound speed casts, logging was stopped to download and apply the new cast and was resumed when the boat circled around and came back on the survey line. Throughout the duration of the survey, the surface sound speed was observed in real-time (by the AML Micro X SV probe). Sound speed data are recorded and included in raw sonar files submitted with this data package.

A quality comparison between the AML Micro X SV sensor and the Teledyne Odom Digibar-S profiler was not performed. However, real-time comparisons between surface sound speed observed by the AML Micro X SV and the surface sound speed entry in the Digibar-S profile suggested these instruments agreed. Annual calibrations were conducted for both sensors by original manufacturers to ensure performance within manufacturer defined standards.

4.0 Data Post-processing

The following is a summary of the procedures used for post-processing and analysis of survey data using Qimera (v.2.5.3, 64-bit edition) and Fledermaus (v.8.5.1, 64-bit edition) software.

4.1 Horizontal Datum

The horizontal datum for these data is WGS 84 projected in UTM zone 19N (meters) (EPSG 32619).

4.2 Vertical Datum and Water Level Corrections

The vertical datum for these data is mean lower-low water (MLLW) level in meters. A tidal zoning file ("Maine_Tide_Zoning_modified.zdf") containing time and range corrections for verified tide station data was provided by NOAA OCS to MCMI in May 2020. This file was used to apply time corrections, tide height offsets, and tide scale (range) for collected data in each zone listed in Table 7 and shown in Figure 12.

Table 7 – Tide zones and corrections referenced to verified Portland, ME (8418150) tide station data

Survey Area	Tide Station	Zone ID	Time Correction (mins.)	Tide Offset (m)	Tide Scale
Mainscheme (W00649)	8418150	NA95	-12	0	0.95

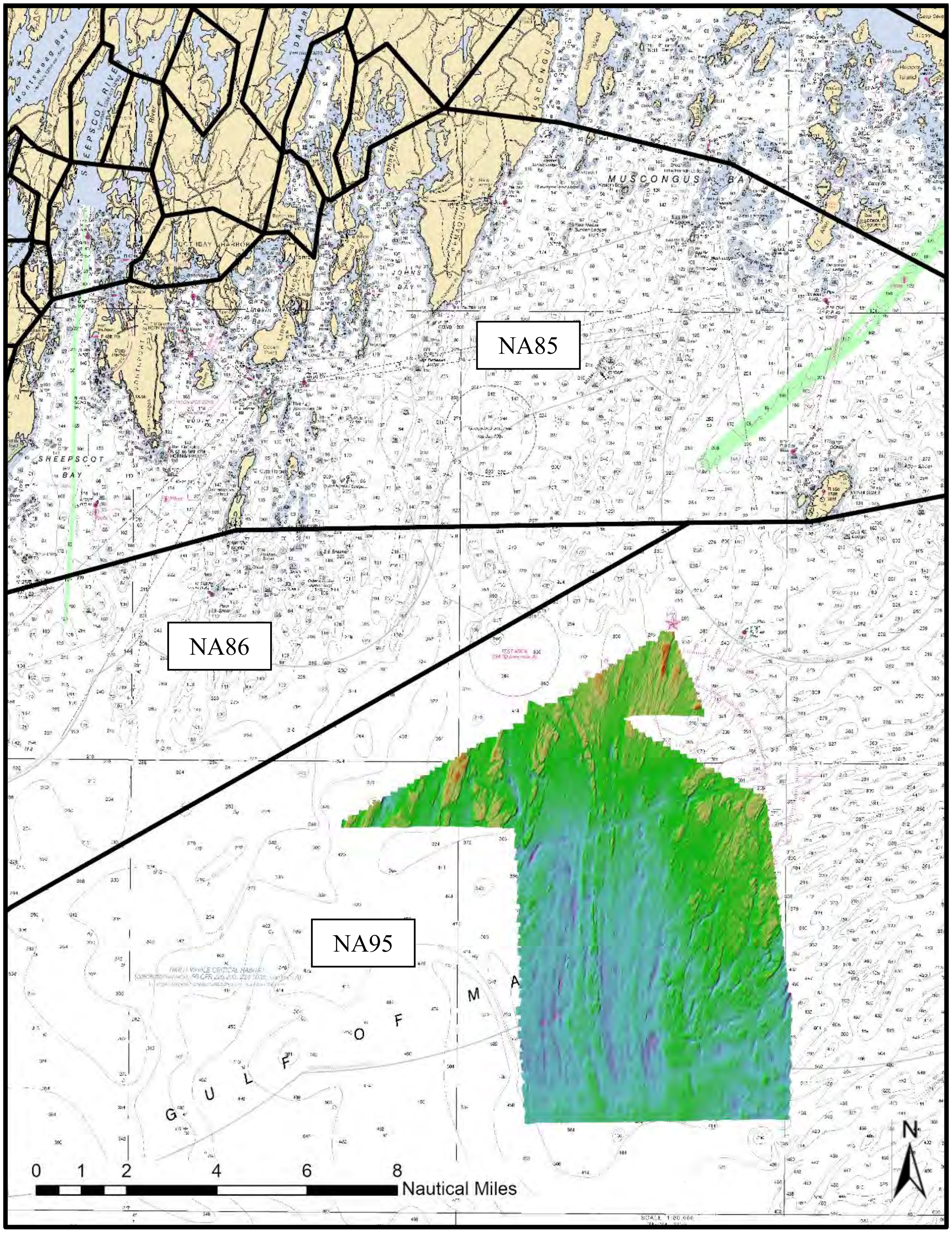


Figure 12 - Tide zones (outlined in black) relative to survey extent

4.3 Processing Workflow

The general post-processing workflow in Qimera was as follows:

1. Create project
2. Add raw sonar files (e.g. metadata extracted and processed bathymetry data converted to .qpd, including vessel configuration and sound velocity)
3. Apply sound velocity profiles via real-time scheduling or by distance/time, contingent upon region surveyed and local conditions
4. Add tide zoning file (.zdf) and associated tide data and integrate into raw files
5. Create dynamic surface with NOAA CUBE settings enabled for desired resolution (e.g. 2-meter, 4 meter)
6. Review and edit soundings/clean surface with slice editor tool, 3D editor tool, and available filters
7. Duplicate surfaces at other grid sizes, if desired
8. Export final surface to .BAG surface
9. Export processed data in .GSF format for backscatter processing

CUBE

A CUBE (Combined Uncertainty and Bathymetry Estimator) surface was created for editing and as a starting point for final products. The corresponding NOAA cube setting (e.g. "NOAA_4m" configuration, Figure 13) was selected for each surface depending on the grid size of the surface.

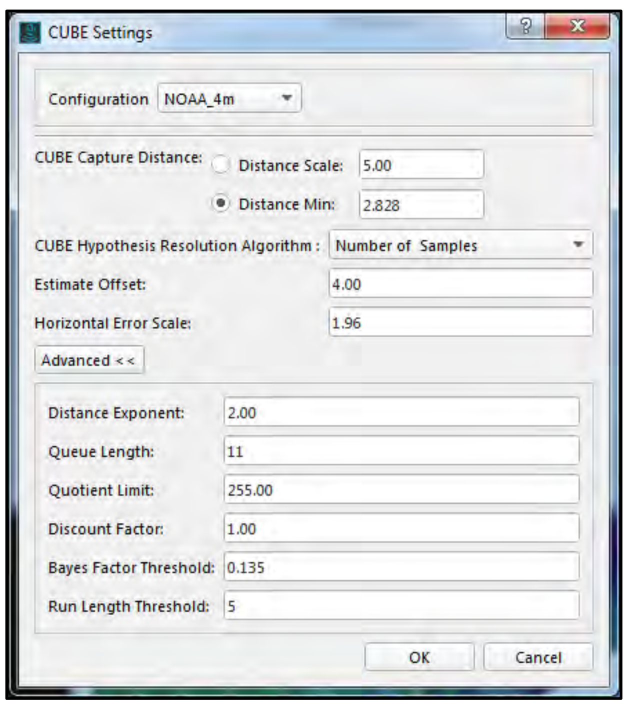


Figure 13 – CUBE settings parameters window shown with settings for NOAA 4-meter grid resolution

4.4 Final Surfaces

The following surfaces were submitted with the survey data. Each BAG file contains the CUBE-processed sounding surface layer and an uncertainty layer.

Table 8 – Bathymetry surfaces submitted for 2022 mainscheme survey data

Surface Name	Resolution (m)	Depth Range (m)	Surface Parameter
W00649_4m_MLLW	4	57 - 198	N/A
W00649_8m_MLLW	8	57 – 198	N/A
W00649_16m_MLLW	16	57 – 198	N/A

4.5 Backscatter

Backscatter data was logged in raw .db files during acquisition. The .db files also hold the navigation record and bottom detections for all lines of surveys. Processed sonar files containing multibeam backscatter data (snippets and beam-average) were exported from Qimera in .GSF format. QPS Fledermaus Geocoder Toolbox (FMGT; v.7.10.2, 64-bit edition) was used to import, process, and mosaic time-series backscatter data. Default backscatter processing settings were used to create the mosaic, except for the Angle Varied Gain (AVG) filter and AVG window size, which were set to 'Adaptive' and '100', respectively. Backscatter mosaics of the data were gridded at 4-meter, 8-meter, and 16-meter resolutions. Mosaics were exported in floating-point GeoTIFF format. The mosaics are shown in Table 9 and Figure 14.

Table 9 – Backscatter mosaics submitted for 2022 mainscheme survey data

Mosaic Name	Pixel Size (m)
W00649_4m_BS	4
W00649_8m_BS	8
W00649_16m_BS	16

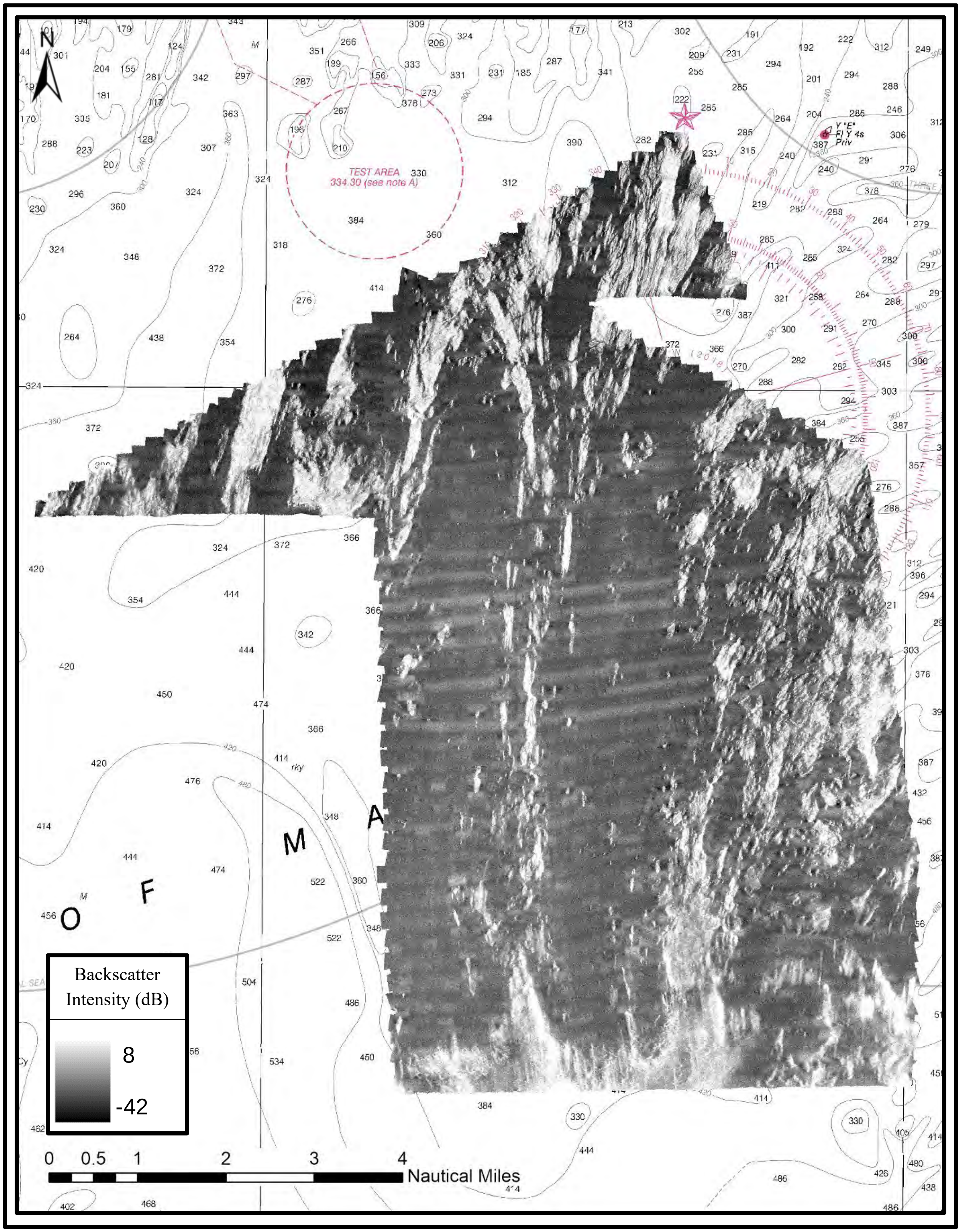


Figure 14 – Backscatter mosaic (4-meter pixel size) of 2022 mainscheme coverage atop NOAA chart 13288

5.0 Results

5.1 Charts Comparison

The hydrographer conducted a qualitative comparison of reclassified bathymetry data and depth contours from the surveyed area to the charted soundings and contours. The largest scale raster navigational charts which cover the survey areas are listed in Table 10. Prior hydrographic surveys in the vicinity were conducted by NOAA in 1888, but only covered a portion of the region and consisted only of partial bottom coverage. These data were not compared with data collected by the MCMI. No existing surveys with digital sounding data was available for reference for much of the survey area.

Table 10 – Largest scale raster charts in survey area

Chart	**Scale**	**Source Edition**	**Source Date**	**NTM Date**
13288	1:80,000	44	02/2016	5/30/2023
13260	1:378,838	44	10/2019	5/30/2023
13009	1:500,000	38	10/2018	6/14/2023

<u>Chart 13288</u>

Surveyed depths show coarse agreement with charted contours in portions of the survey area but much of the data disagrees, especially where contours are absent (Figure 15). Throughout much of the southern portion of the survey area, depths do not agree with marked soundings and show values sometimes exceeding 200 feet deeper than charted. Agreement between surveyed values and charted values were found to be stronger in the northern portion of the dataset, with disagreements becoming more apparent moving south. It is likely this is due to a lack of sounding data and/or outdated data sources within the surveyed region. It is recommended that contours showing disagreement in this area be revised based on the findings of this report. Furthermore, it is recommended that the new data provided by this survey be incorporated into drawing new contours where no sounding data previously existed.

<u>Chart 13260</u>

Surveyed depths show coarse agreement with charted contours in portions of the survey area but much of the data disagrees, especially where contours are absent (Figure 16). Throughout much of the southern portion of the survey area, depths do not agree with marked soundings and show values sometimes exceeding 200 feet deeper than charted. Agreement between surveyed values and charted values were found to be stronger in the northern portion of the dataset, with disagreements becoming more apparent moving south. It is likely this is due to a lack of sounding data and/or outdated data sources within the surveyed region. It is recommended that contours showing disagreement in this area be revised based on the findings of this report. Furthermore, it is recommended that the new data provided by this survey be incorporated into drawing new contours where no sounding data previously existed.

Chart 13009

Surveyed depths show coarse agreement with charted contours in portions of the survey area but much of the data disagrees, especially where contours are absent (Figure 17). Throughout much of the southern portion of the survey area, depths do not agree with marked soundings and show values sometimes exceeding 200 feet deeper than charted. Agreement between surveyed values and charted values were found to be stronger in the northern portion of the dataset, with disagreements becoming more apparent moving south. It is likely this is due to a lack of sounding data and/or outdated data sources within the surveyed region. It is recommended that contours showing disagreement in this area be revised based on the findings of this report. Furthermore, it is recommended that the new data provided by this survey be incorporated into drawing new contours where no sounding data previously existed.

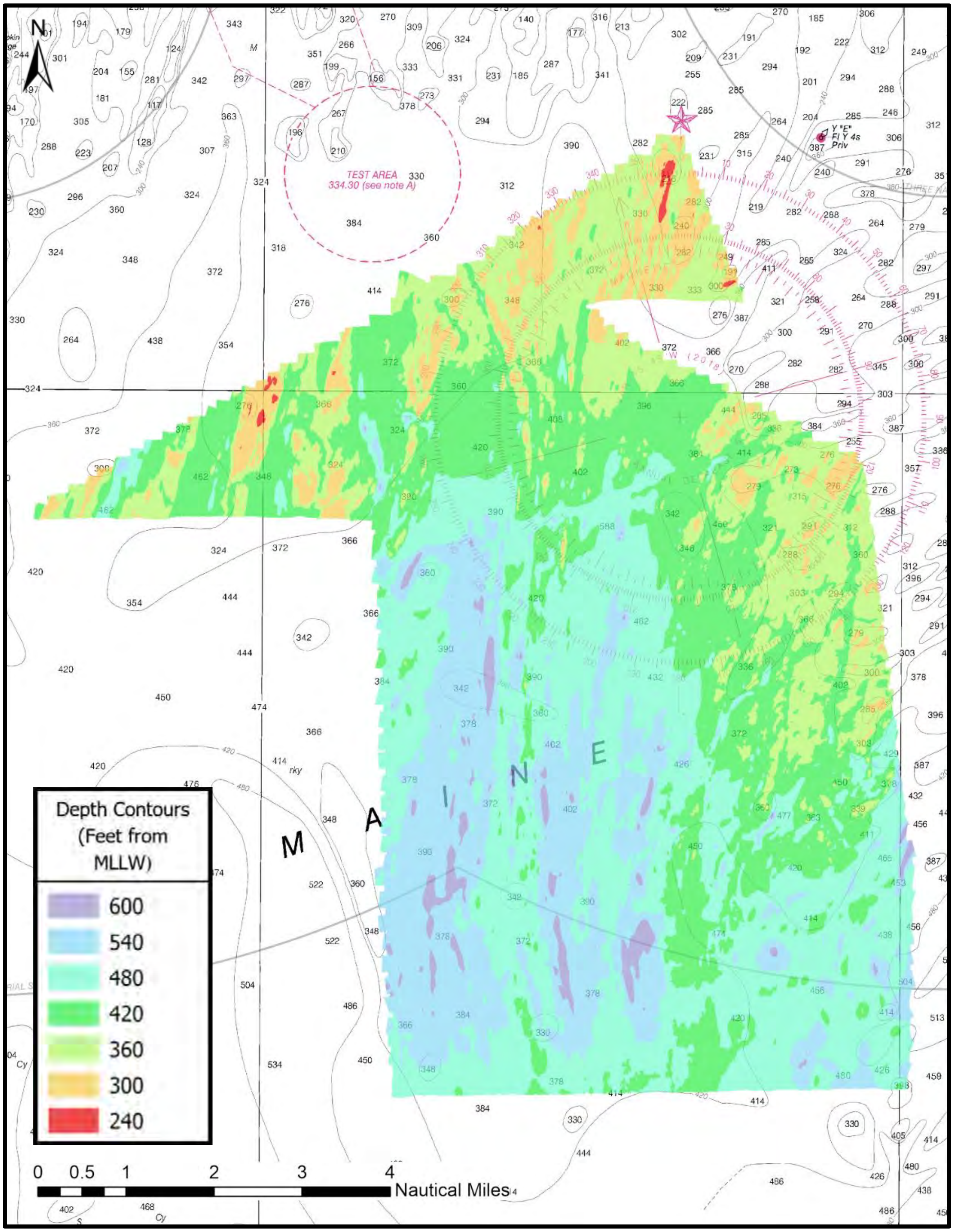


Figure 15 – 2022 Mainscheme data comparison between surveyed depth (re-classified at 60-feet intervals) and chart 13288 contours (60-feet intervals)

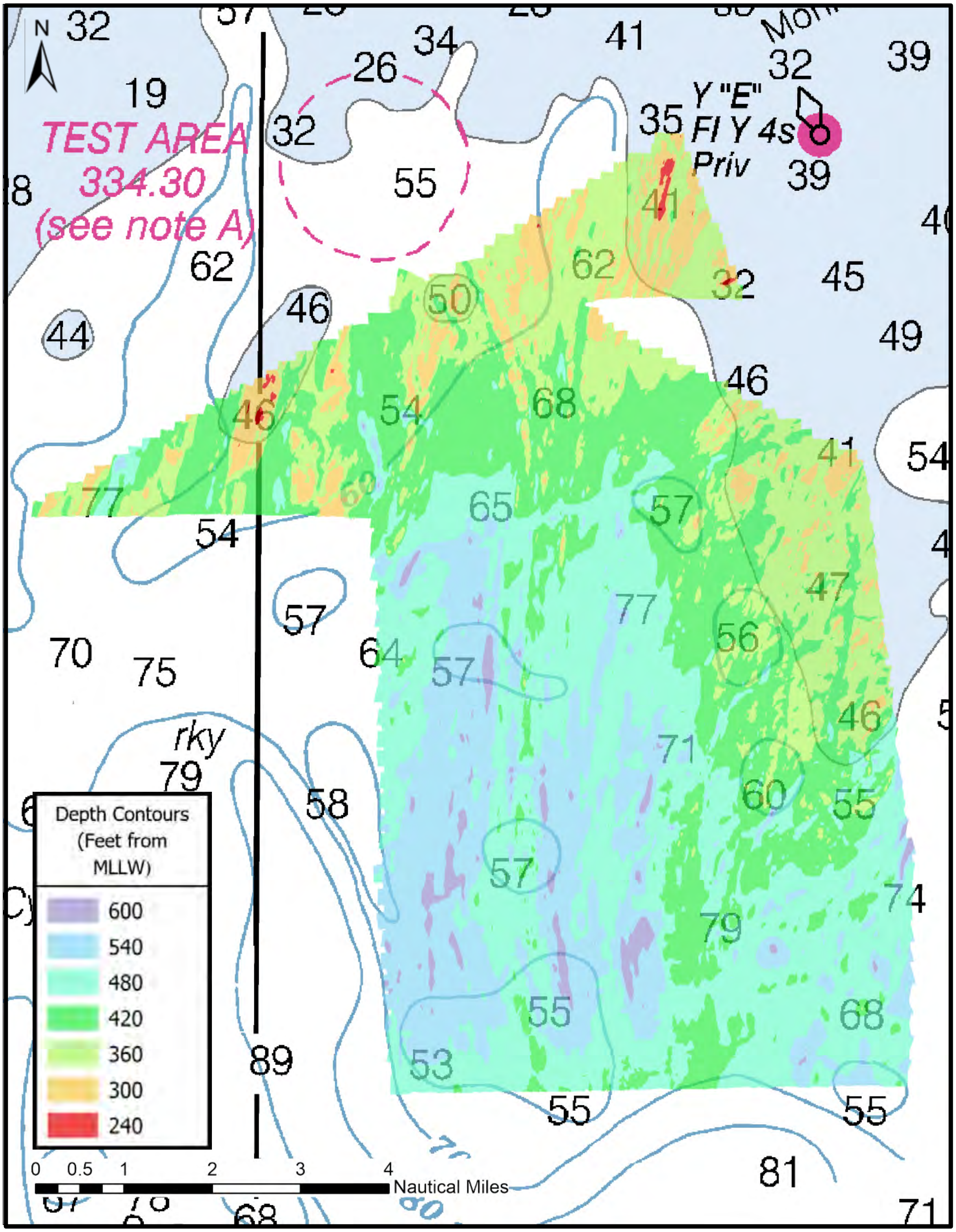


Figure 16 – 2022 Mainscheme data comparison between surveyed depth (re-classified at 60-feet intervals) and chart 13260 contours (60-feet intervals)

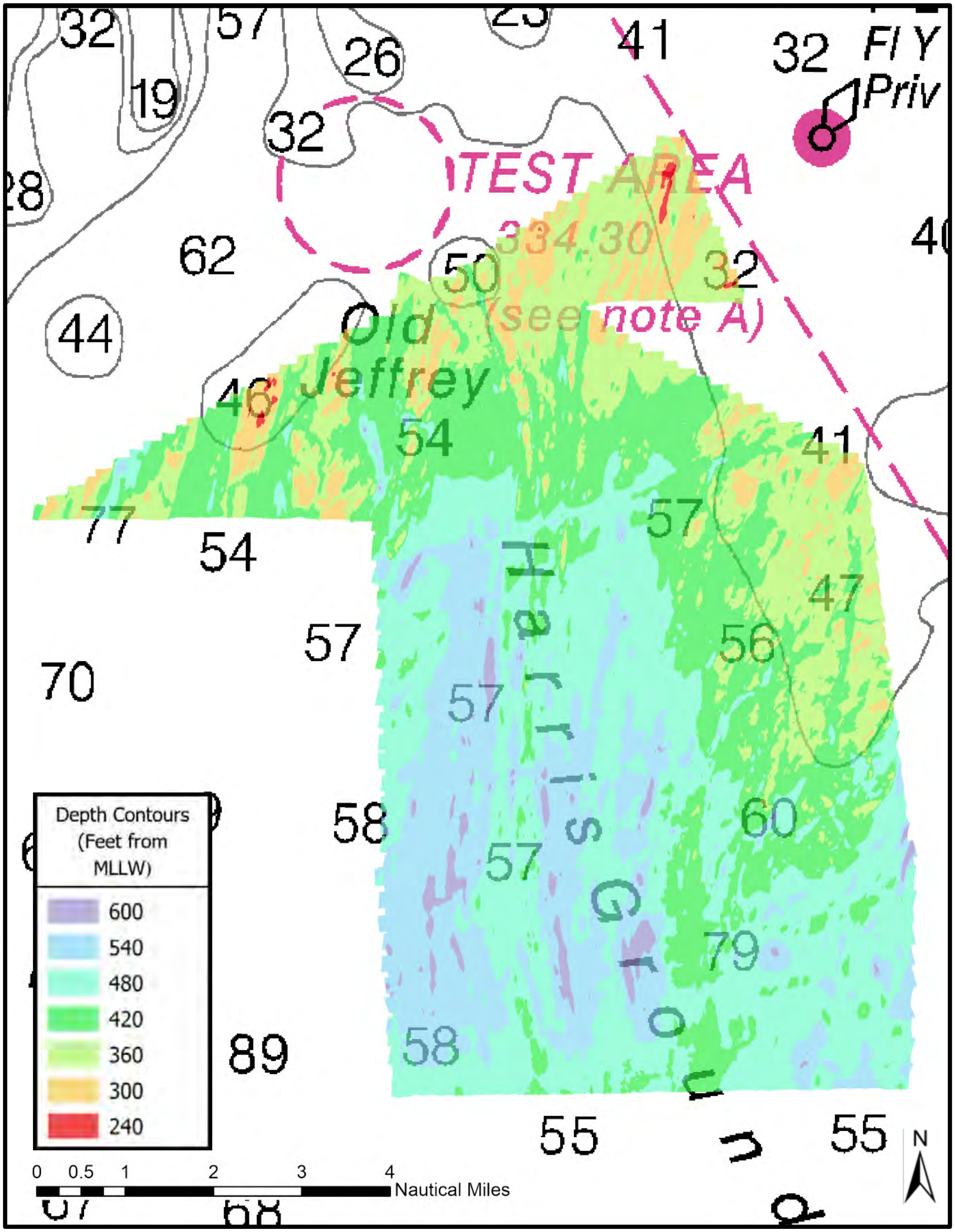


Figure 17 – 2022 Mainscheme data comparison between surveyed depth (re-classified at 60-feet intervals) and chart 13009 contours (60-feet intervals)

5.2 Bottom Samples

A total of 60 bottom sampling sites were planned for collection throughout the course of the acquisition effort in state and federal waters to supplement existing sediment data collected previously by other agencies (Maine Geological Survey and University of Maine) in and surrounding the survey area (Figure 26). A total of 52 sites were successfully completed, with 36 retrieving sediment samples for analysis. The results of grain-size and video analyses will be used to calibrate, refine, and digitize interpretations of seafloor substrate. These data are also used to investigate how these data relate to benthic infauna in the survey area.

Additional details on the bottom samples are provided in Table 11. More detailed analysis of grain size composition of these samples and benthic fauna composition will be determined after laboratory processing is complete for the collected samples. Metadata sheets for all bottom samples are provided as part of the submitted data package accompanying this report.

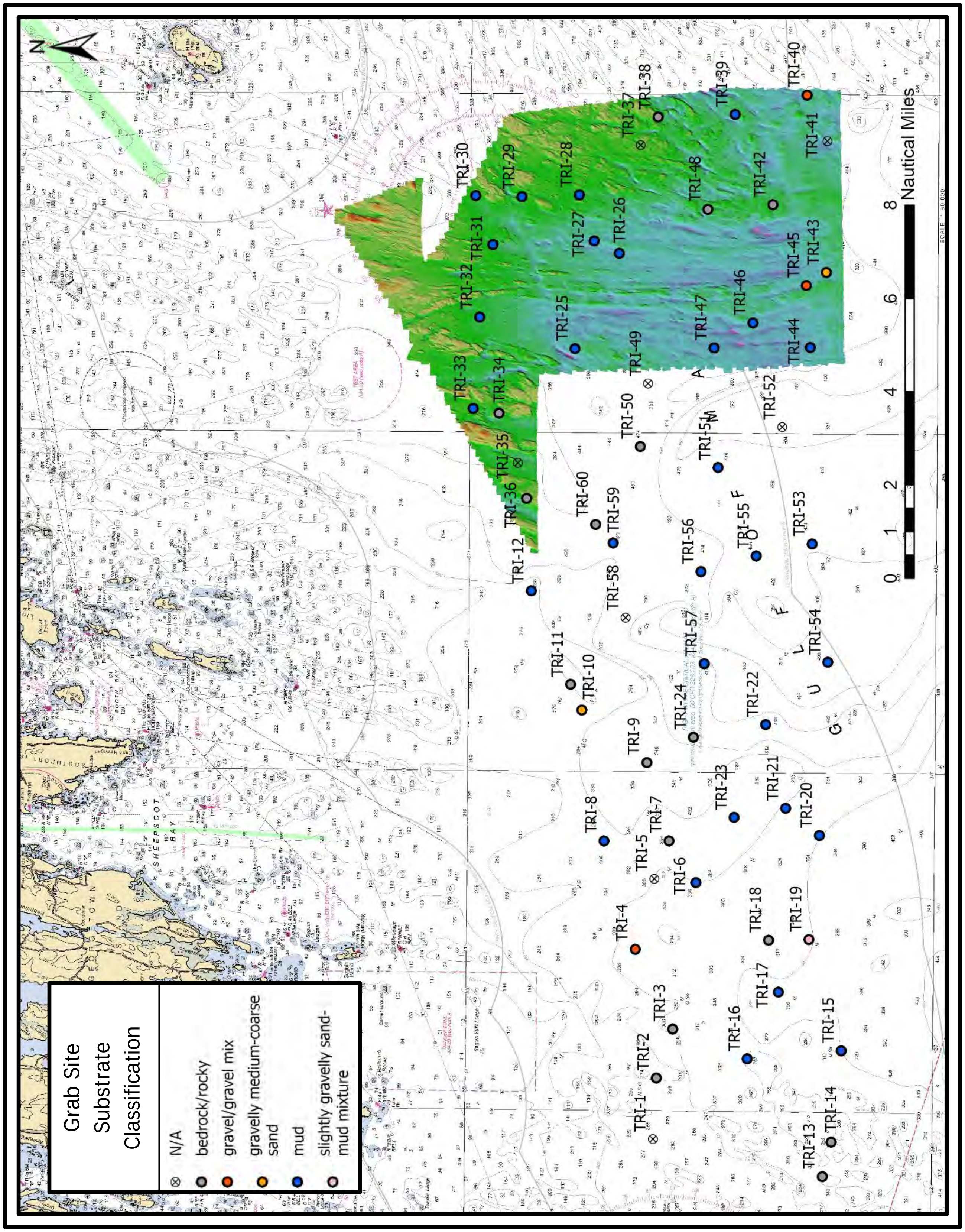


Figure 18 – Bottom sample locations collected over the course of the 2022 season in and around the survey area. Sites classified via modified CMECS 7-class scheme from field observations (Appendix H).

Table 11 – Grab Sample Information

Site Name	Date	Latitude (decimal degrees N)	Longitude (decimal degrees W)	Depth (m)	Grain Size (field observation)	Backscatter Intensity (dB)
TRI-1	07/05/2022	43.5995	-69.84725	-87.4	N/A	-32.21
TRI-2	07/05/2022	43.59851667	-69.81718333	-54.9	rock	-13
TRI-3	07/05/2022	43.59288333	-69.79306667	-67.4	rock	-17.09
TRI-4	07/05/2022	43.6065	-69.75398333	-72.9	muddy sandy gravel with large cobbles	-10.48
TRI-5	07/05/2022	43.59986667	-69.71921667	-99.5	N/A	-29.38
TRI-6	07/05/2022	43.58505	-69.72093333	-97.8	silty clayey mud with sand / sandy silty clay	-26.86
TRI-7	07/05/2022	43.59478333	-69.70046667	-50.2	rock	-18.04
TRI-8	07/05/2022	43.61791667	-69.70073333	-90.3	sandy clayey mud	-28.43
TRI-9	07/05/2022	43.60291667	-69.66205	-85.1	rock	-15.2
TRI-10	07/05/2022	43.62623333	-69.63643333	-92.7	gravelly mud with trace sand	-22.45
TRI-11	07/05/2022	43.63035	-69.62381667	-65.7	rock	-13.94
TRI-12	07/05/2022	43.6446	-69.57801667	-99.1	silty mud with trace fine sand	-22.45
TRI-13	07/20/2022	43.53897	-69.8648	-80.5	rock	Unavailable
TRI-14	07/20/2022	43.536	-69.8479	-90	rock	Unavailable
TRI-15	07/20/2022	43.53266667	-69.80288333	-118.1	silty clayey mud with trace sand and gravel	1.65*
TRI-16	07/20/2022	43.56613333	-69.80735	-110	clayey mud with trace sand	-25.91
TRI-17	07/20/2022	43.55521667	-69.77433333	-119	silty clayey mud with trace sand	Unavailable
TRI-18	07/20/2022	43.5589	-69.74896667	-96.7	rock	Unavailable
TRI-19	07/20/2022	43.5445	-69.74831667	-107	slightly gravelly sandy mud	Unavailable
TRI-20	07/20/2022	43.54111667	-69.69725	-123	silty clayey mud with trace sand	Unavailable
TRI-21	07/20/2022	43.55323333	-69.68403333	-125	silty clayey mud with trace sand and shell hash	Unavailable
TRI-22	07/20/2022	43.56058333	-69.64288333	-135	silty clayey mud with trace sand	Unavailable
TRI-23	07/20/2022	43.57155	-69.6887	-110	clayey mud with trace sand	Unavailable
TRI-24	07/20/2022	43.58635	-69.64941667	-89.6	rock	Unavailable
TRI-25	07/26/2022	43.62946667	-69.45856667	-142	clayey mud with trace sand	-19.93
TRI-26	07/26/2022	43.61393333	-69.41156667	-161	clayey silty mud with trace fine sand	Unavailable
TRI-27	07/26/2022	43.62281667	-69.40556667	-156	clayey silty mud with trace sand	Unavailable
TRI-28	07/26/2022	43.62825	-69.38288333	-121	clayey mud with trace sand	Unavailable
TRI-29	07/26/2022	43.64876667	-69.38405	-110	gravelly sandy mud	-16.15
TRI-30	07/26/2022	43.66521667	-69.38356667	-117	clayey mud with trace sand	-18.67
TRI-31	07/26/2022	43.65901667	-69.40758333	-123	clayey mud with trace sand	-18.04
TRI-32	07/26/2022	43.6636	-69.44328333	-121	clayey mud with trace sand	-15.52
TRI-33	07/26/2022	43.6657	-69.48828333	-113	clayey mud with trace sand	-27.17
TRI-34	07/26/2022	43.65653333	-69.49051667	-87.8	rock	Unavailable
TRI-35	07/26/2022	43.64965	-69.51498333	-120	N/A	Unavailable
TRI-36	07/26/2022	43.64646667	-69.53255	-96.9	rock	-20.56
TRI-37	08/11/2022	43.60641667	-69.35831667	-103	N/A	Unavailable
TRI-38	08/11/2022	43.6003	-69.3445	-106	rock	Unavailable
TRI-39	08/11/2022	43.57283333	-69.343	-130	clayey mud with trace sand	Unavailable
TRI-40	08/11/2022	43.5471	-69.33345	-135	gravel with large cobbles; consolidated clay chunks present	
TRI-41	08/11/2022	43.53983333	-69.356	-157	N/A	14.88*
TRI-42	08/11/2022	43.55921667	-69.38738333	-128	rock	Unavailable
TRI-43	08/11/2022	43.53998333	-69.42053333	-146	gravelly mud with trace sand; pebbles present	17.63*
TRI-44	08/11/2022	43.54561667	-69.45748333	-155	silty clayey mud with trace fine sand	7.71*
TRI-45	08/11/2022	43.54703333	-69.42691667	-153	muddy sandy gravel with cobbles	24.8*
TRI-46	08/11/2022	43.56608333	-69.44546667	-149	silty clayey mud with trace sand	Unavailable
TRI-47	08/11/2022	43.57983333	-69.45785	-155	clayey mud with trace sand	Unavailable
TRI-48	08/11/2022	43.58231667	-69.38973333	-114	rock	Unavailable
TRI-49	08/16/2022	43.60338333	-69.47555	-134	N/A	Unavailable
TRI-50	08/16/2022	43.60598333	-69.50658333	-103	rock	Unavailable
TRI-51	08/16/2022	43.57826667	-69.5167	-140	silty mud	Unavailable
TRI-52	08/16/2022	43.55543333	-69.49663333	-152	N/A	Unavailable
TRI-53	08/16/2022	43.5445	-69.55398333	-137	gravelly sandy mud; large pebbles present	15.98*
TRI-54	08/16/2022	43.53856667	-69.61198333	-142	silty clayey mud with trace sand	7.16*
TRI-55	08/16/2022	43.56436667	-69.5601	-143	clayey mud with trace sand and gravel	Unavailable
TRI-56	08/16/2022	43.58401667	-69.56791667	-136	clayey silty mud with trace sand	Unavailable
TRI-57	08/16/2022	43.58268333	-69.61311667	-126	slightly sandy mud	Unavailable
TRI-58	08/16/2022	43.61085	-69.59086667	-131	N/A	Unavailable
TRI-59	08/16/2022	43.61548333	-69.55416667	-134	silty clayey mud with trace sand	Unavailable
TRI-60	08/16/2022	43.62176667	-69.54516667	-89	rock	Unavailable

Note: Backscatter values were unavailable for several grab sites at time of deployment and are shown above. Backscatter values marked with an asterisk were obtained by an EM2040 and are not of the same profile as the EM2040C.

6.0 Summary

A total of 76.18 mi^2 (197.31 km^2) of high-resolution multibeam data were collected throughout the 2022 mainscheme area, located in the vicinity of Monhegan Island, Maine from June of 2022 to April of 2023. Except for select few small holidays due to seafloor elevation-induced sonic shadows, multibeam coverage was 100% in all areas surveyed.

Bathymetry and backscatter data products were produced at 4-meter, 8-meter, and 16-meter grid resolution. The bathymetry and backscatter information for the survey area are supplemented by seafloor surficial sediment samples, water column data, video, and benthic fauna collection in 52 locations.

Consistency of hydrographic data collected aboard the F/V Amy Gale was reflected in the results of the surface difference tests between crosslines and junction survey data, where mean vertical differences across all tests were less than 10 centimeters, 95% of all nodes having maximum deviation of +/- 0.83 meters, and within allowable tolerances for IHO and NOAA specifications at the depths ensonified. Standard deviations of all tests were relatively low and comparable to those achieved by small vessels in similar surveys of the area (e.g. *Ferdinand R. Hassler* and previous submissions by *Amy Gale*). Total vertical uncertainties for all areas surveyed were within tolerances for IHO and NOAA specifications at all depths, where 99.97% of all nodes fell within the allowable range.

Comparisons between survey data and the largest scale nautical charts in the vicinity show coarse agreement with charted contours in portions of the survey area but much of the data disagrees, especially where contours are absent. Throughout much of the southern portion of the survey area, depths do not agree with marked soundings and show values sometimes exceeding 200 feet deeper than charted. Agreement between surveyed values and charted values were found to be stronger in the northern portion of the dataset, with disagreements becoming more apparent moving south. It is recommended that the corresponding charts be updated in this area to reflect these data, and that contours be adjusted throughout the survey area to the refined values delivered in these updated datasets.

These data were acquired and processed to meet Office of Coast Survey bathymetry standards as best as possible and were shared with the NOAA Office of Coast Survey for review.

Please contact the Maine Coastal Program's Research Coordinator for additional information or data requests.

References

International Hydrographic Organization (2020) IHO Standards for Hydrographic Surveys, Edition 6.0.0, September 2020. Monaco, International Hydrographic Organization, 41pp. (International Hydrographic Organization Special Publication, S-44). DOI: https://doi.org/10.25607/OBP-1354.2

NOAA. (2021). NOS hydrographic surveys specifications and deliverables: U.S Department of Commerce National Oceanic and Atmospheric Administration. 162pp.

NOAA, Office of Coast Survey (2021). Field Procedures Manual, February 2021. Silver Spring, MD, National Oceanic and Atmospheric Administration, Office of Coast Survey, 165pp. DOI: http://dx.doi.org/10.25607/OBP-153.3

U.S. Department of the Interior (2014). Proposed geophysical and geological activities in the Atlantic OCS to identify sand resources and borrow areas north Atlantic, mid-Atlantic, and south Atlantic-Straits of Florida planning areas, *final environmental assessment.* OCS EIS/EA BOEM 2013-219 U.S. Department of the Interior Bureau of Ocean Energy Management Division of Environmental Assessment Herndon, VA, January 2014.

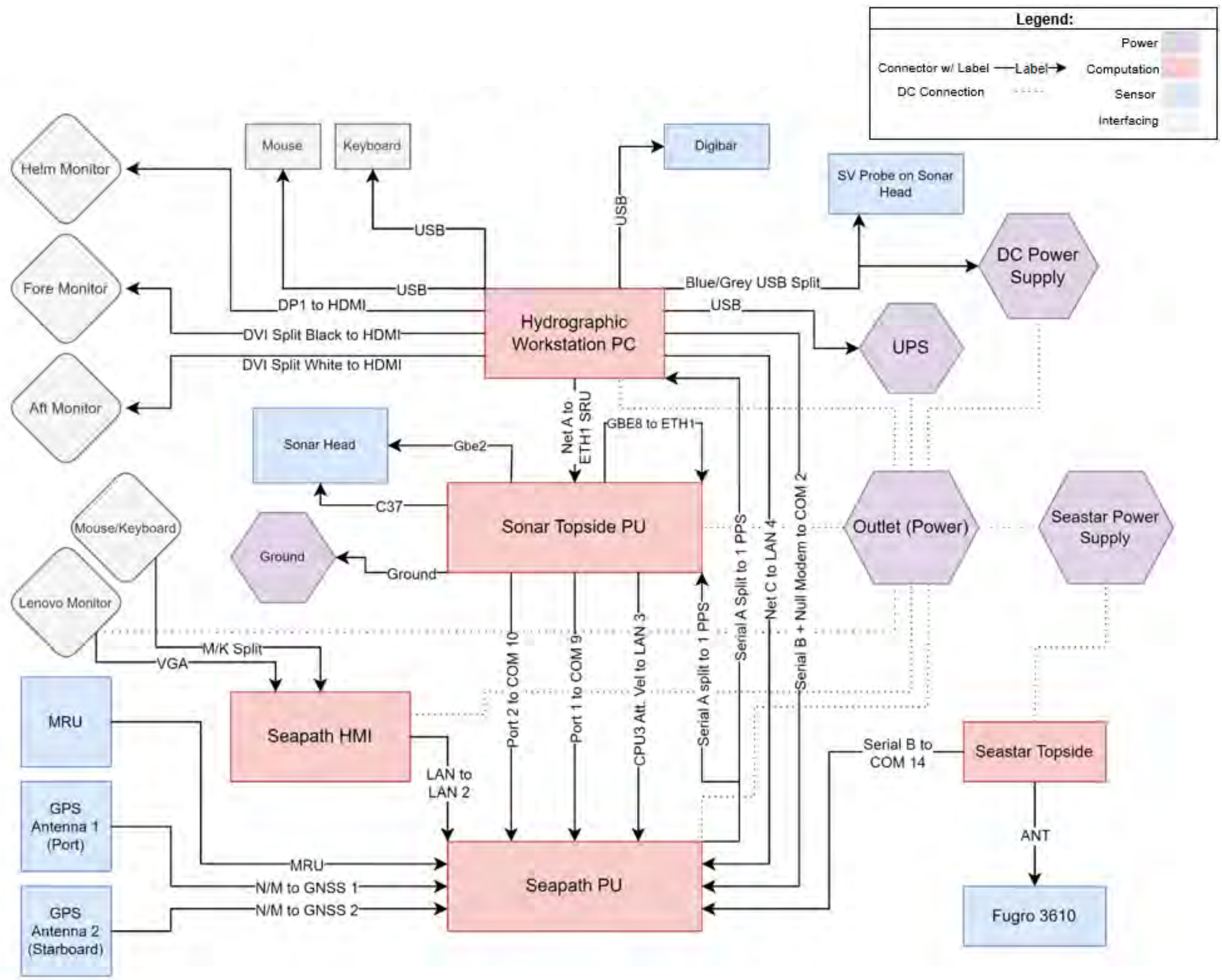
Appendix A – Specific dates of data acquisition for surveys

Dates (mm/dd/yy) of Data Acquisition for 2022 Mainscheme Surveys*

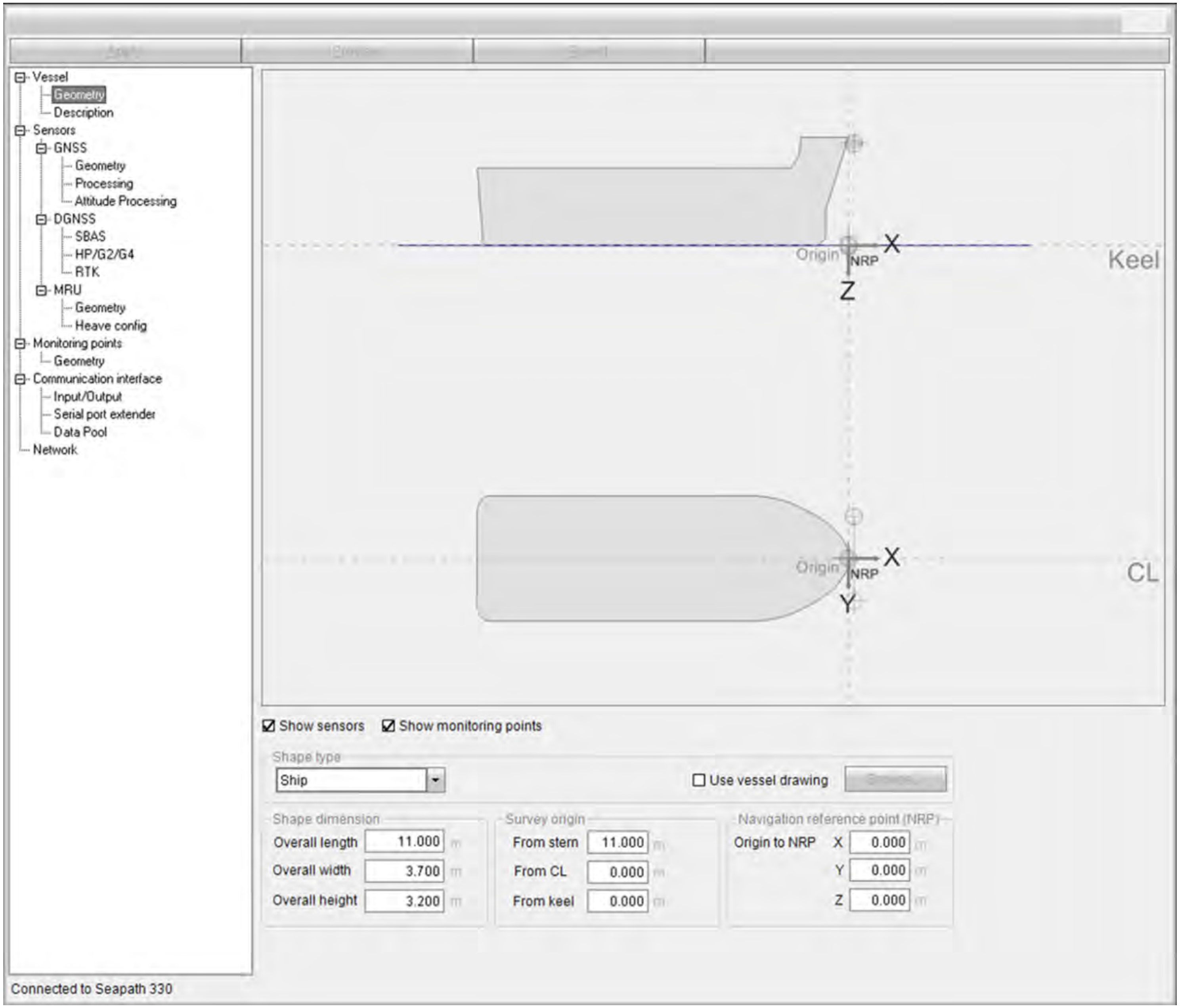
W00649
06/14/2022
06/21/2022
06/24/2022
07/07/2022
07/14/2022
07/28/2022
08/01/2022
08/05/2022
08/10/2022 Crosslines
08/12/2022
08/15/2022
08/22/2022
08/24/2022
08/25/2022 Collection and Crosslines
09/08/2022 Crosslines
09/09/2022 Crosslines
09/30/2022
04/14/2023 Crosslines

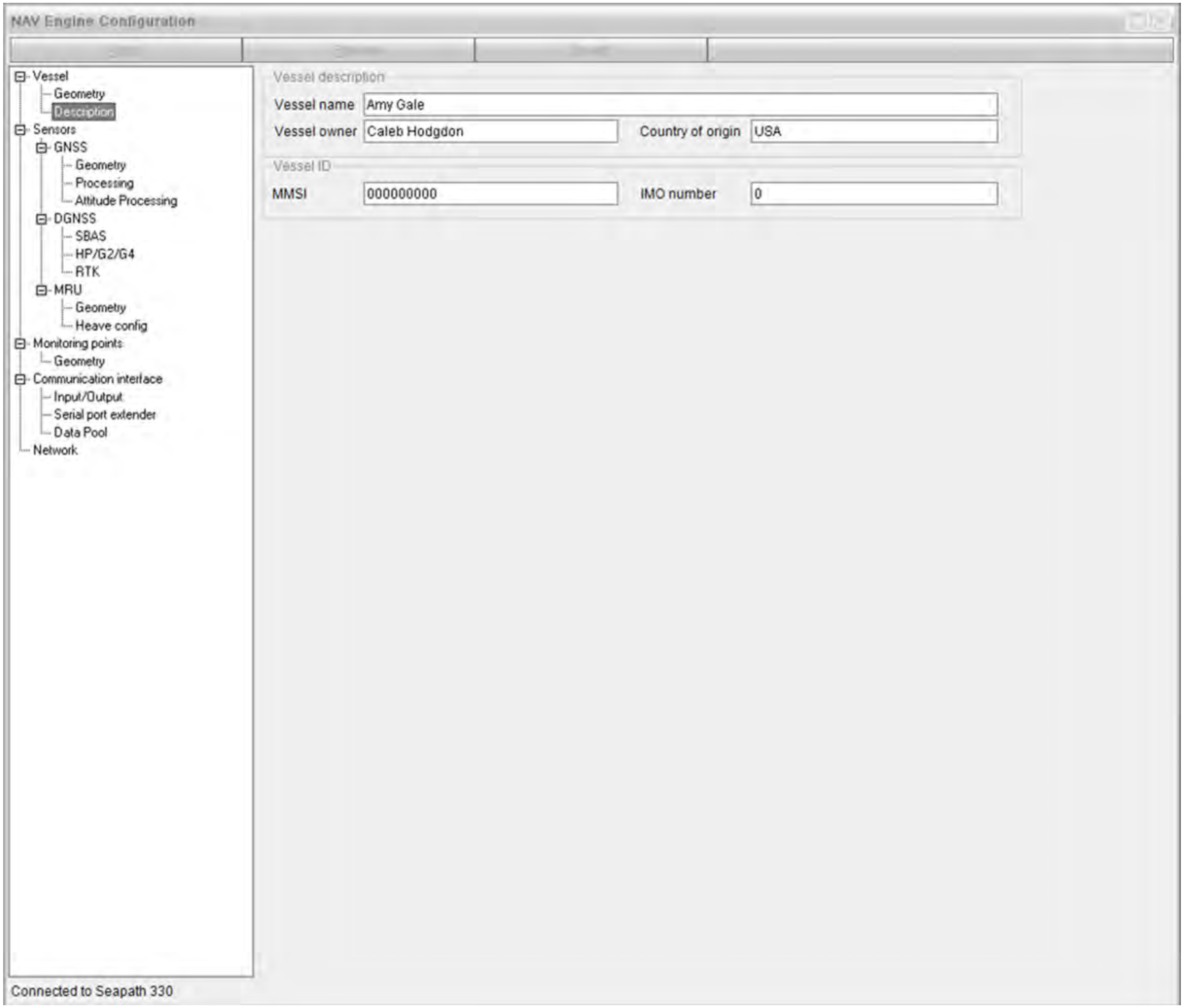
*Dates of surveys not summarized in this report not listed

Appendix B – 2022 MCMI Survey Systems Diagram for the F/V Amy Gale



Appendix C – 2022 Configuration settings for Seapath 330





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SBAS
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RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
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Caleb Hodgdon
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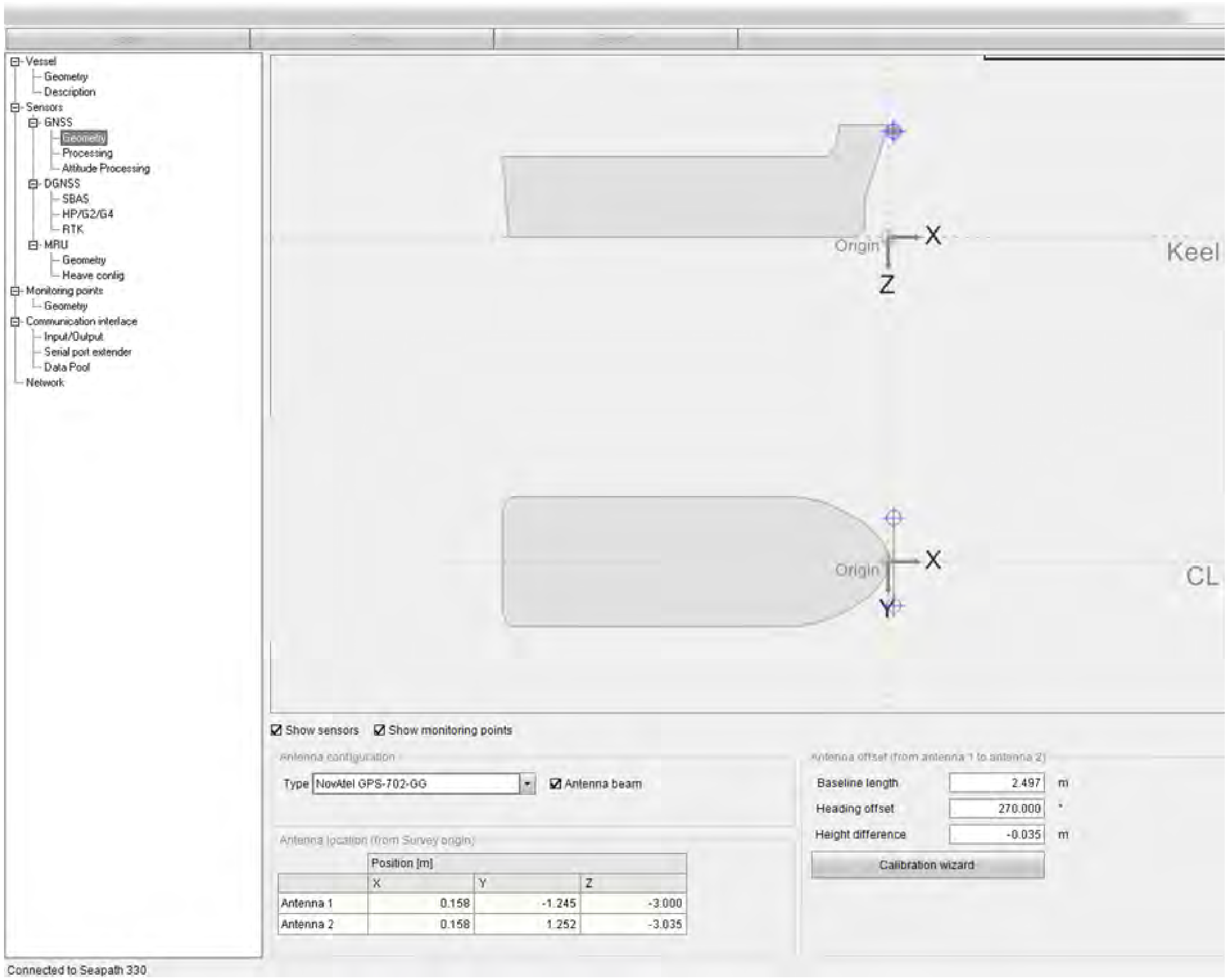
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Monitoring points
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Input/Output
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Y
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Show sensors
Show monitoring points
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Antenna beam
Antenna location (from Survey origin)
Position [m]
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Y
Z
Antenna 1 0.158 -1.245 -3.000
Antenna 2 0.158 1.252 -3.035
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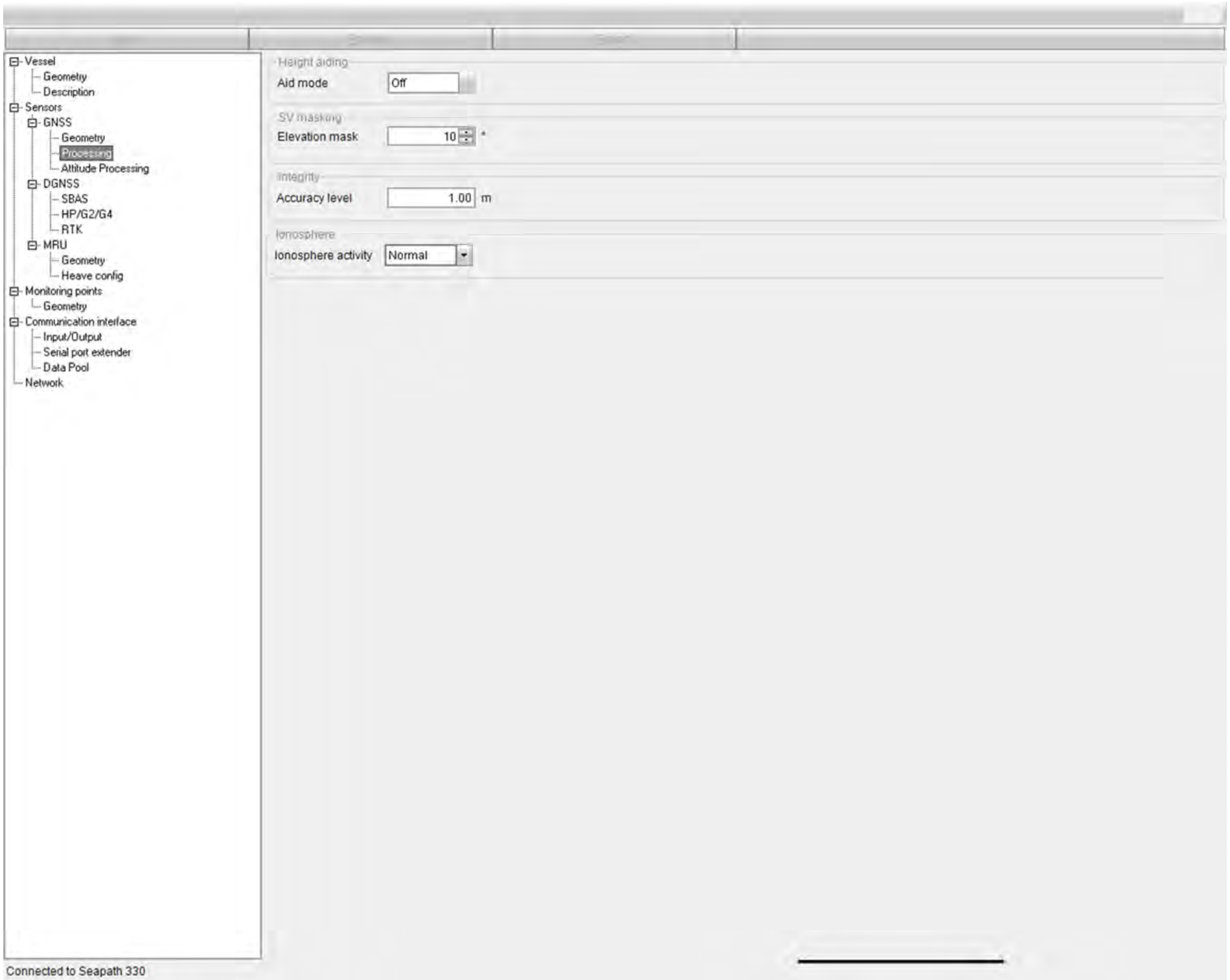
Heading offset 270.000 °
Height difference -0.035 m
Calibration wizard
Connected to Seapath 330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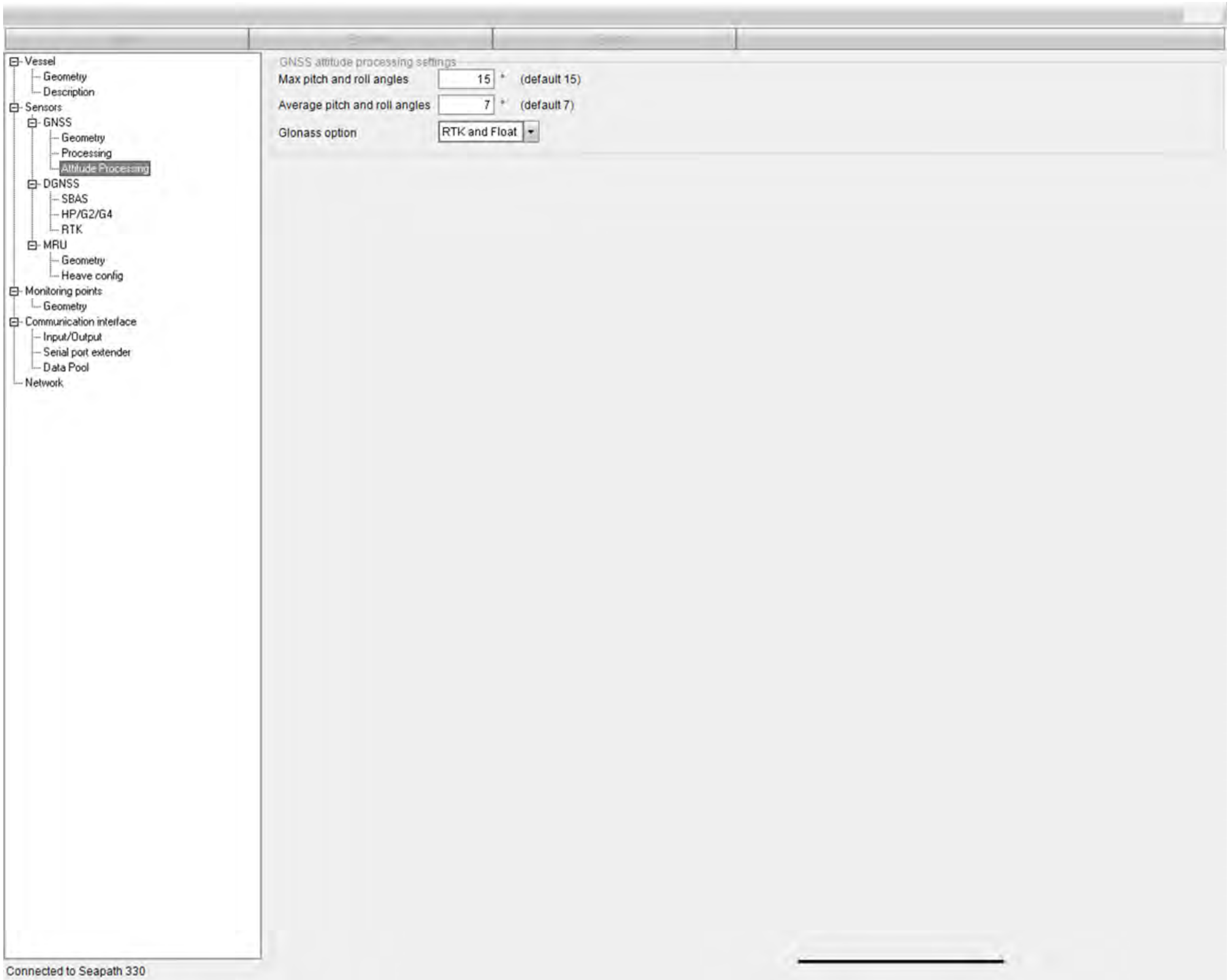
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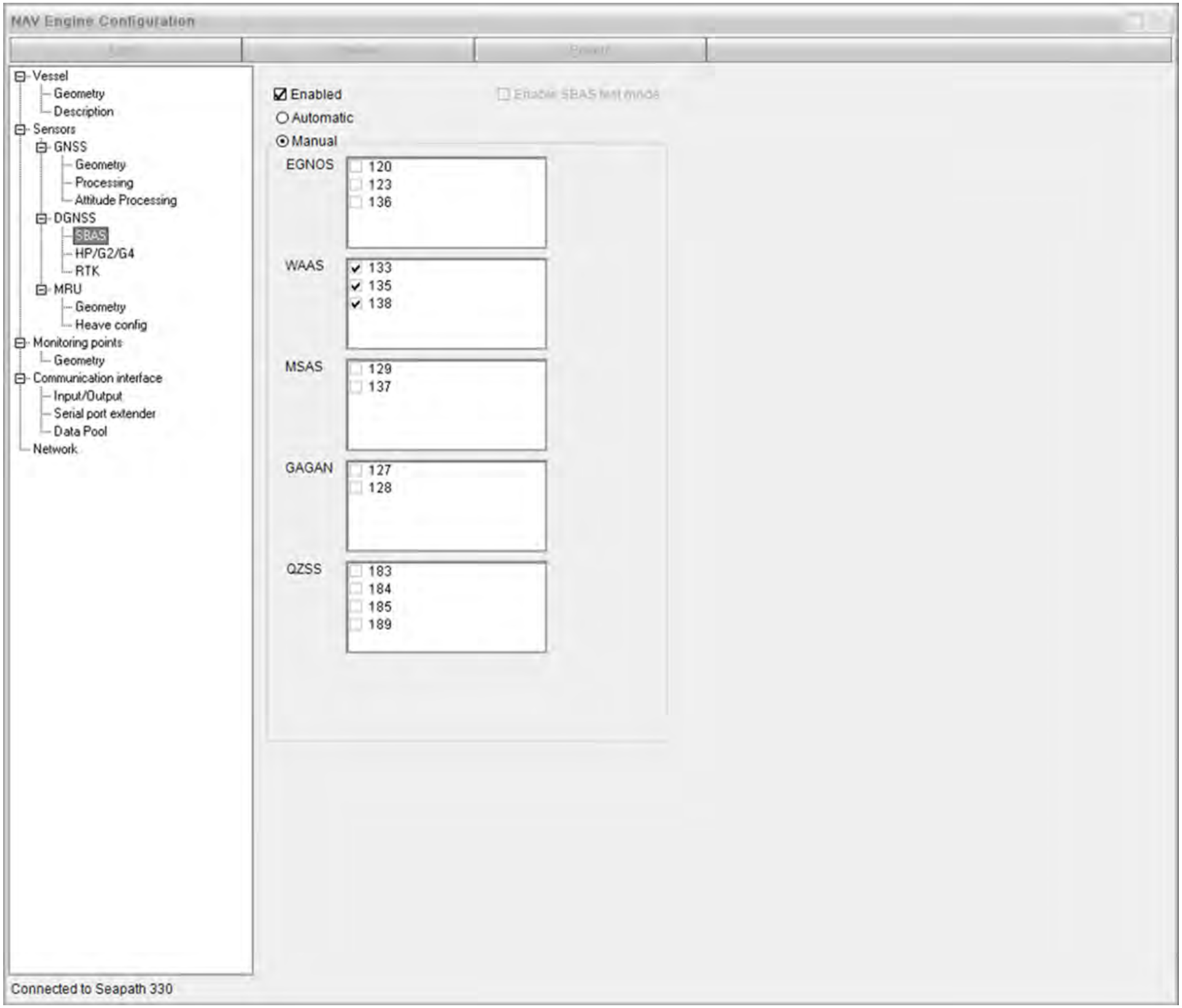
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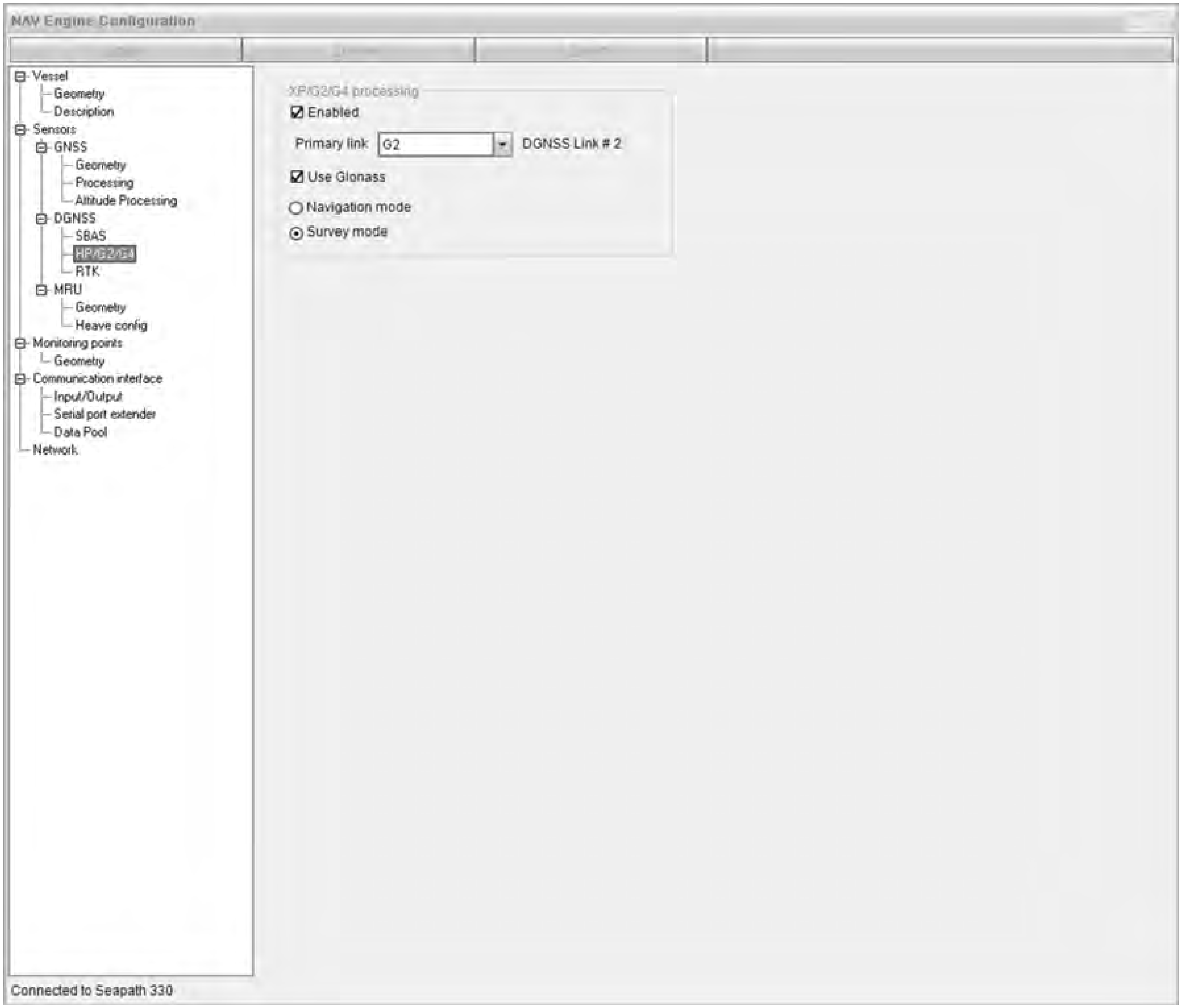
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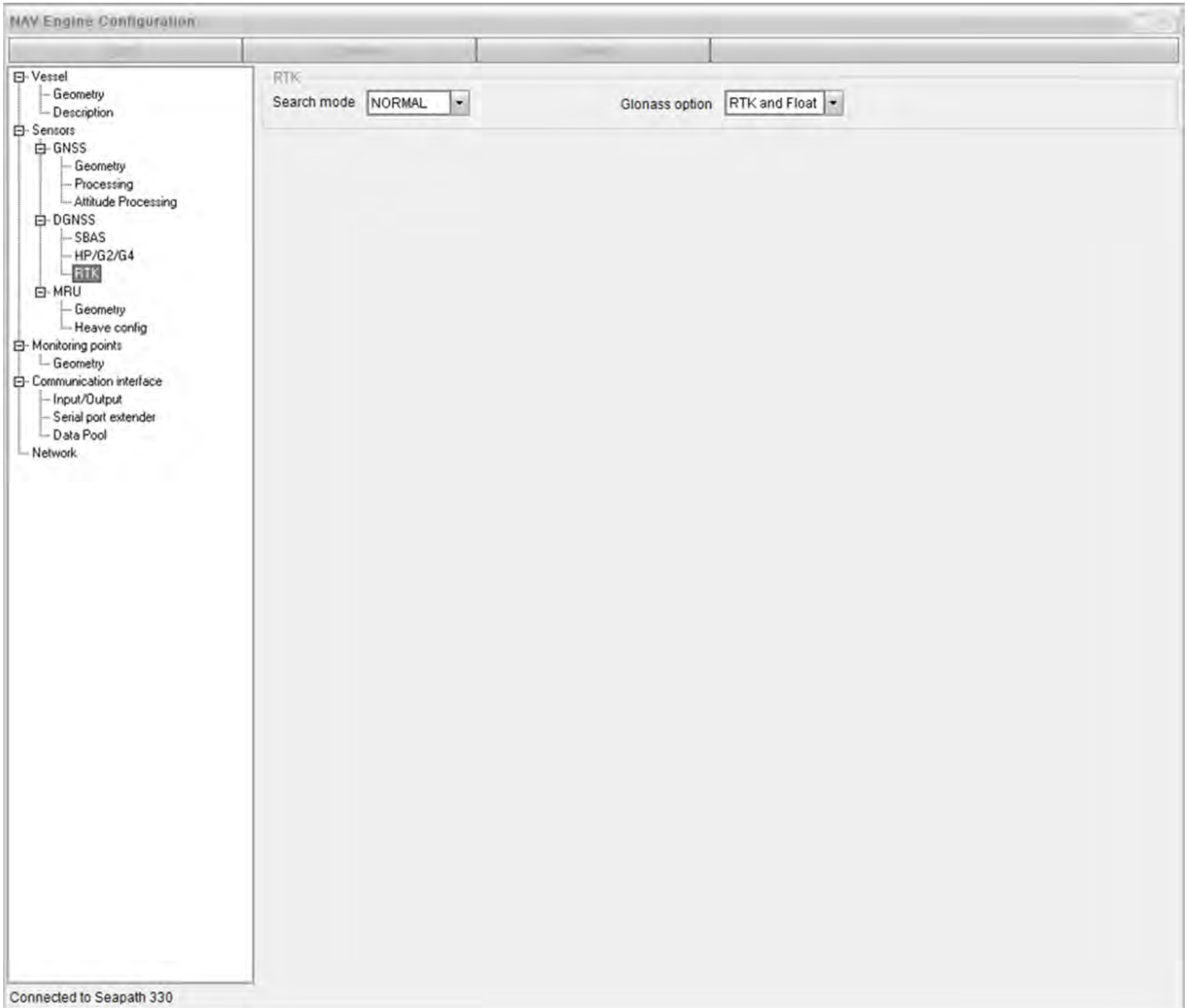
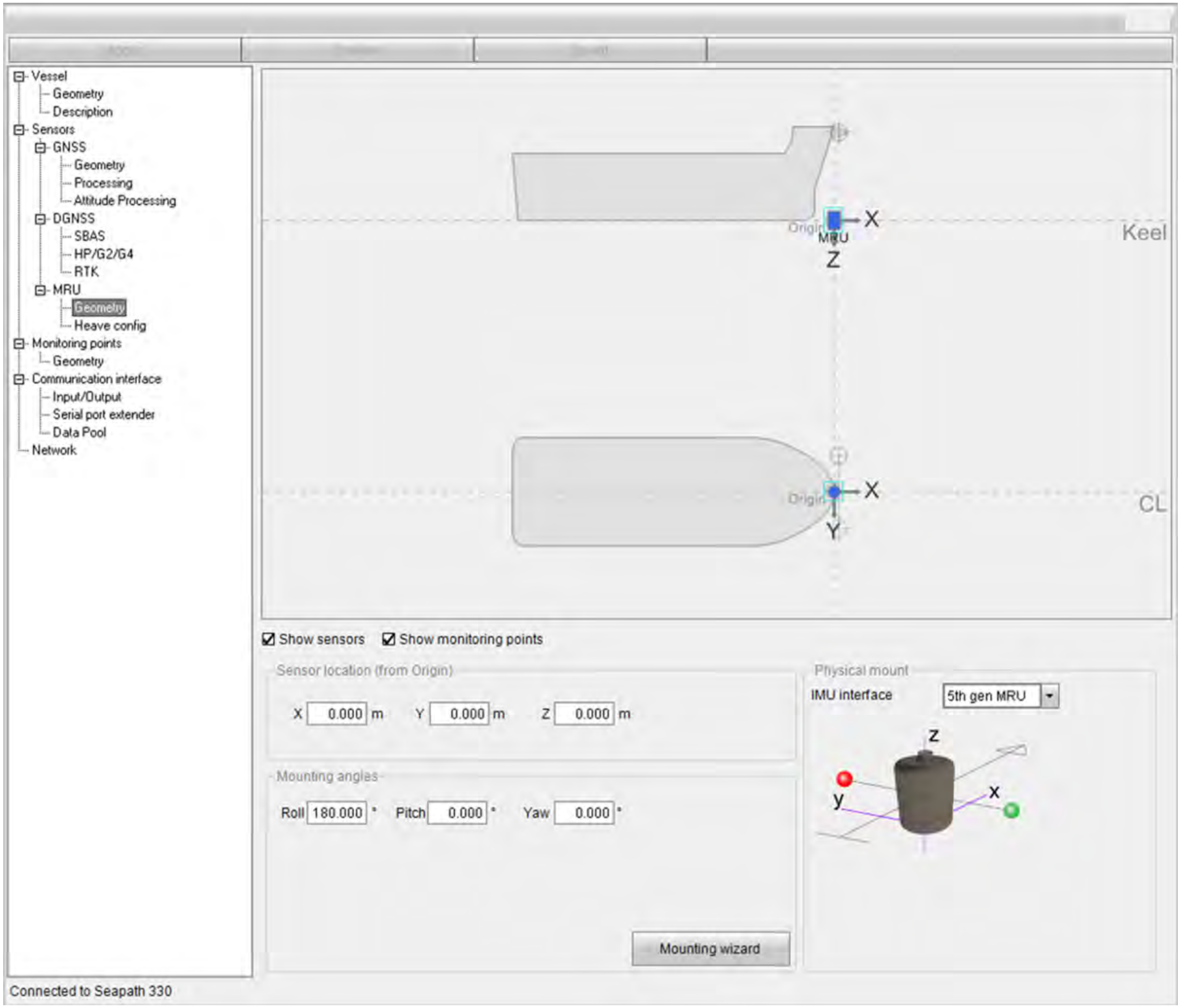
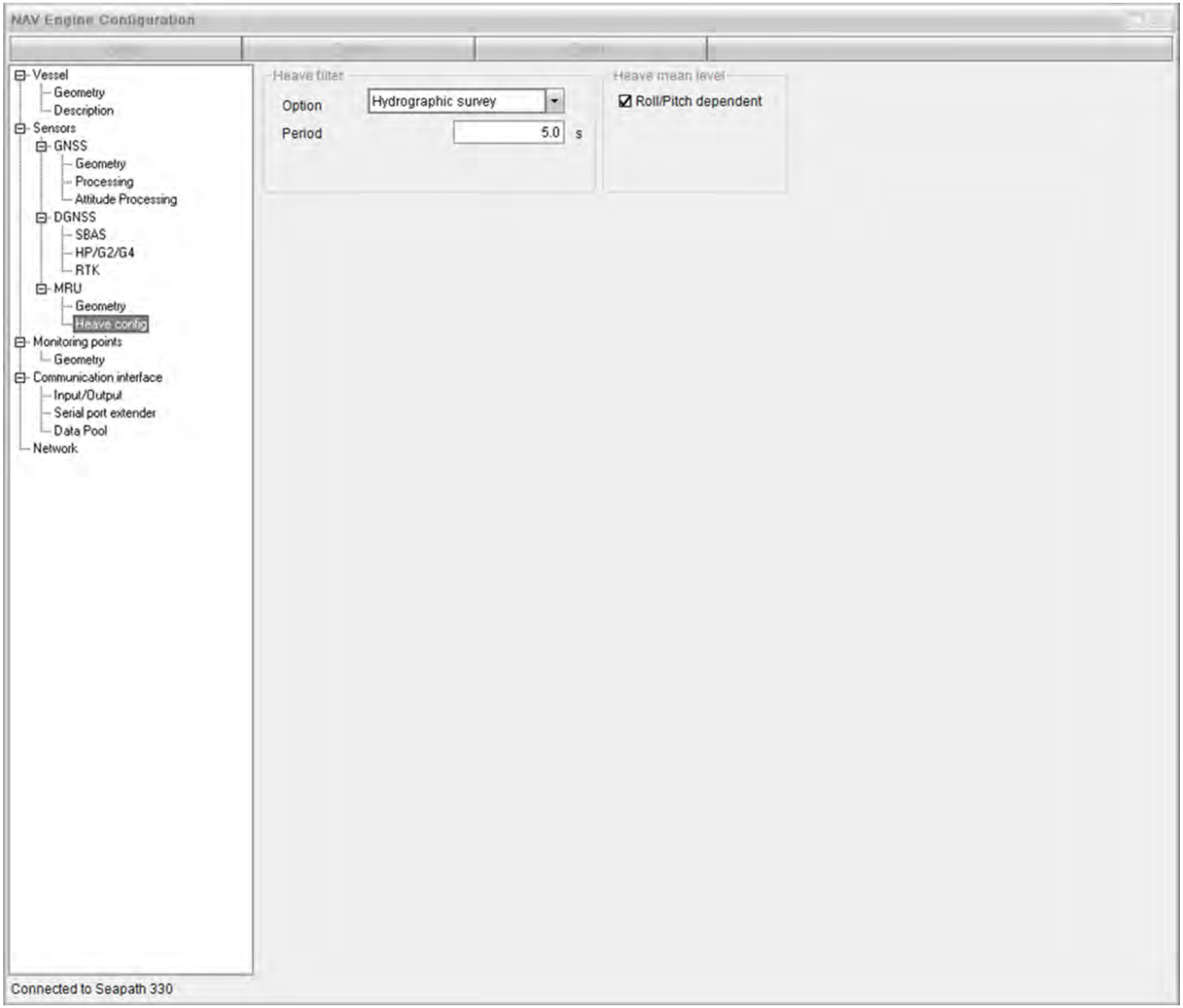
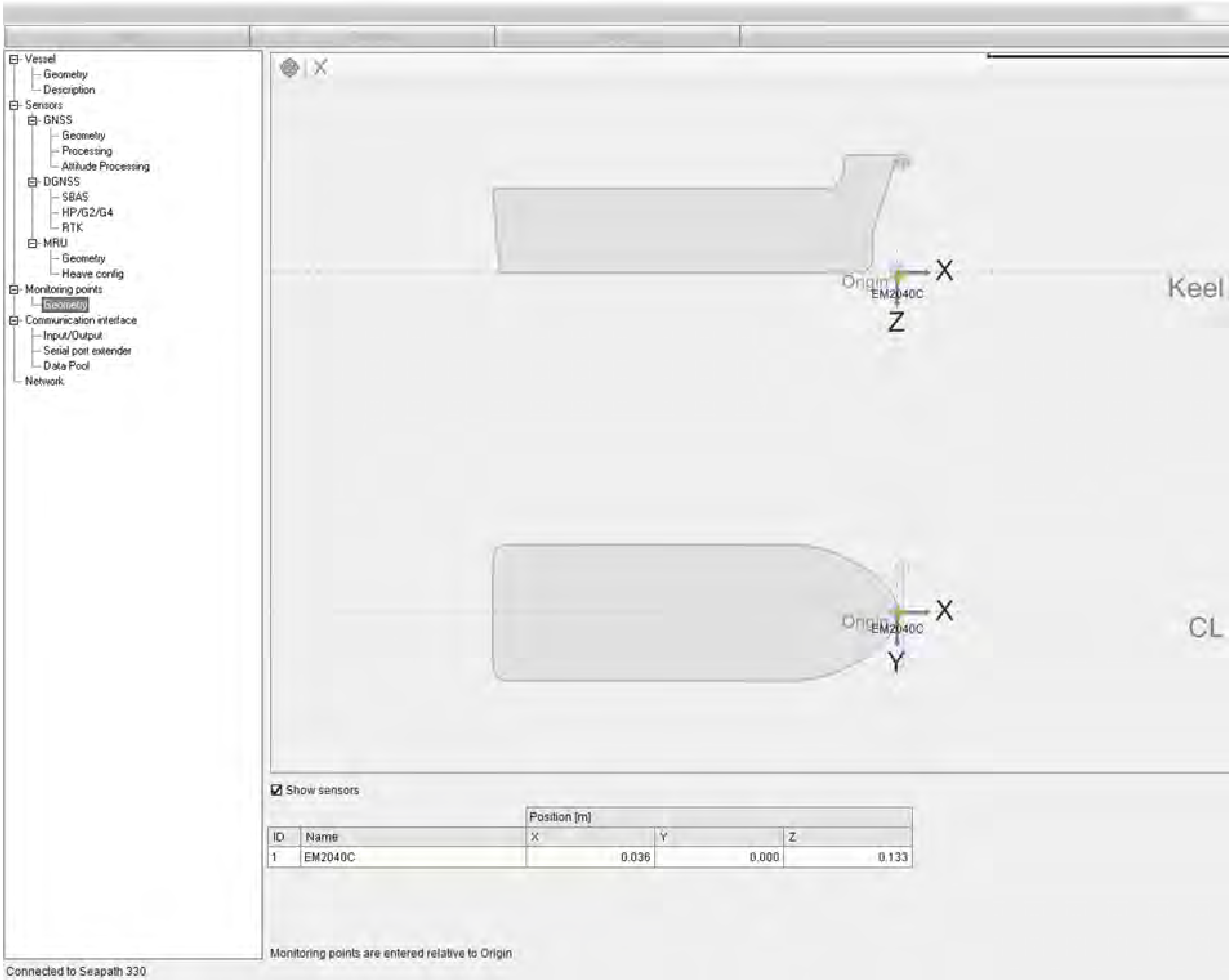
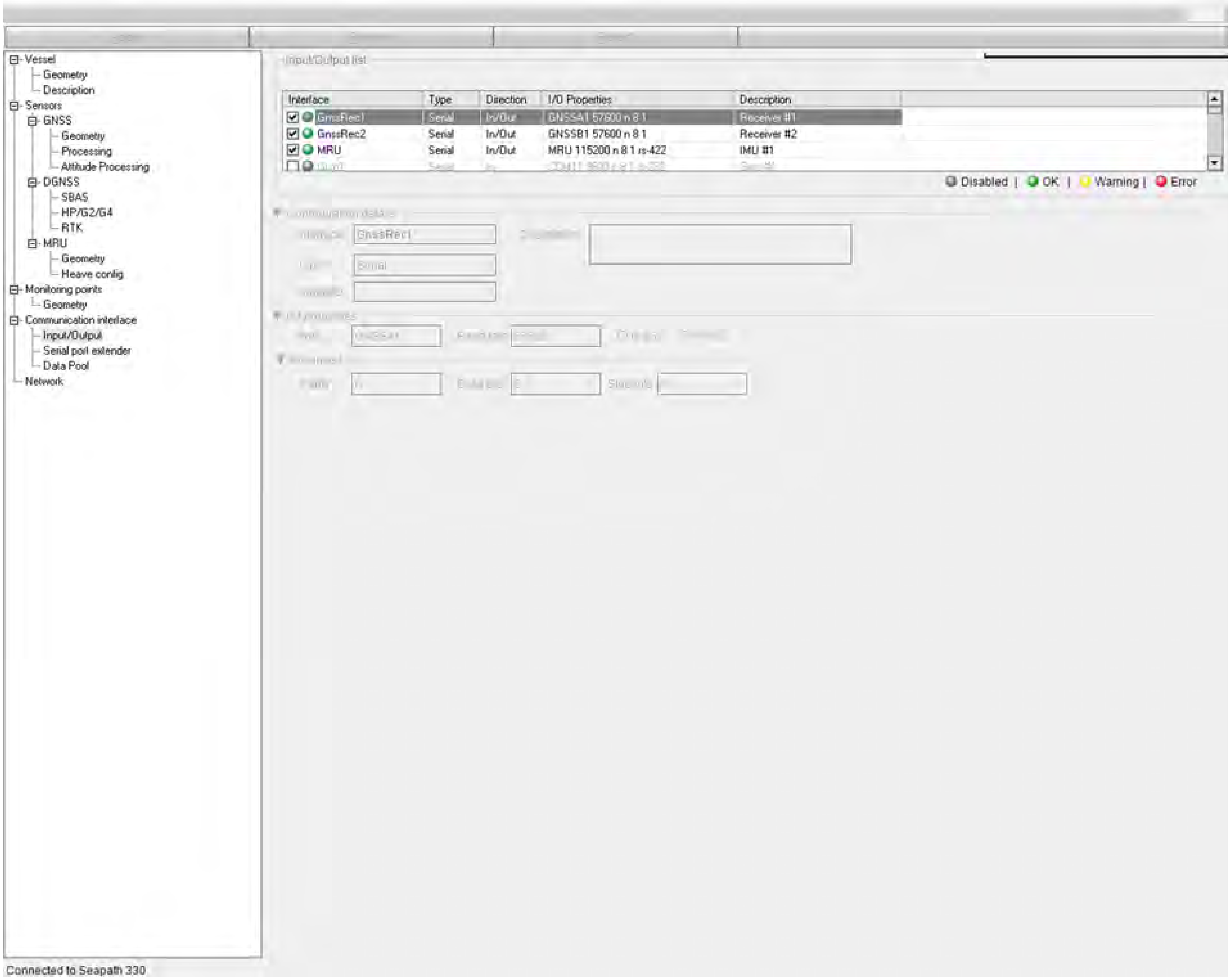
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
XP/G2/G4 processing
Enabled
Primary link
G2
DGNSS Link # 2
Use Glonass
Navigation mode
Survey mode
Connected to Seapath 330

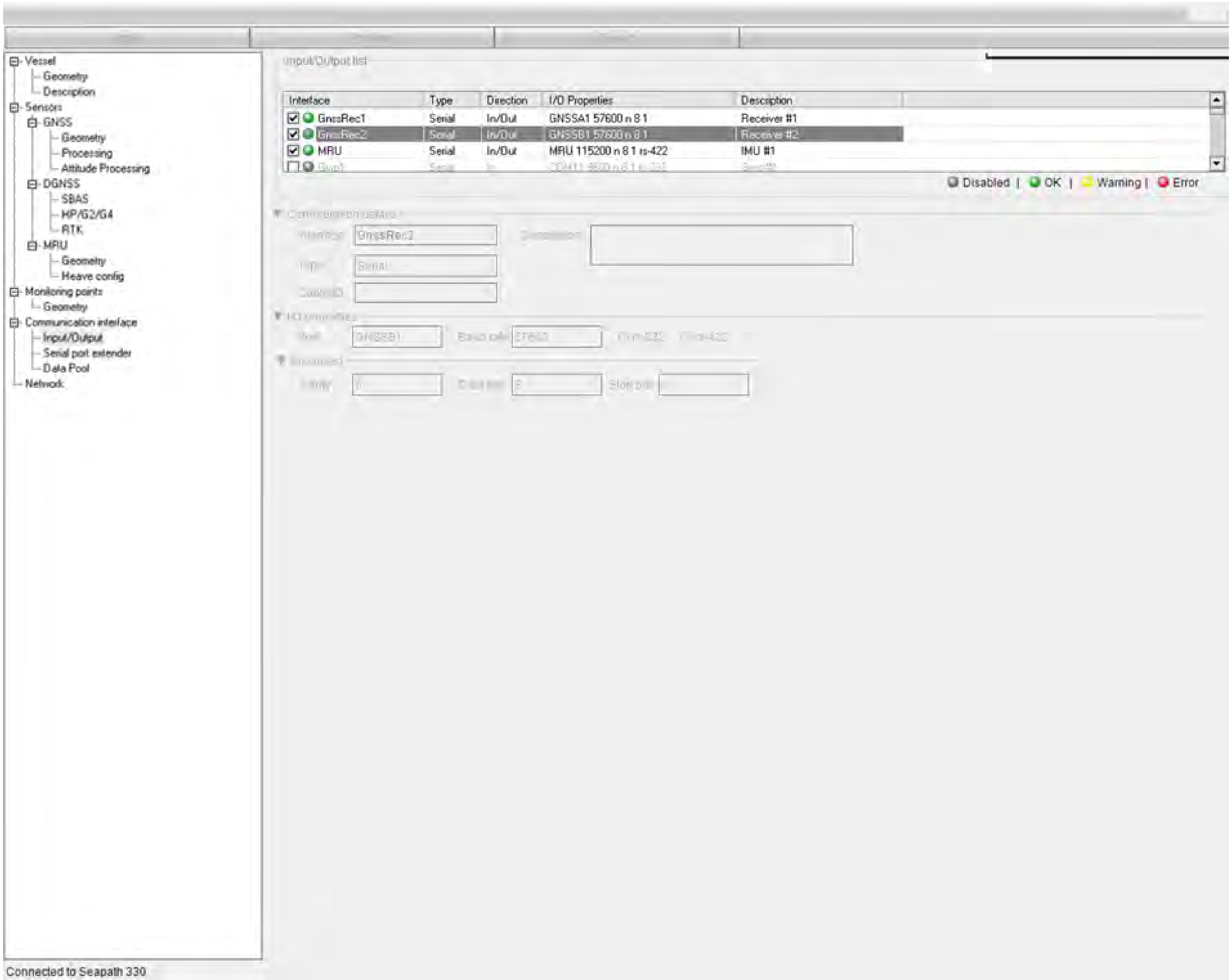

NAV Engine Configuration
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
RTK
Search mode
NORMAL
Glonass option
RTK and Float
Connected to Seapath 330

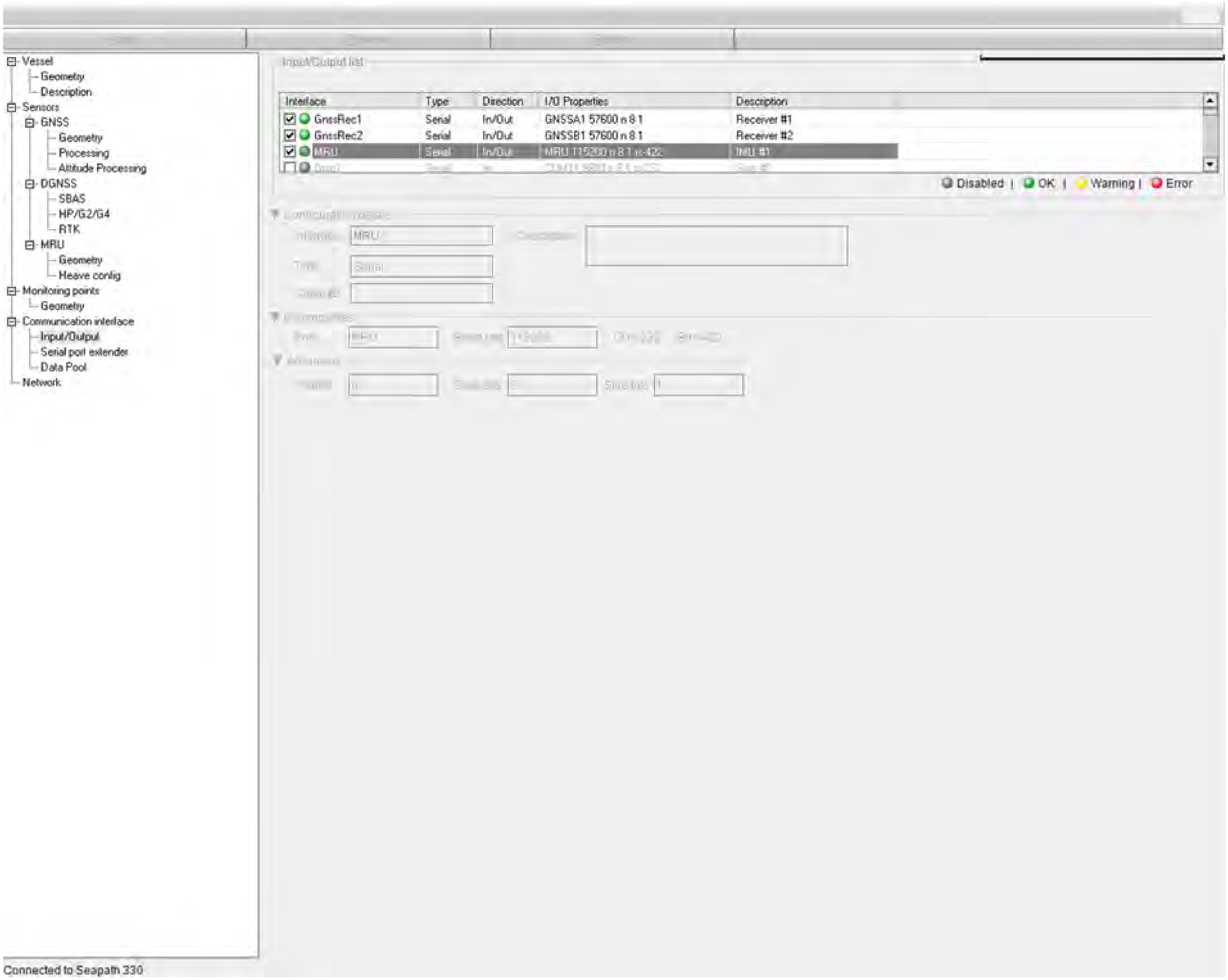

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Keel
CL
Origin
MRU
X
Z
Y
Show sensors
Show monitoring points
Sensor location (from Origin)
X 0.000 m
Y 0.000 m
Z 0.000 m
Mounting angles
Roll 180.000 °
Pitch 0.000 °
Yaw 0.000 °
Mounting wizard
Physical mount
IMU interface
5th gen MRU
Connected to Seapath 330

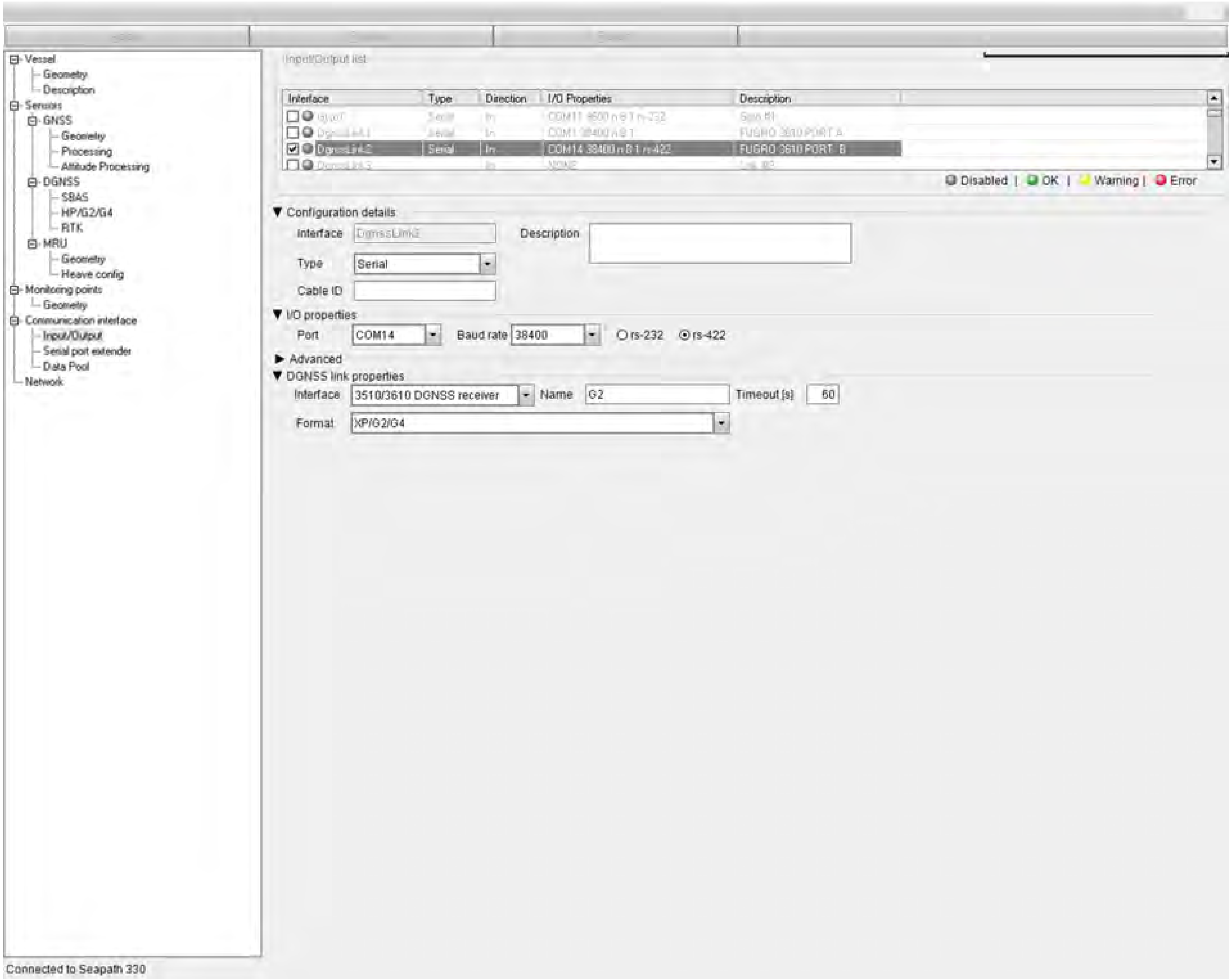

NAV Engine Configuration
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Heave filter
Option
Hydrographic survey
Period
5.0
s
Heave mean level
Roll/Pitch dependent
Connected to Seapath 330

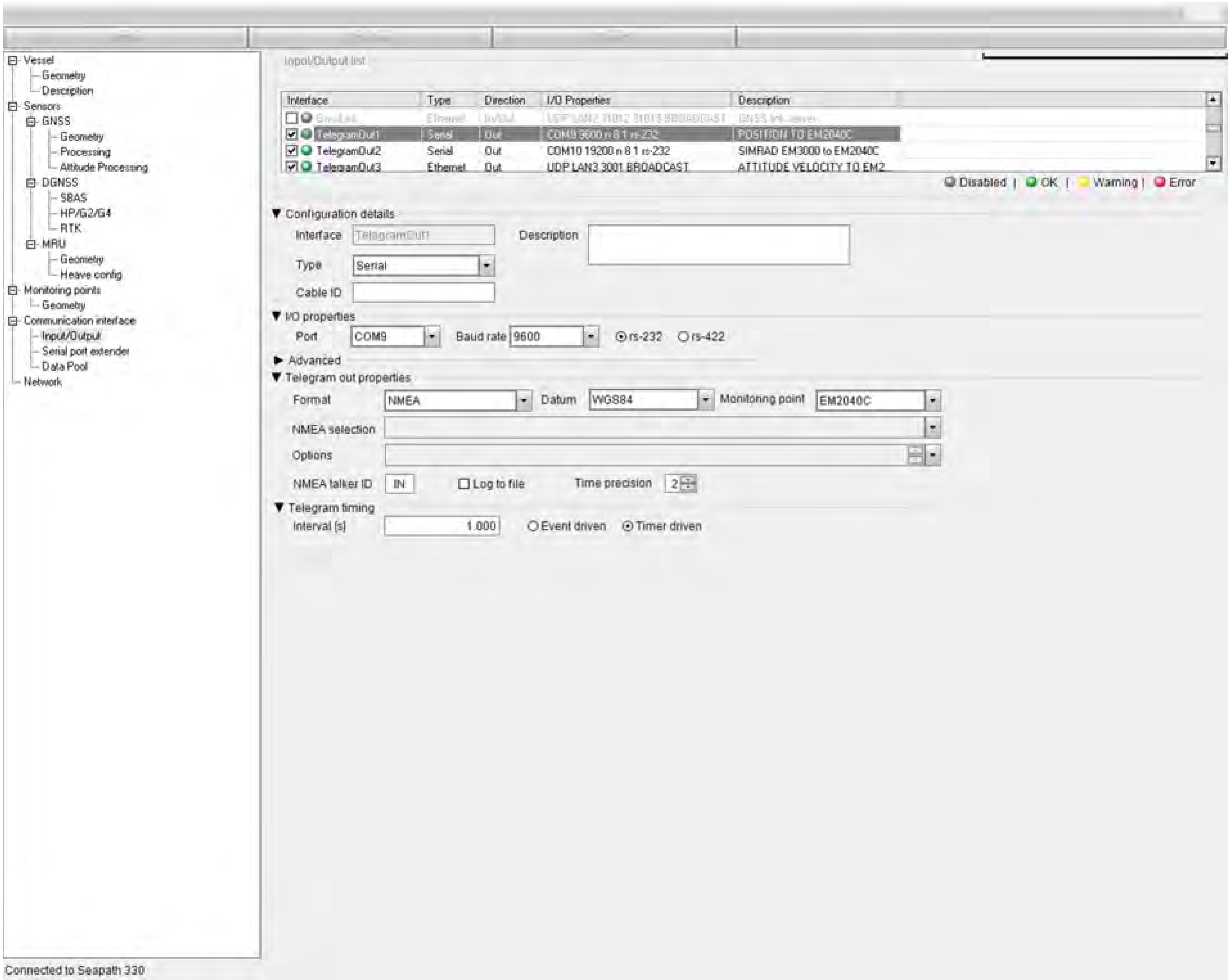

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Origin
EM2040C
X
Z
Keel
Y
CL
Show sensors
Position [m]
ID
Name
X
Y
Z
1
EM2040C
0.036
0.000
0.133
Monitoring points are entered relative to Origin
Connected to Seapath 330

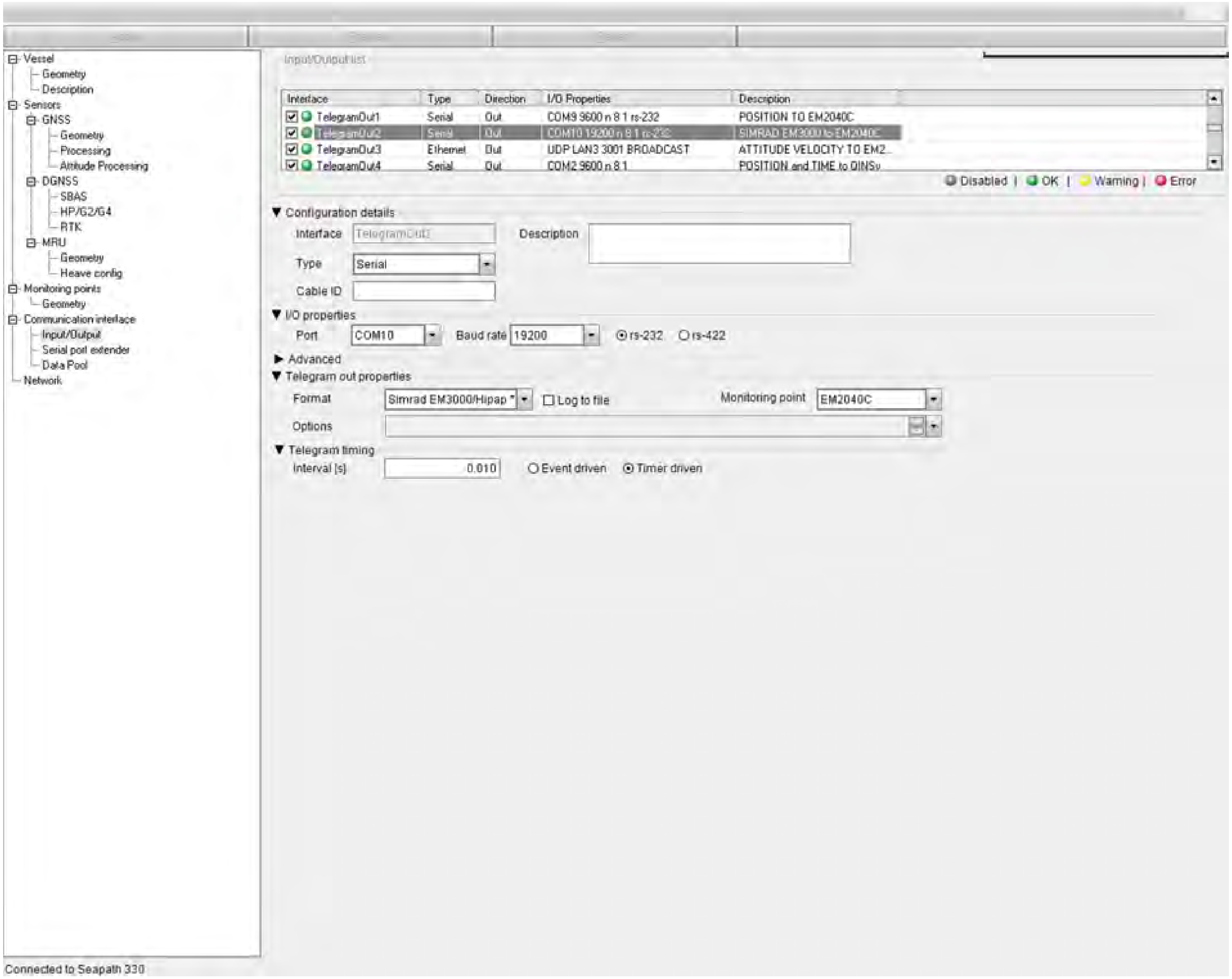

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Interface
Type
Direction
I/O Properties
Description
GnssRec1
Serial
In/Out
GNSSA1 57600 n 8 1
Receiver #1
GnssRec2
Serial
In/Out
GNSSB1 57600 n 8 1
Receiver #2
MRU
Serial
In/Out
MRU 115200 n 8 1 rs-422
IMU #1
Disabled | OK | Warning | Error
GnssRec1
Serial
Connected to Seapath 330

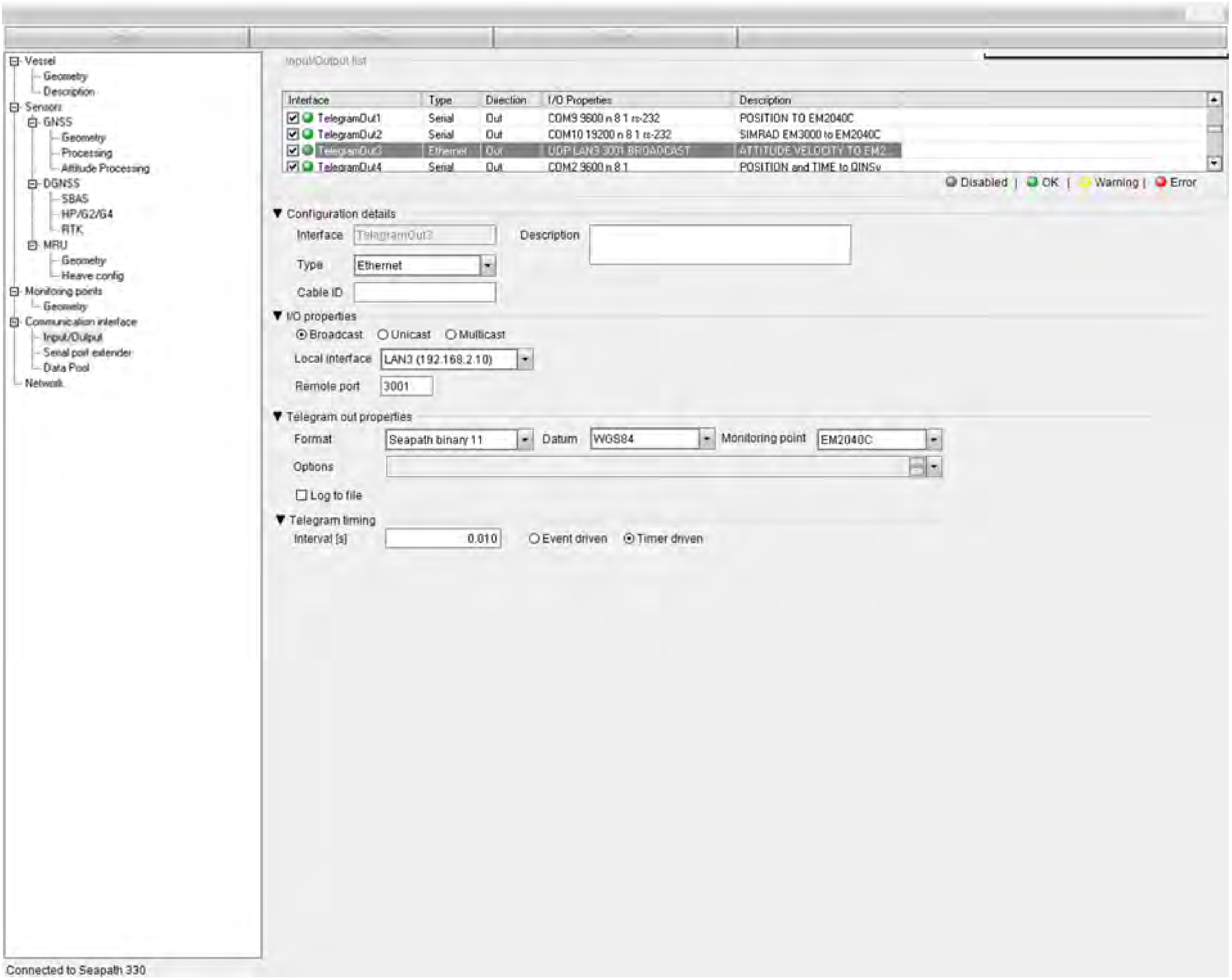

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Input/Output list
Interface | Type | Direction | I/O Properties | Description
GnssRec1 | Serial | In/Out | GNSSA1 57600 n 8 1 | Receiver #1
GnssRec2 | Serial | In/Out | GNSSB1 57600 n 8 1 | Receiver #2
MRU | Serial | In/Out | MRU 115200 n 8 1 rs-422 | IMU #1
Disabled | OK | Warning | Error
GnssRec2
Serial
GNSSB1
57600
Connected to Seapath 330

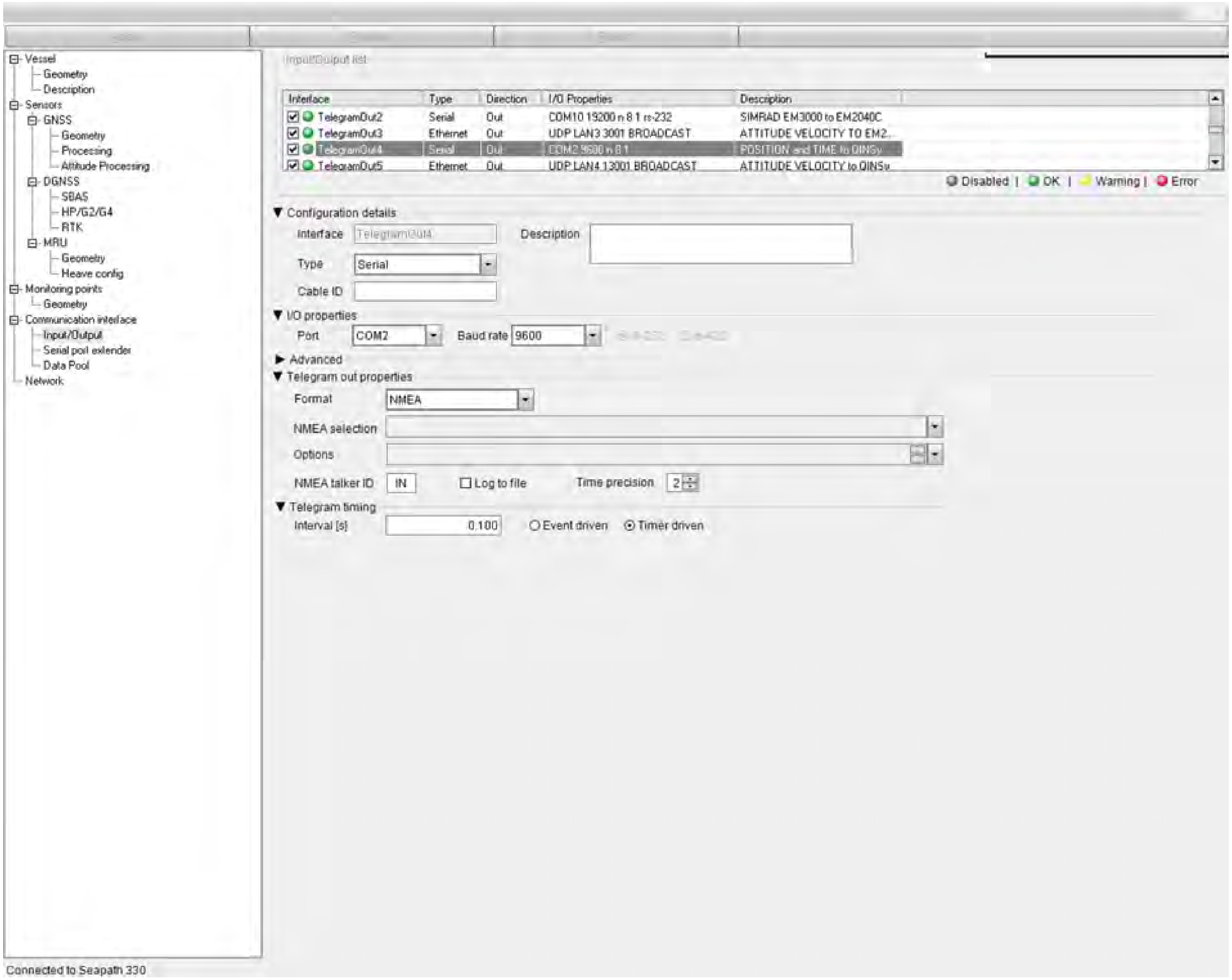

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Input/Output list
Interface
Type
Direction
I/O Properties
Description
GnssRec1
Serial
In/Out
GNSSA1 57600 n 8 1
Receiver #1
GnssRec2
Serial
In/Out
GNSSB1 57600 n 8 1
Receiver #2
MRU
Serial
In/Out
MRU 115200 n 8 1 rs-422
IMU #1
Disabled | OK | Warning | Error
Connected to Seapath 330

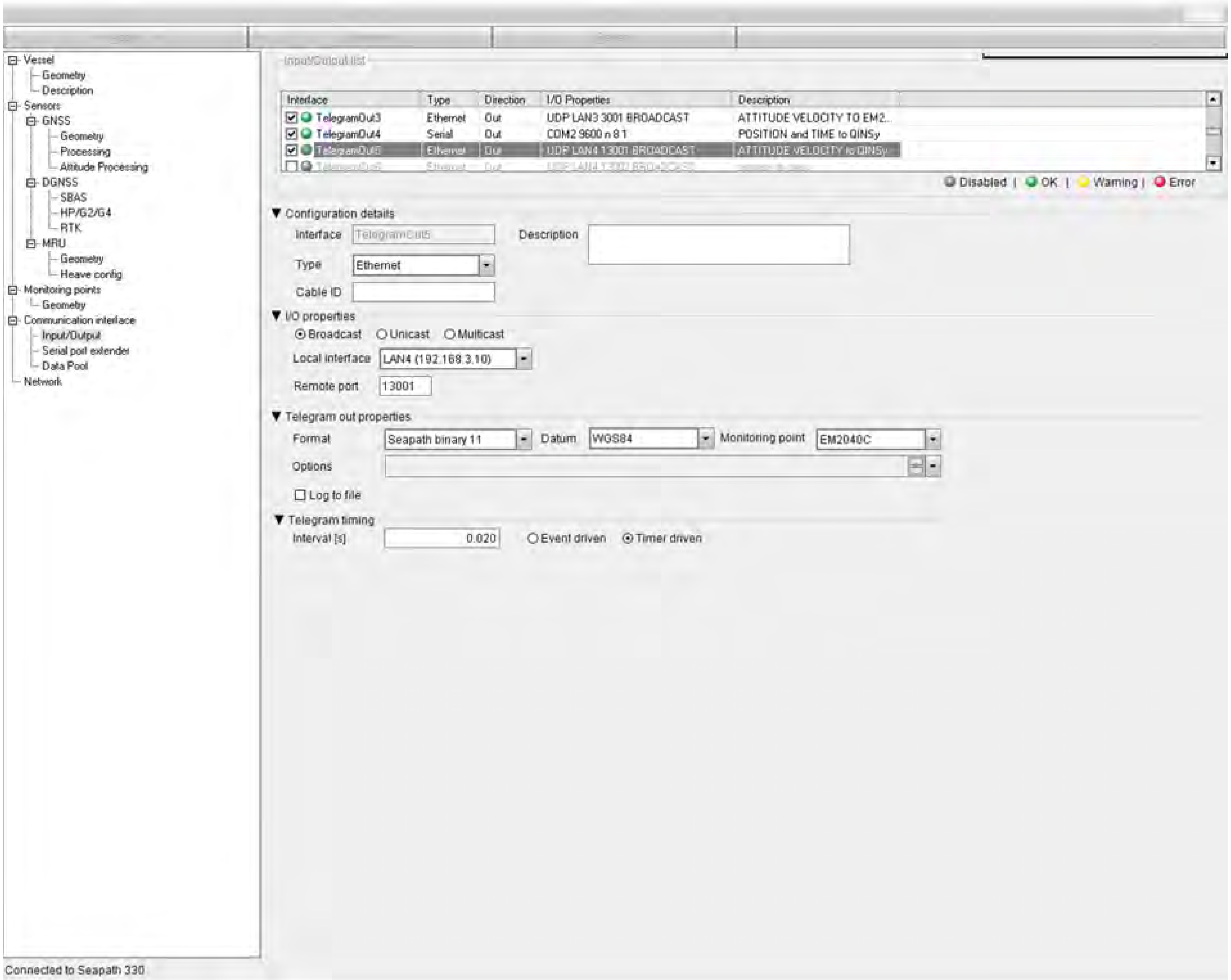

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Interface
Type
Direction
I/O Properties
Description
DgnssLink2
Serial
In
COM14 38400 n 8 1 rs-422
FUGRO 3610 PORT B
Disabled | OK | Warning | Error
Configuration details
Interface
Description
Type
Serial
Cable ID
I/O properties
Port
COM14
Baud rate
38400
rs-232
rs-422
Advanced
DGNSS link properties
Interface
3510/3610 DGNSS receiver
Name
G2
Timeout [s]
60
Format
XP/G2/G4
Connected to Seapath 330

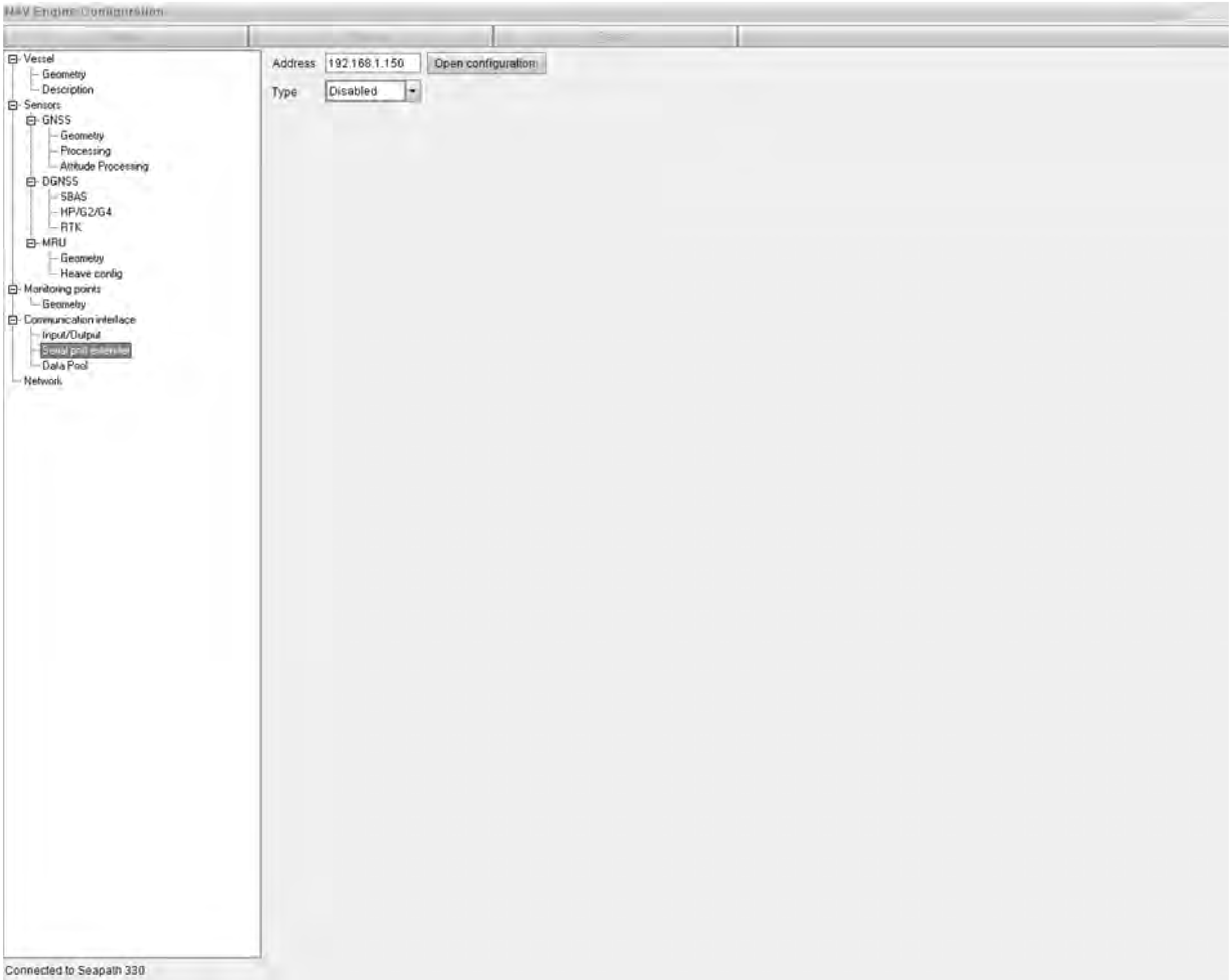

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Interface
Type
Direction
I/O Properties
Description
TelegramOut1
Serial
Out
COM9 9600 n 8 1 rs-232
POSITION TO EM2040C
TelegramOut2
Serial
Out
COM10 19200 n 8 1 rs-232
SIMRAD EM3000 to EM2040C
TelegramOut3
Ethernet
Out
UDP LAN3 3001 BROADCAST
ATTITUDE VELOCITY TO EM2
Disabled | OK | Warning | Error
Configuration details
Interface
Description
Type
Serial
Cable ID
I/O properties
Port
COM9
Baud rate
9600
rs-232
rs-422
Advanced
Telegram out properties
Format
NMEA
Datum
WGS84
Monitoring point
EM2040C
NMEA selection
Options
NMEA talker ID
IN
Log to file
Time precision
2
Telegram timing
Interval (s)
1.000
Event driven
Timer driven
Connected to Seapath 330

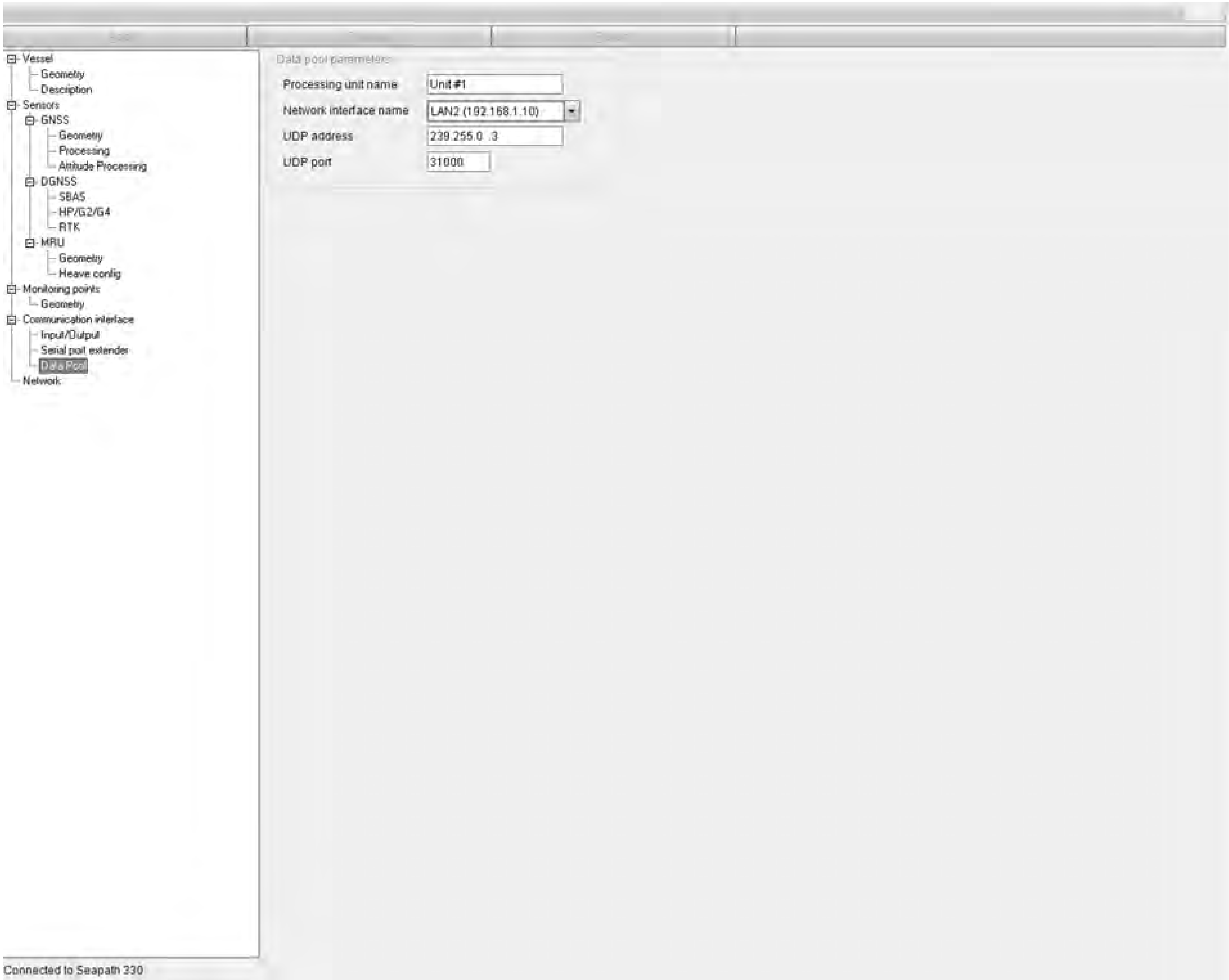

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Input/Output list
Interface
Type
Direction
I/O Properties
Description
TelegramOut1 Serial Out COM9 9600 n 8 1 rs-232 POSITION TO EM2040C
TelegramOut3 Ethernet Out UDP LAN3 3001 BROADCAST ATTITUDE VELOCITY TO EM2...
TelegramOut4 Serial Out COM2 9600 n 8 1 POSITION and TIME to QINSy
Disabled | OK | Warning | Error
Configuration details
Interface
Description
Type
Serial
Cable ID
I/O properties
Port
COM10
Baud rate
19200
rs-232
rs-422
Advanced
Telegram out properties
Format
Simrad EM3000/Hipap
Log to file
Monitoring point
EM2040C
Options
Telegram timing
Interval [s]
0.010
Event driven
Timer driven
Connected to Seapath 330

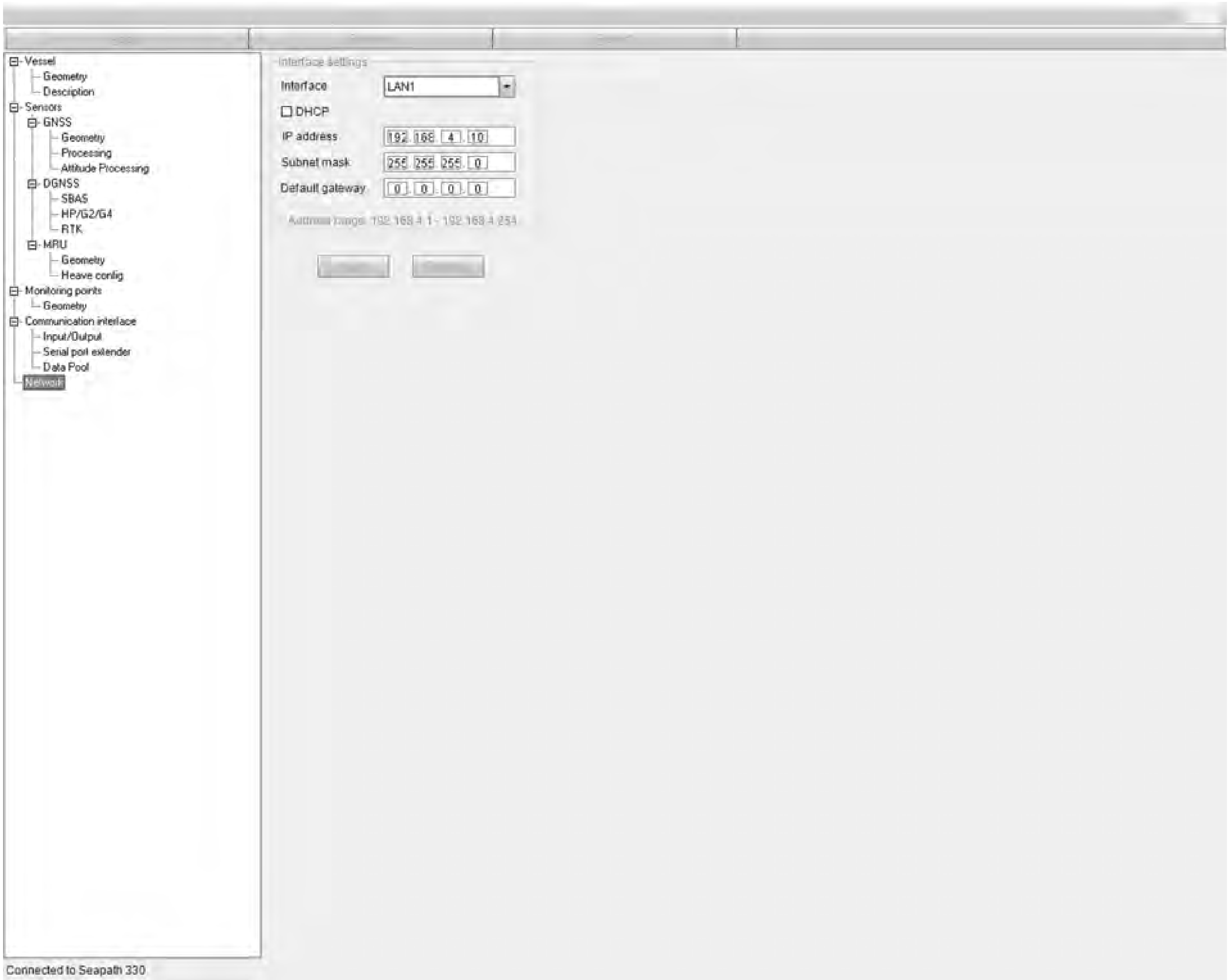

Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Input/Output list
Interface
Type
Direction
I/O Properties
Description
TelegramOut1
Serial
Out
COM9 9600 n 8 1 rs-232
POSITION TO EM2040C
TelegramOut2
Serial
Out
COM10 19200 n 8 1 rs-232
SIMRAD EM3000 to EM2040C
TelegramOut3
Ethernet
Out
UDP LAN3 3001 BROADCAST
ATTITUDE VELOCITY TO EM2...
TelegramOut4
Serial
Out
COM2 9600 n 8 1
POSITION and TIME to QINSy
Disabled | OK | Warning | Error
Configuration details
Interface
TelegramOut3
Description
Type
Ethernet
Cable ID
I/O properties
Broadcast
Unicast
Multicast
Local interface
LAN3 (192.168.2.10)
Remote port
3001
Telegram out properties
Format
Seapath binary 11
Datum
WGS84
Monitoring point
EM2040C
Options
Log to file
Telegram timing
Interval [s]
0.010
Event driven
Timer driven
Connected to Seapath 330


Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Interface
Type
Direction
I/O Properties
Description
TelegramOut2
Serial
Out
COM10 19200 n 8 1 rs-232
SIMRAD EM3000 to EM2040C
TelegramOut3
Ethernet
Out
UDP LAN3 3001 BROADCAST
ATTITUDE VELOCITY TO EM2...
TelegramOut4
Serial
Out
COM2 9600 n 8 1
POSITION and TIME to QINSy
TelegramOut5
Ethernet
Out
UDP LAN4 13001 BROADCAST
ATTITUDE VELOCITY to QINSy
Disabled | OK | Warning | Error
Configuration details
Interface
Description
Type
Serial
Cable ID
I/O properties
Port
COM2
Baud rate
9600
Advanced
Telegram out properties
Format
NMEA
NMEA selection
Options
NMEA talker ID
IN
Log to file
Time precision
2
Telegram timing
Interval [s]
0.100
Event driven
Timer driven
Connected to Seapath 330


Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Connected to Seapath 330
Interface
Type
Direction
I/O Properties
Description
TelegramOut3
Ethernet
Out
UDP LAN3 3001 BROADCAST
ATTITUDE VELOCITY TO EM2...
TelegramOut4
Serial
Out
COM2 9600 n 8 1
POSITION and TIME to QINSy
UDP LAN4 13001 BROADCAST
ATTITUDE VELOCITY to QINSy
Disabled | OK | Warning | Error
Configuration details
Interface
Description
Type
Ethernet
Cable ID
I/O properties
Broadcast
Unicast
Multicast
Local interface
LAN4 (192.168.3.10)
Remote port
13001
Telegram out properties
Format
Seapath binary 11
Datum
WGS84
Monitoring point
EM2040C
Options
Log to file
Telegram timing
Interval [s]
0.020
Event driven
Timer driven


Address
192.168.1.150
Open configuration
Type
Disabled
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Data Pool
Network
Connected to Seapath 330


Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Data pool parameters
Processing unit name
Unit #1
Network interface name
LAN2 (192.168.1.10)
UDP address
239.255.0 .3
UDP port
31000
Connected to Seapath 330


Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
HP/G2/G4
RTK
MRU
Geometry
Heave config
Monitoring points
Geometry
Communication interface
Input/Output
Serial port extender
Data Pool
Network
Interface settings
Interface
LAN1
DHCP
IP address
192.168.4.10
Subnet mask
255.255.255.0
Default gateway
0.0.0.0
Connected to Seapath 330

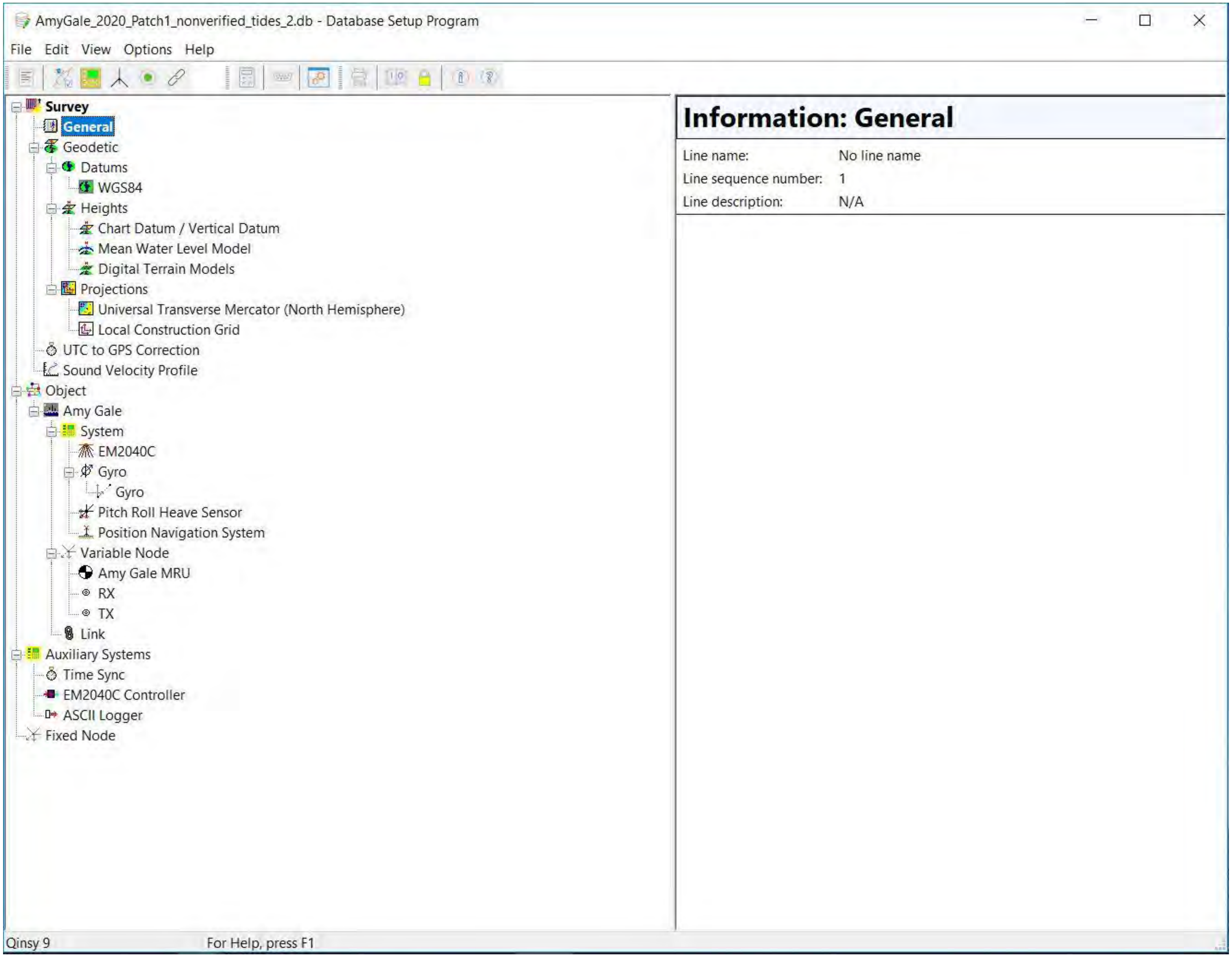
Appendix D – Template database settings in Qinsy (for acquisition)

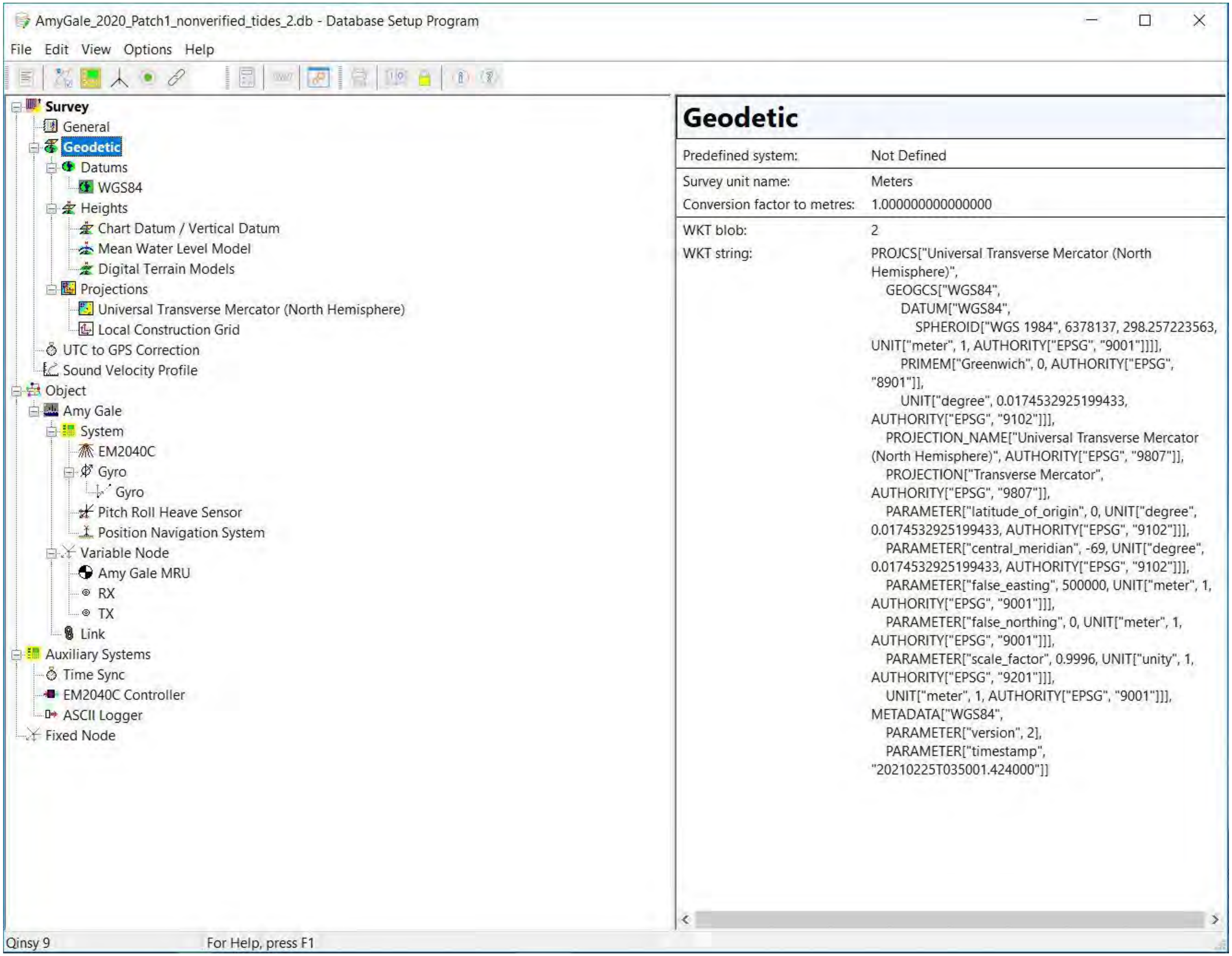
Note: Depicted Qinsy template settings show configuration from a 2020 survey project. All settings remain the same for the seasons described in this report apart from changes to pitch, roll, heading for EM2040C from patch test results (Table 4), as well as latency offsets applied to Position Navigation Systems and Motion Reference output values.

Qinsy uses the following reference frame conventions (these differ from those used by Seapath 330):

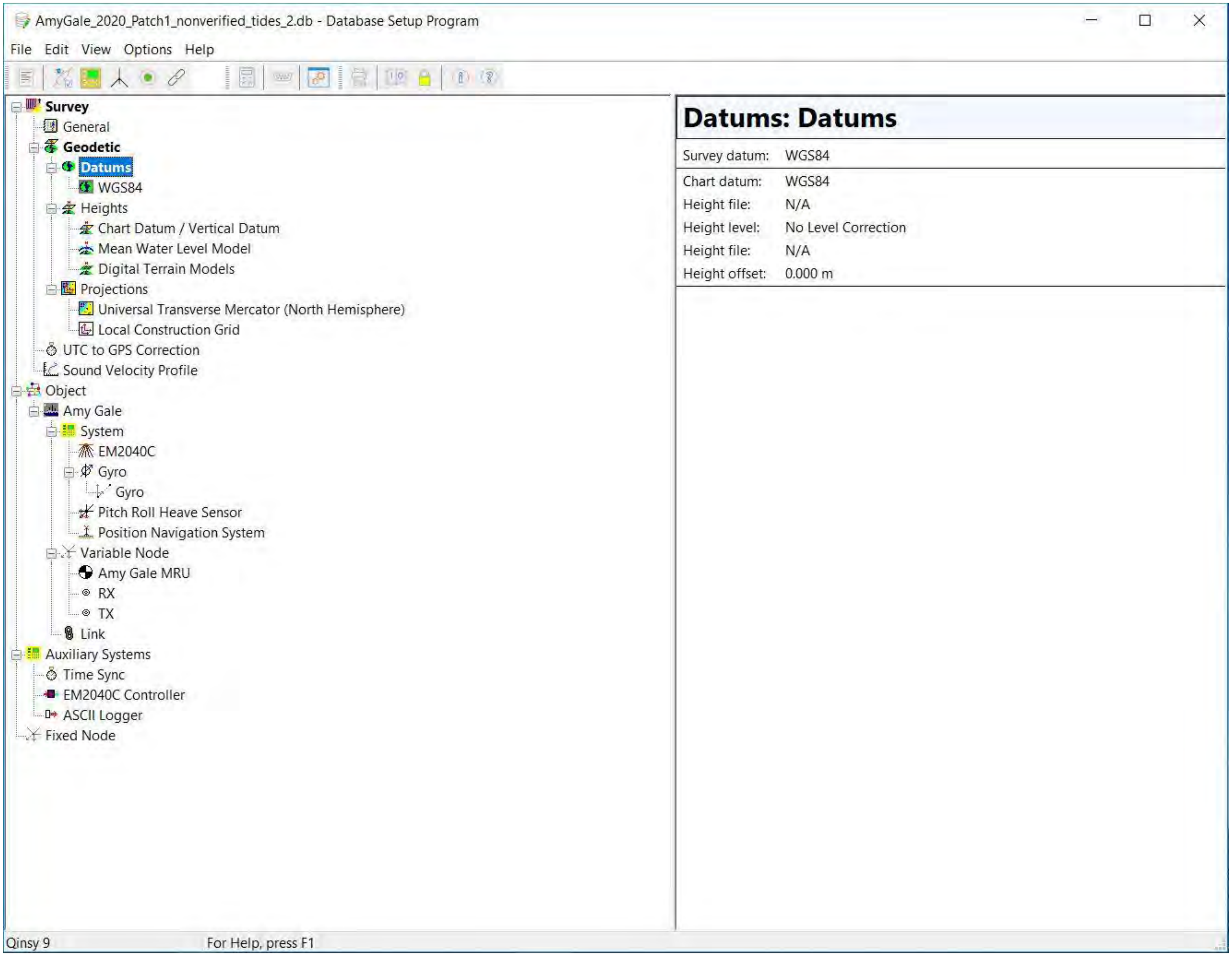
Pitch rotation: + bow up
Roll rotation: + heeling to starboard
Heave: + upwards

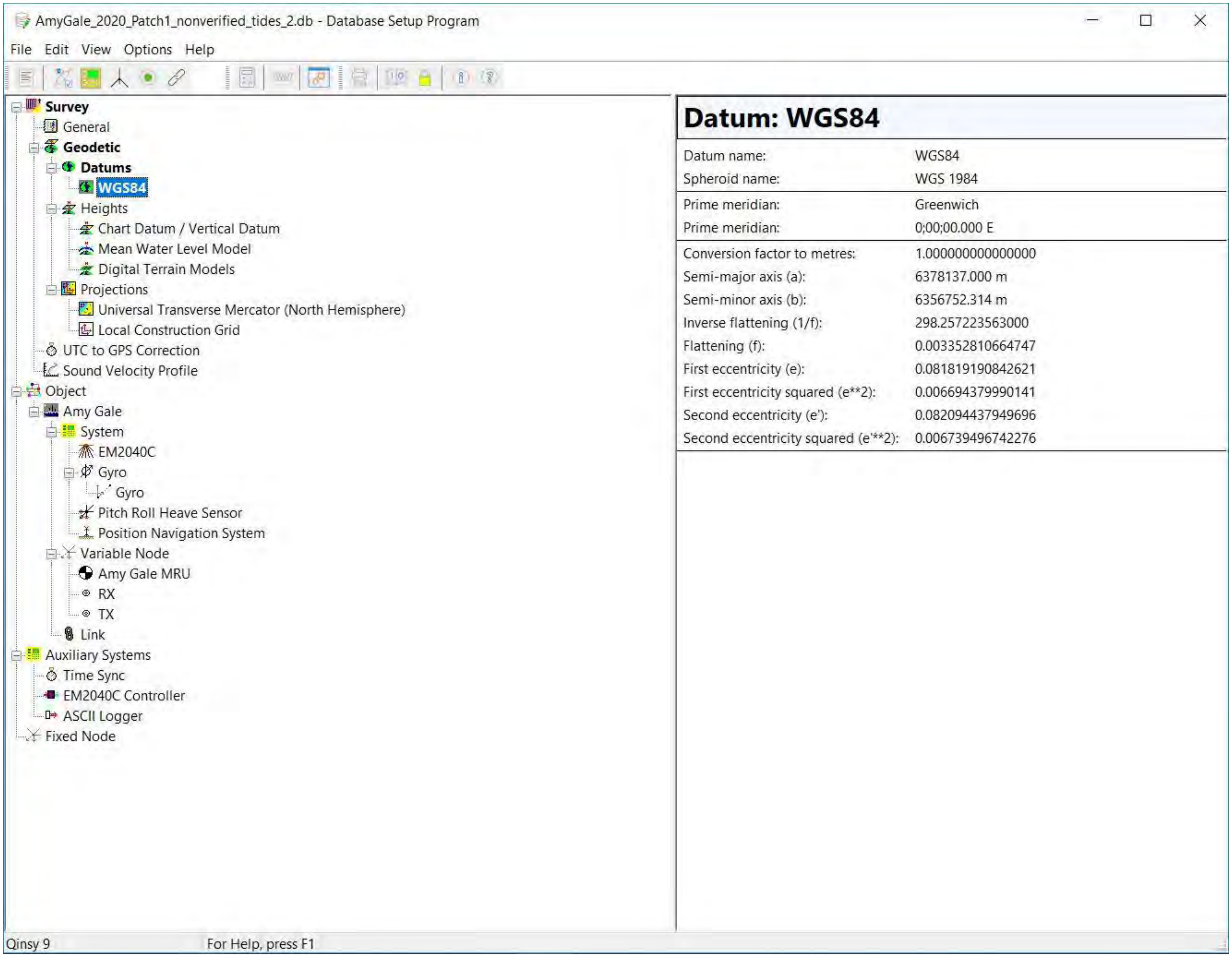
X: + to starboard
Y: + towards bow
Z: + up

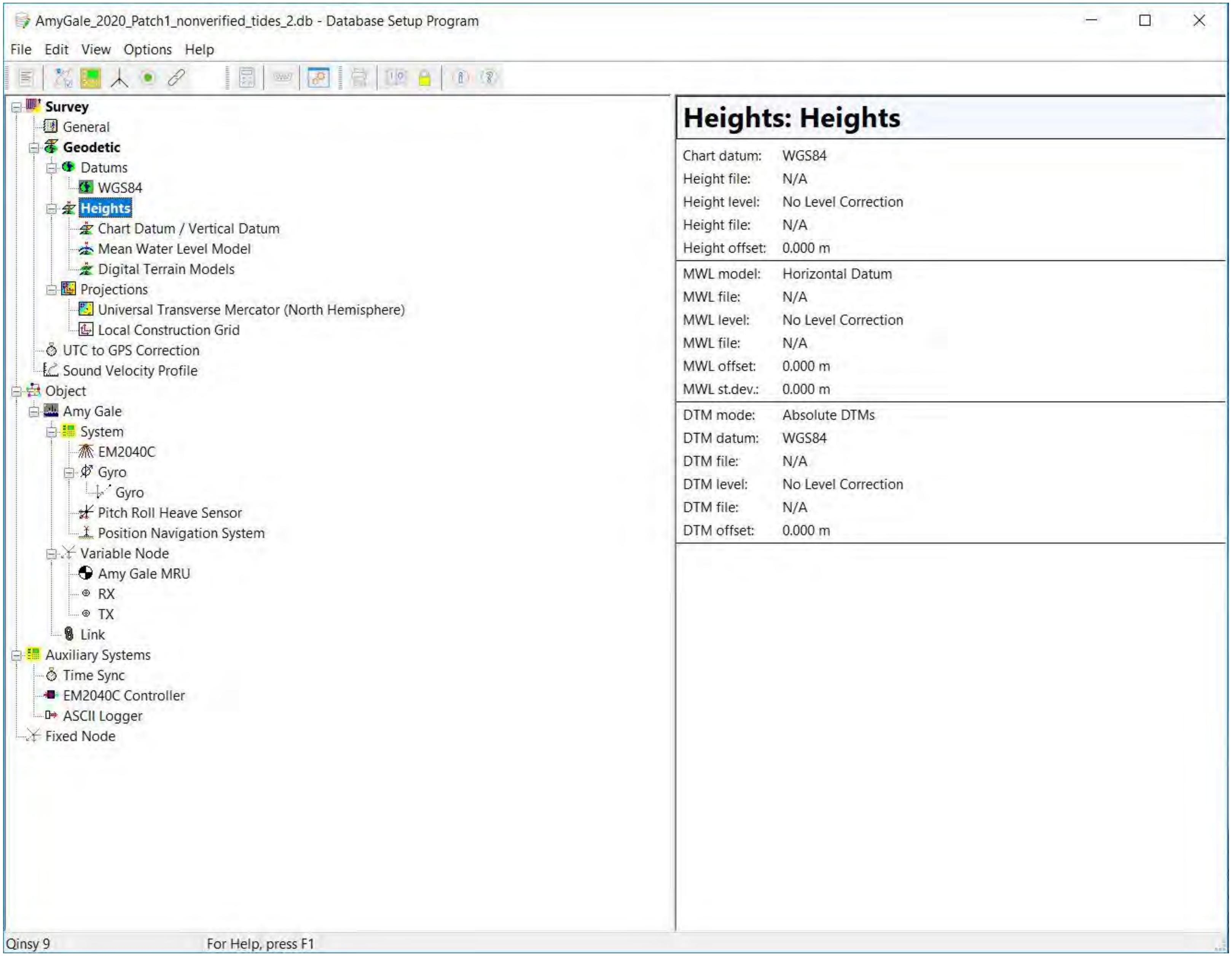

AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Information: General
Line name: No line name
Line sequence number: 1
Line description: N/A
Qinsy 9
For Help, press F1

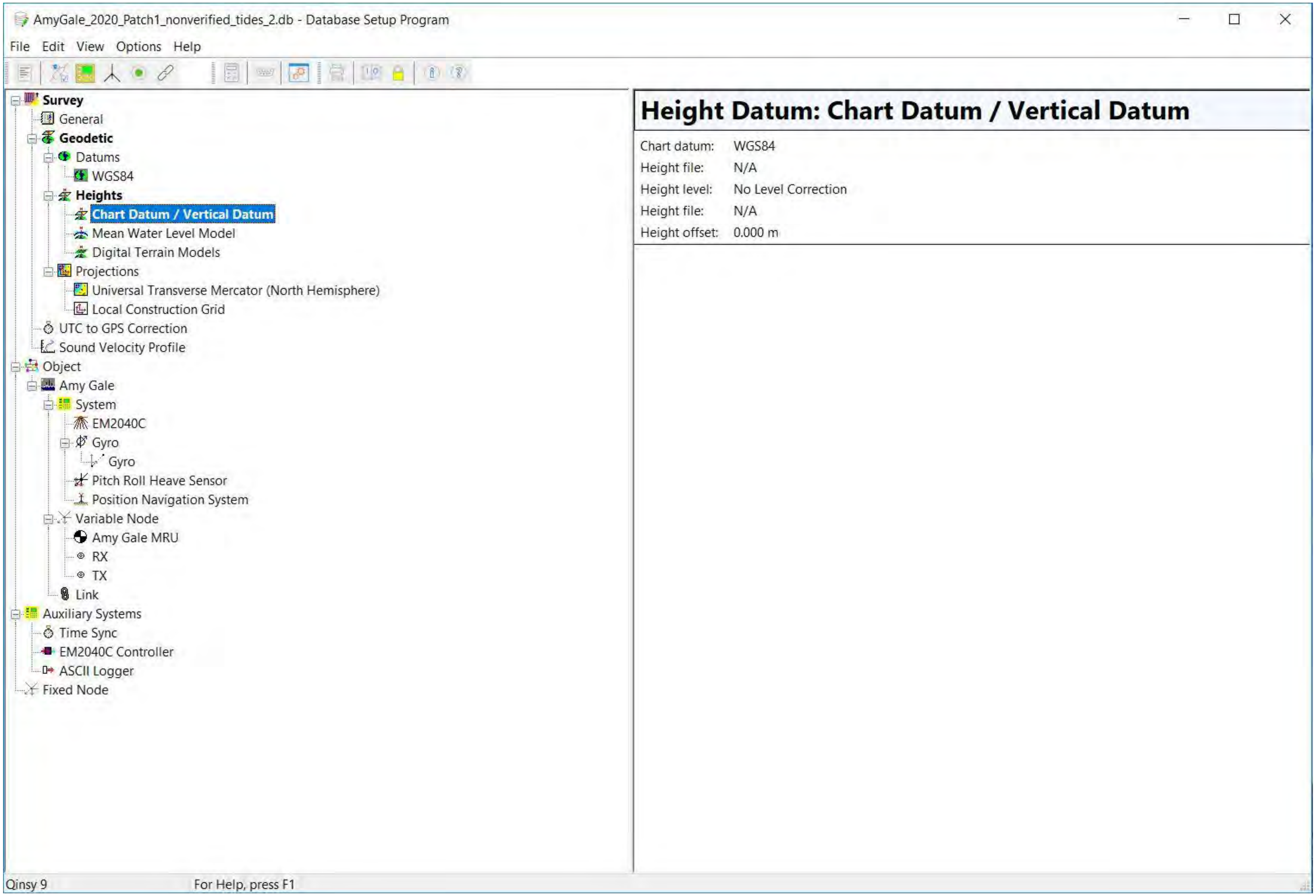


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Geodetic
Predefined system: Not Defined
Survey unit name: Meters
Conversion factor to metres: 1.000000000000000
WKT blob: 2
WKT string: PROJCS["Universal Transverse Mercator (North Hemisphere)",
GEOGCS["WGS84",
DATUM["WGS84",
SPHEROID["WGS 1984", 6378137, 298.257223563, UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]]],
PRIMEM["Greenwich", 0, AUTHORITY["EPSG", "8901"]],
UNIT["degree", 0.0174532925199433, AUTHORITY["EPSG", "9102"]]],
PROJECTION_NAME["Universal Transverse Mercator (North Hemisphere)", AUTHORITY["EPSG", "9807"]],
PROJECTION["Transverse Mercator", AUTHORITY["EPSG", "9807"]],
PARAMETER["latitude_of_origin", 0, UNIT["degree", 0.0174532925199433, AUTHORITY["EPSG", "9102"]]],
PARAMETER["central_meridian", -69, UNIT["degree", 0.0174532925199433, AUTHORITY["EPSG", "9102"]]],
PARAMETER["false_easting", 500000, UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]],
PARAMETER["false_northing", 0, UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]],
PARAMETER["scale_factor", 0.9996, UNIT["unity", 1, AUTHORITY["EPSG", "9201"]]],
UNIT["meter", 1, AUTHORITY["EPSG", "9001"]]],
METADATA["WGS84",
PARAMETER["version", 2],
PARAMETER["timestamp", "20210225T035001.424000"]]
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Datums: Datums
Survey datum: WGS84
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Datum: WGS84
Datum name: WGS84
Spheroid name: WGS 1984
Prime meridian: Greenwich
Prime meridian: 0;00;00.000 E
Conversion factor to metres: 1.000000000000000
Semi-major axis (a): 6378137.000 m
Semi-minor axis (b): 6356752.314 m
Inverse flattening (1/f): 298.257223563000
Flattening (f): 0.003352810664747
First eccentricity (e): 0.081819190842621
First eccentricity squared (e**2): 0.006694379990141
Second eccentricity (e'): 0.082094437949696
Second eccentricity squared (e'**2): 0.006739496742276
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Heights: Heights
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
MWL model: Horizontal Datum
MWL file: N/A
MWL level: No Level Correction
MWL file: N/A
MWL offset: 0.000 m
MWL st.dev.: 0.000 m
DTM mode: Absolute DTMs
DTM datum: WGS84
DTM file: N/A
DTM level: No Level Correction
DTM file: N/A
DTM offset: 0.000 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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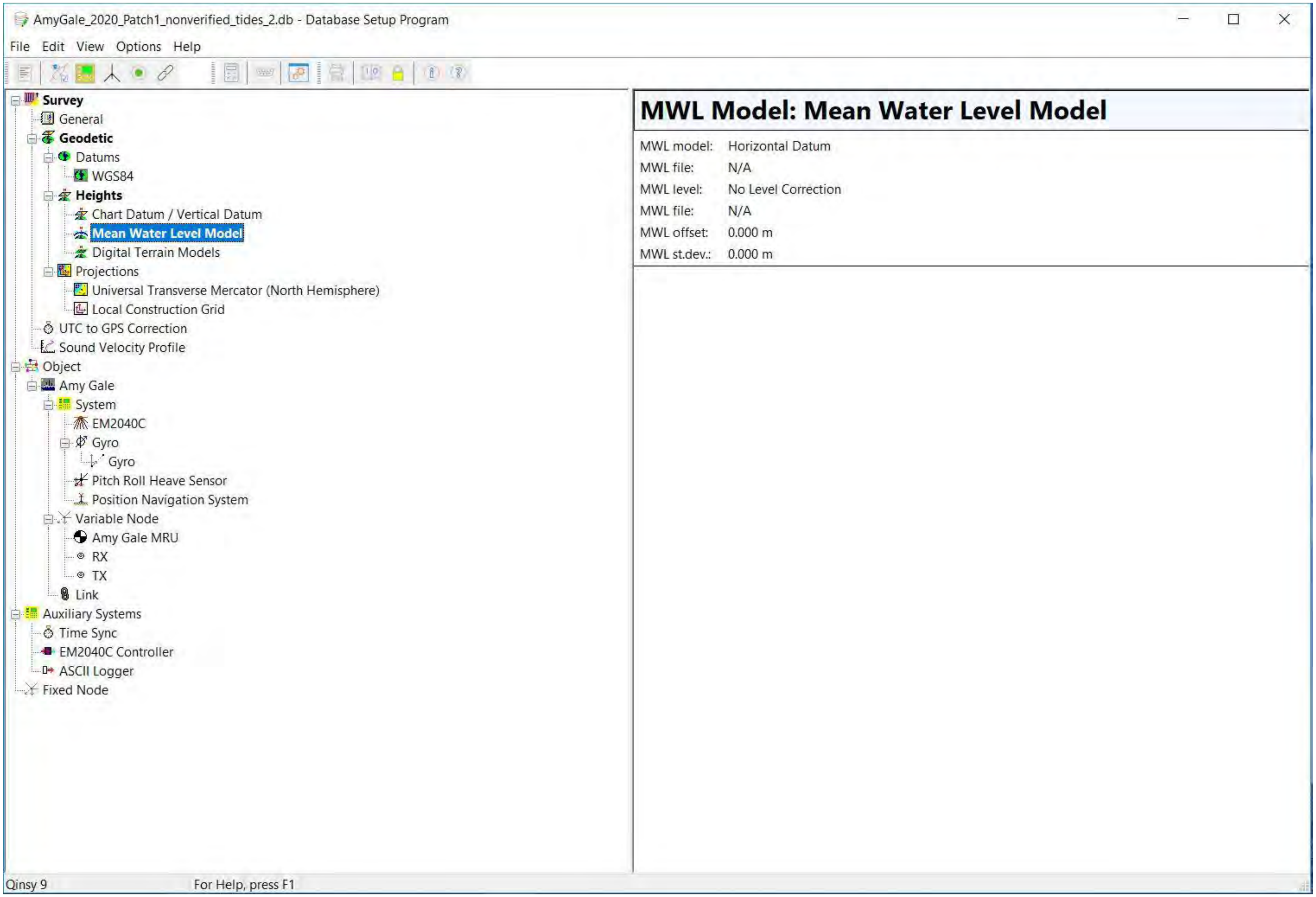
Height Datum: Chart Datum / Vertical Datum
Chart datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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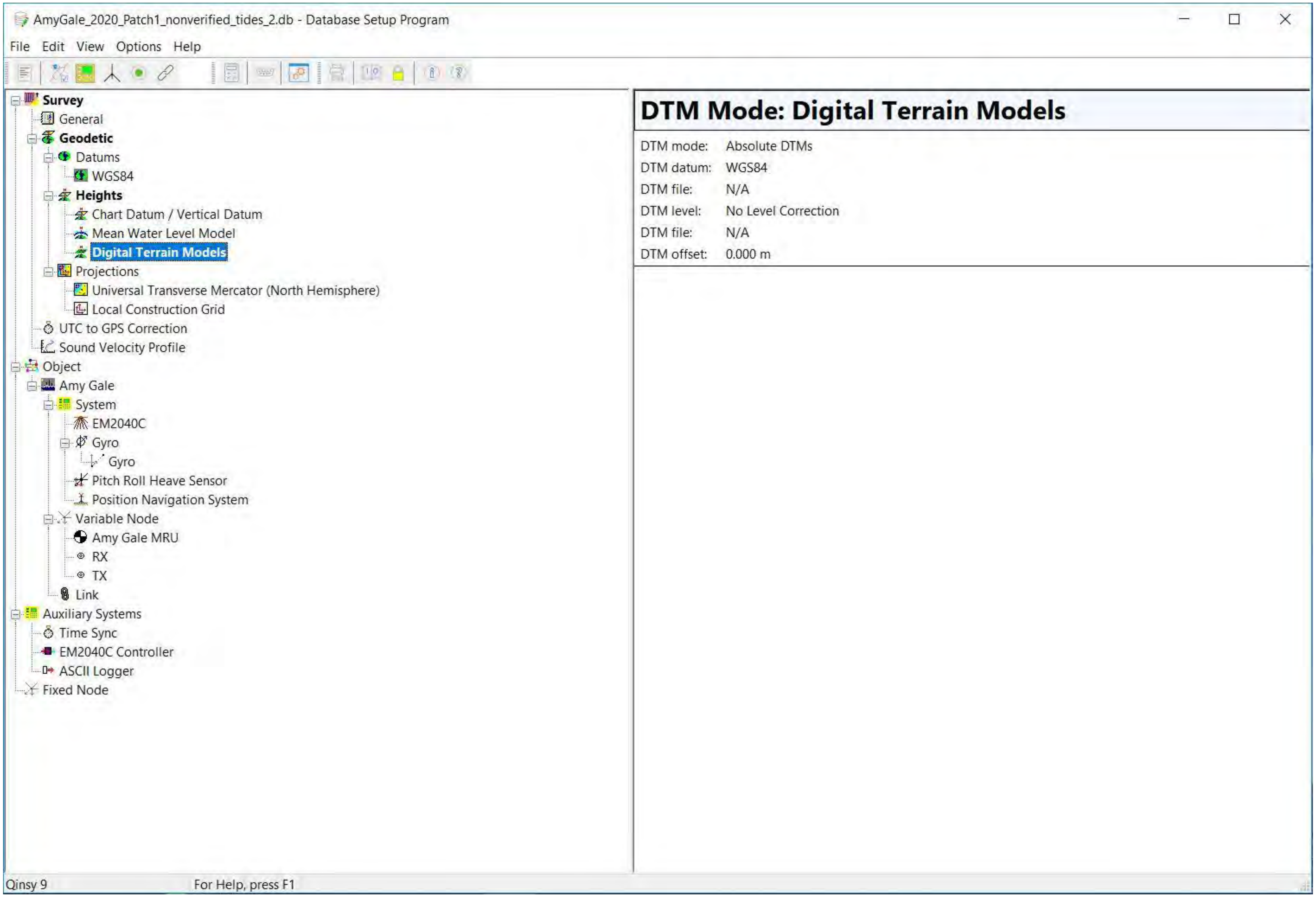
MWL Model: Mean Water Level Model
MWL model: Horizontal Datum
MWL file: N/A
MWL level: No Level Correction
MWL file: N/A
MWL offset: 0.000 m
MWL st.dev.: 0.000 m
Qinsy 9
For Help, press F1



AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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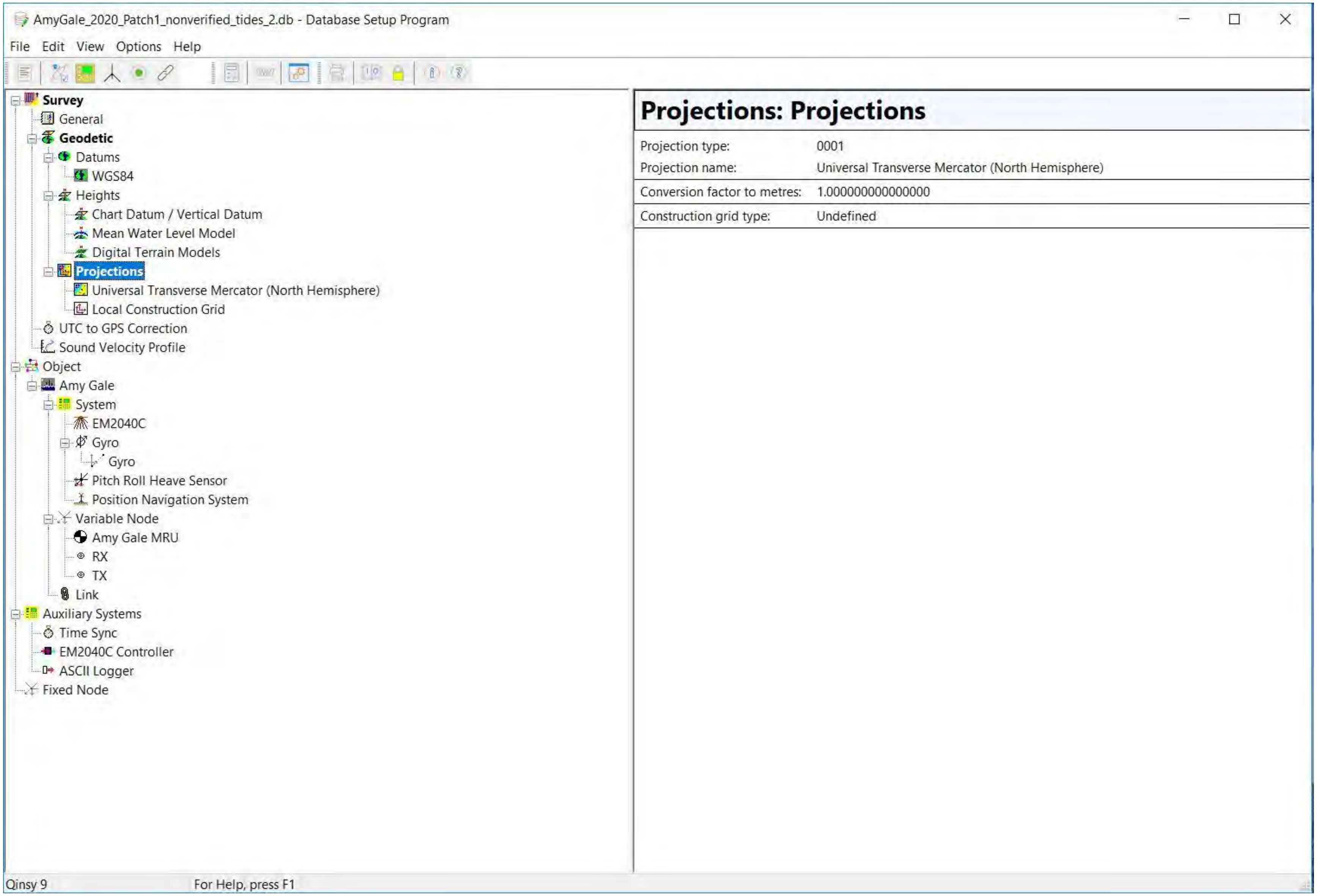
DTM Mode: Digital Terrain Models
DTM mode: Absolute DTMs
DTM datum: WGS84
DTM file: N/A
DTM level: No Level Correction
DTM file: N/A
DTM offset: 0.000 m
Qinsy 9
For Help, press F1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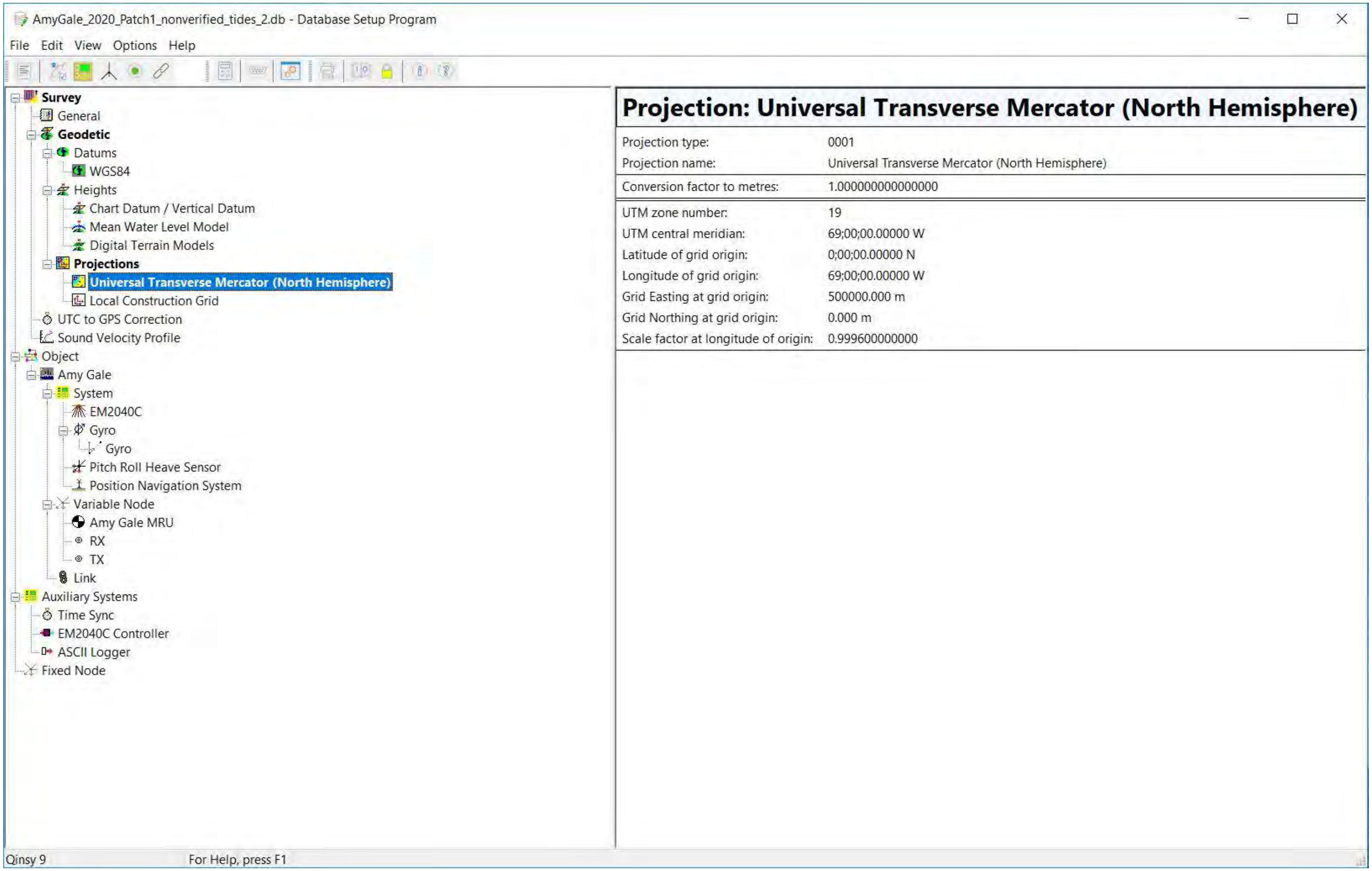
Projections: Projections
Projection type: 0001
Projection name: Universal Transverse Mercator (North Hemisphere)
Conversion factor to metres: 1.000000000000000
Construction grid type: Undefined
Qinsy 9
For Help, press F1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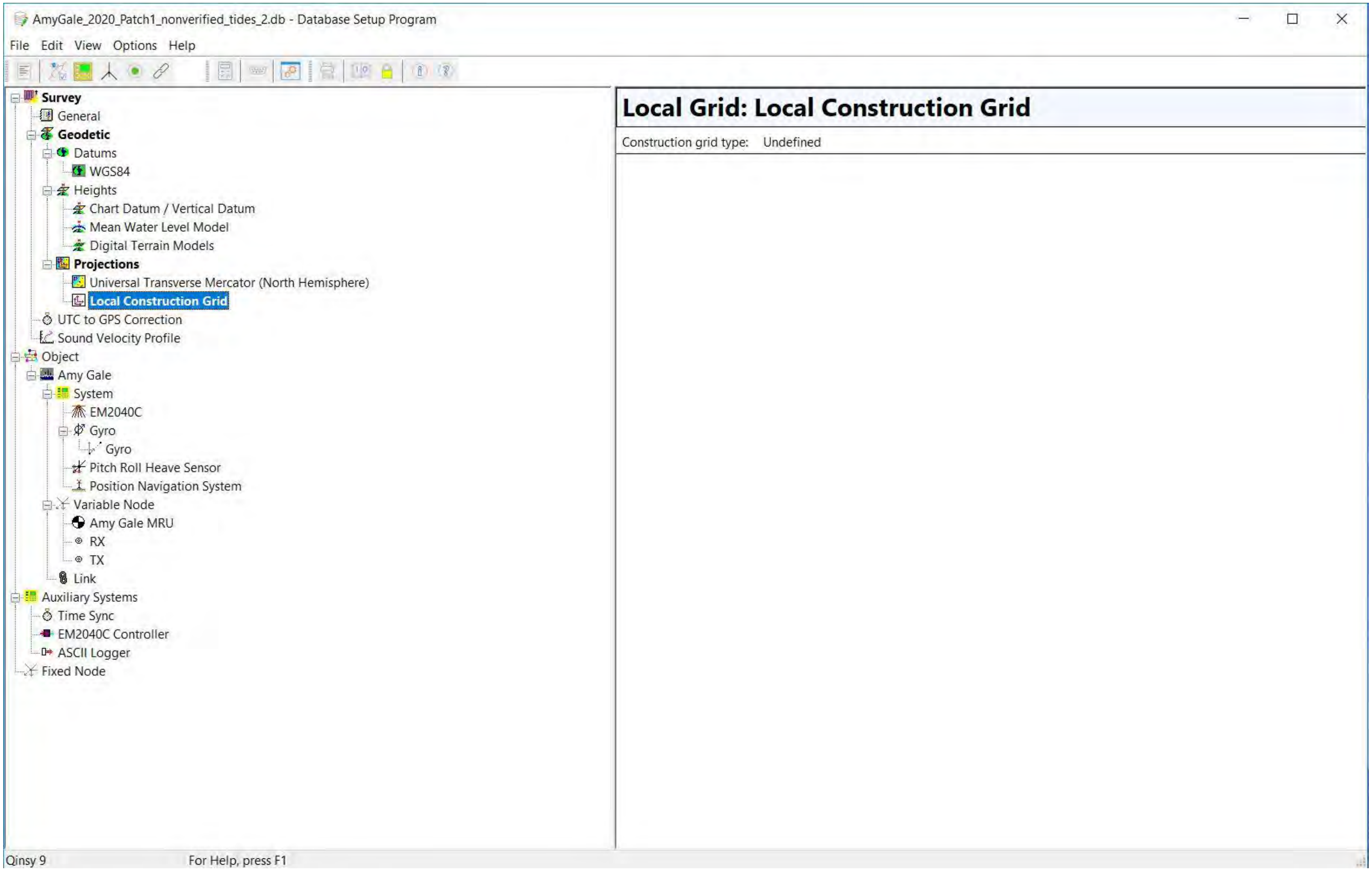
Projection: Universal Transverse Mercator (North Hemisphere)
Projection type: 0001
Projection name: Universal Transverse Mercator (North Hemisphere)
Conversion factor to metres: 1.000000000000000
UTM zone number: 19
UTM central meridian: 69;00;00.00000 W
Latitude of grid origin: 0;00;00.00000 N
Longitude of grid origin: 69;00;00.00000 W
Grid Easting at grid origin: 500000.000 m
Grid Northing at grid origin: 0.000 m
Scale factor at longitude of origin: 0.999600000000
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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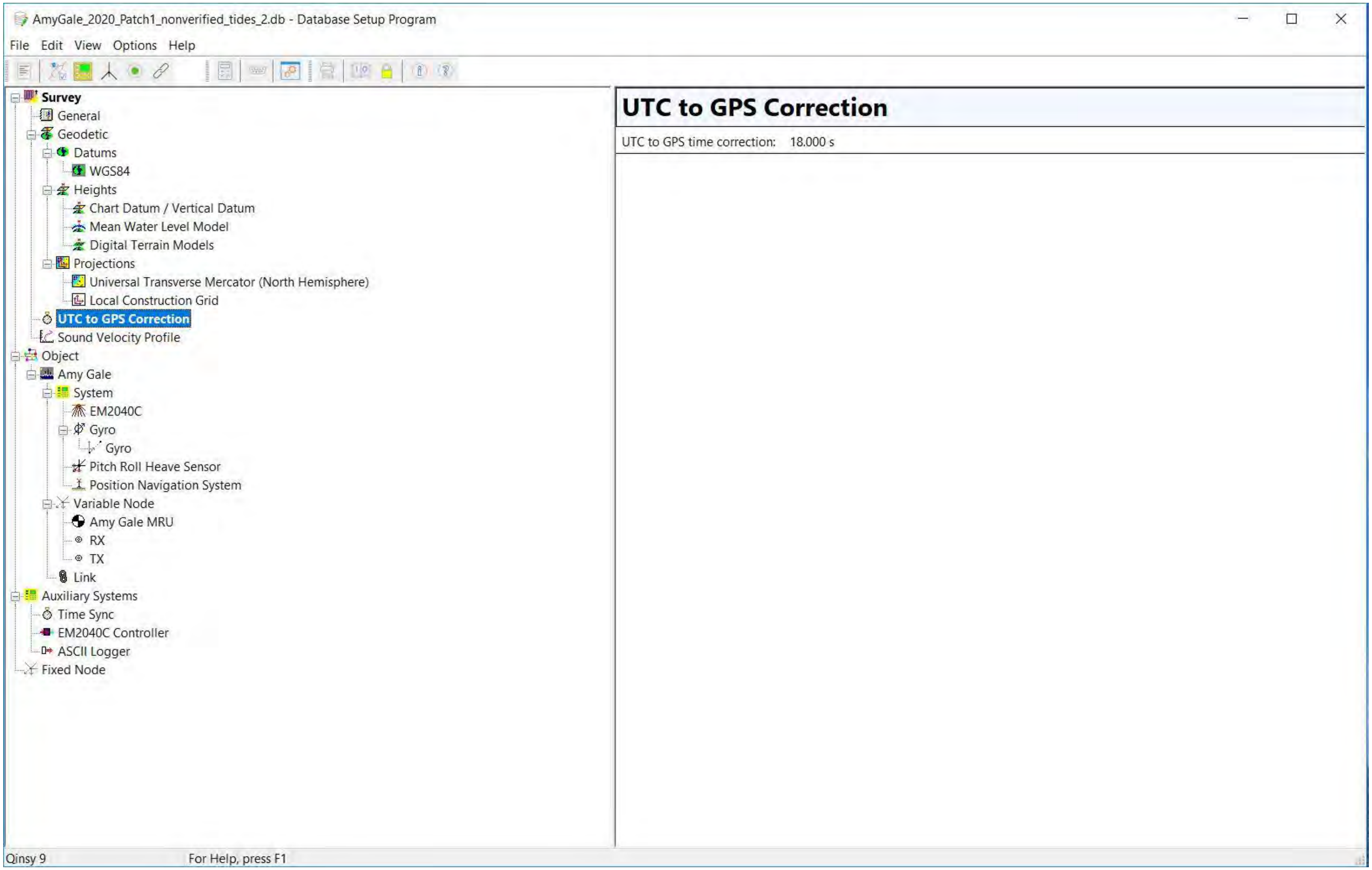
Local Grid: Local Construction Grid
Construction grid type: Undefined
Qinsy 9
For Help, press F1



AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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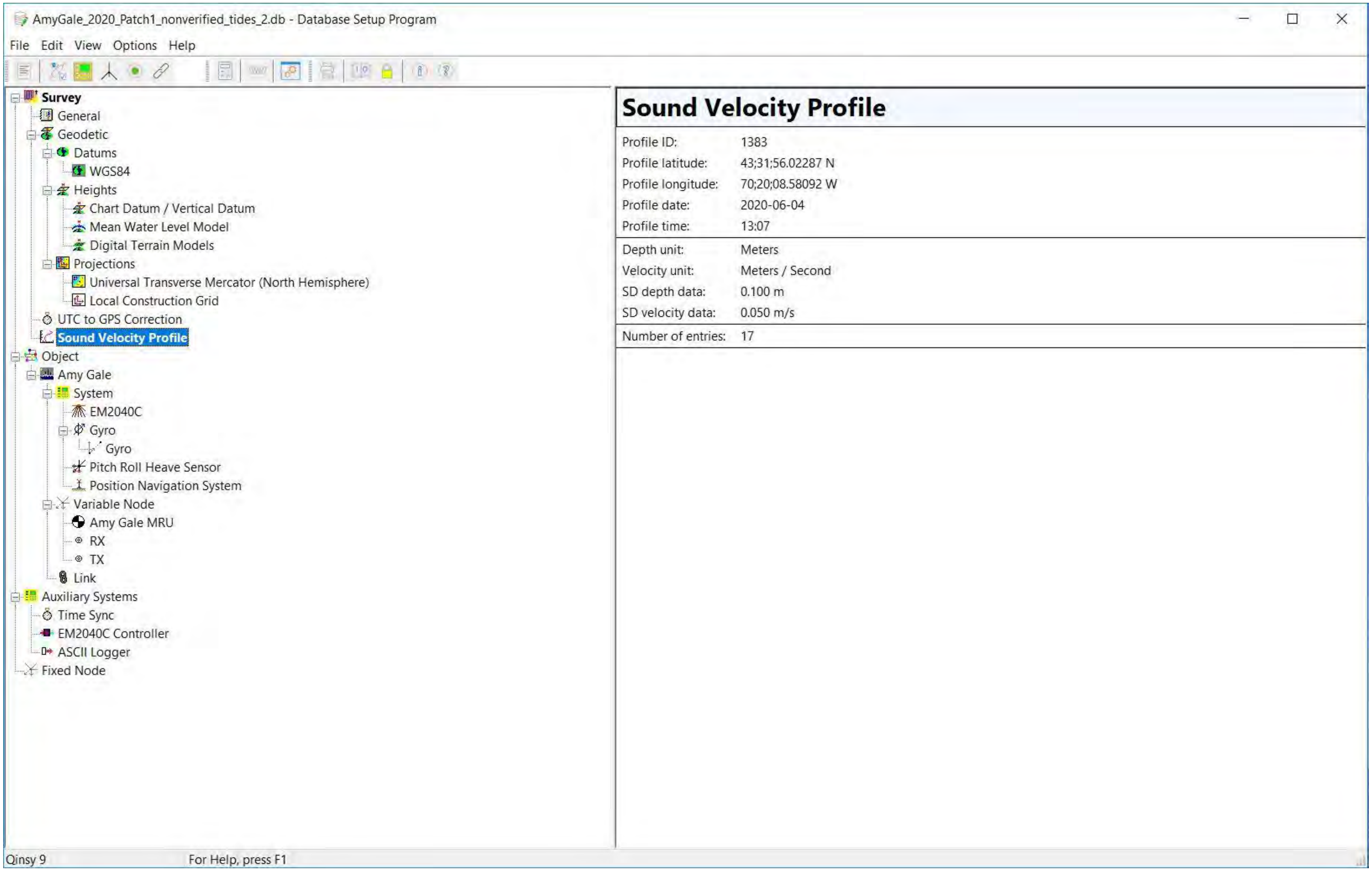
UTC to GPS Correction
UTC to GPS time correction: 18.000 s
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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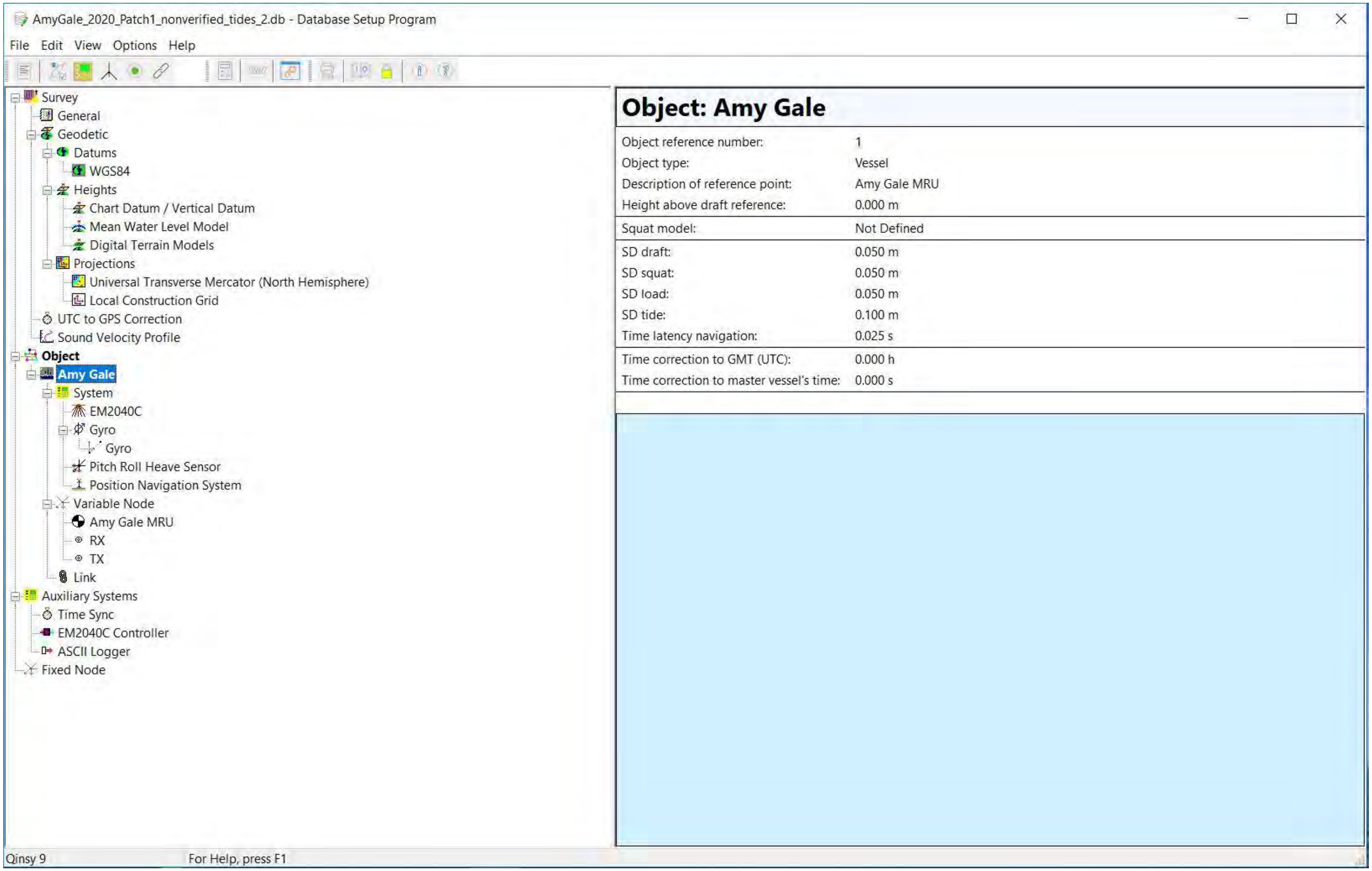
Sound Velocity Profile
Profile ID: 1383
Profile latitude: 43;31;56.02287 N
Profile longitude: 70;20;08.58092 W
Profile date: 2020-06-04
Profile time: 13:07
Depth unit: Meters
Velocity unit: Meters / Second
SD depth data: 0.100 m
SD velocity data: 0.050 m/s
Number of entries: 17
Qinsy 9
For Help, press F1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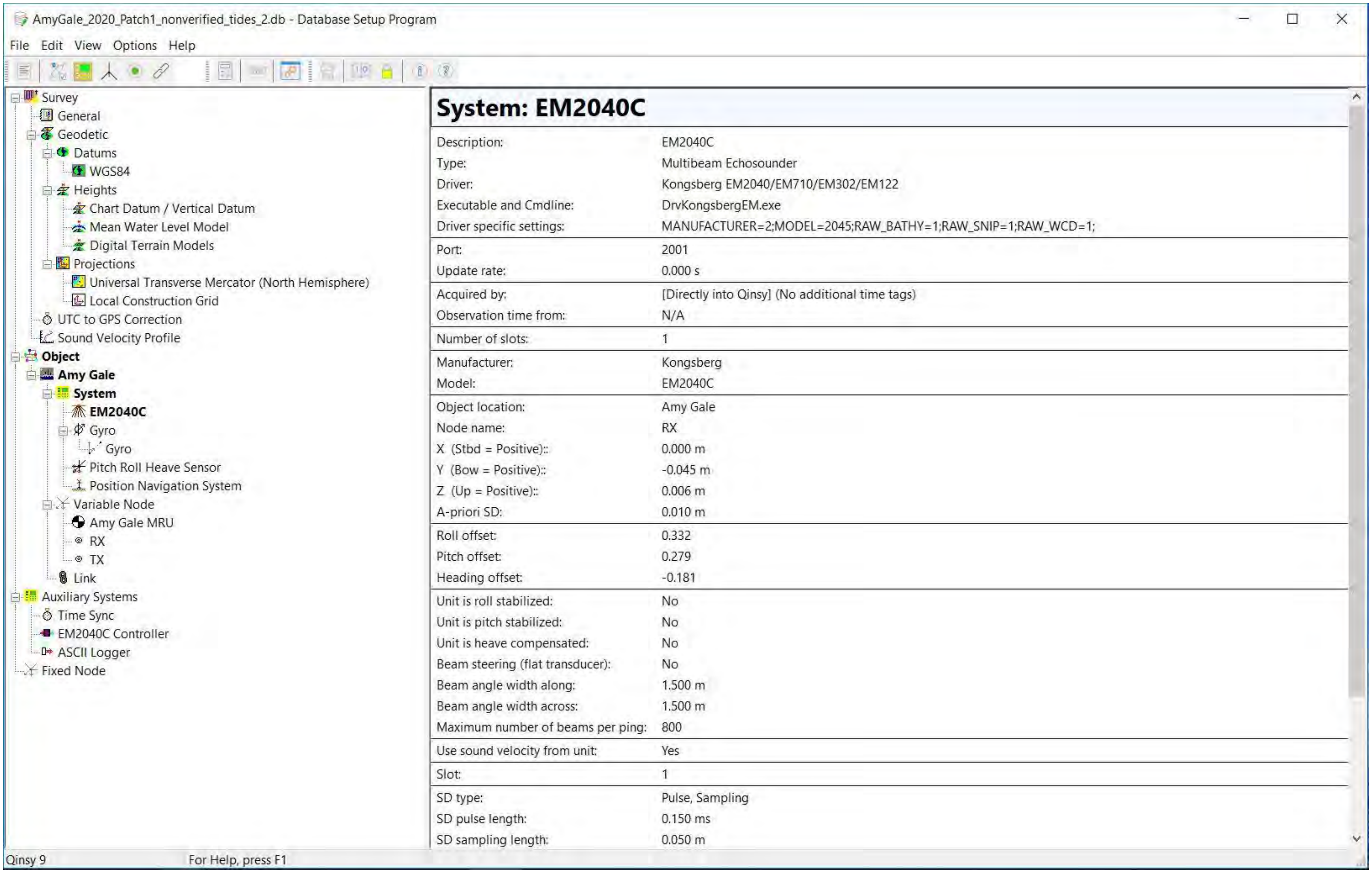
Fixed Node
Object: Amy Gale
Object reference number: 1
Object type: Vessel
Description of reference point: Amy Gale MRU
Height above draft reference: 0.000 m
Squat model: Not Defined
SD draft: 0.050 m
SD squat: 0.050 m
SD load: 0.050 m
SD tide: 0.100 m
Time latency navigation: 0.025 s
Time correction to GMT (UTC): 0.000 h
Time correction to master vessel's time: 0.000 s
Qinsy 9
For Help, press F1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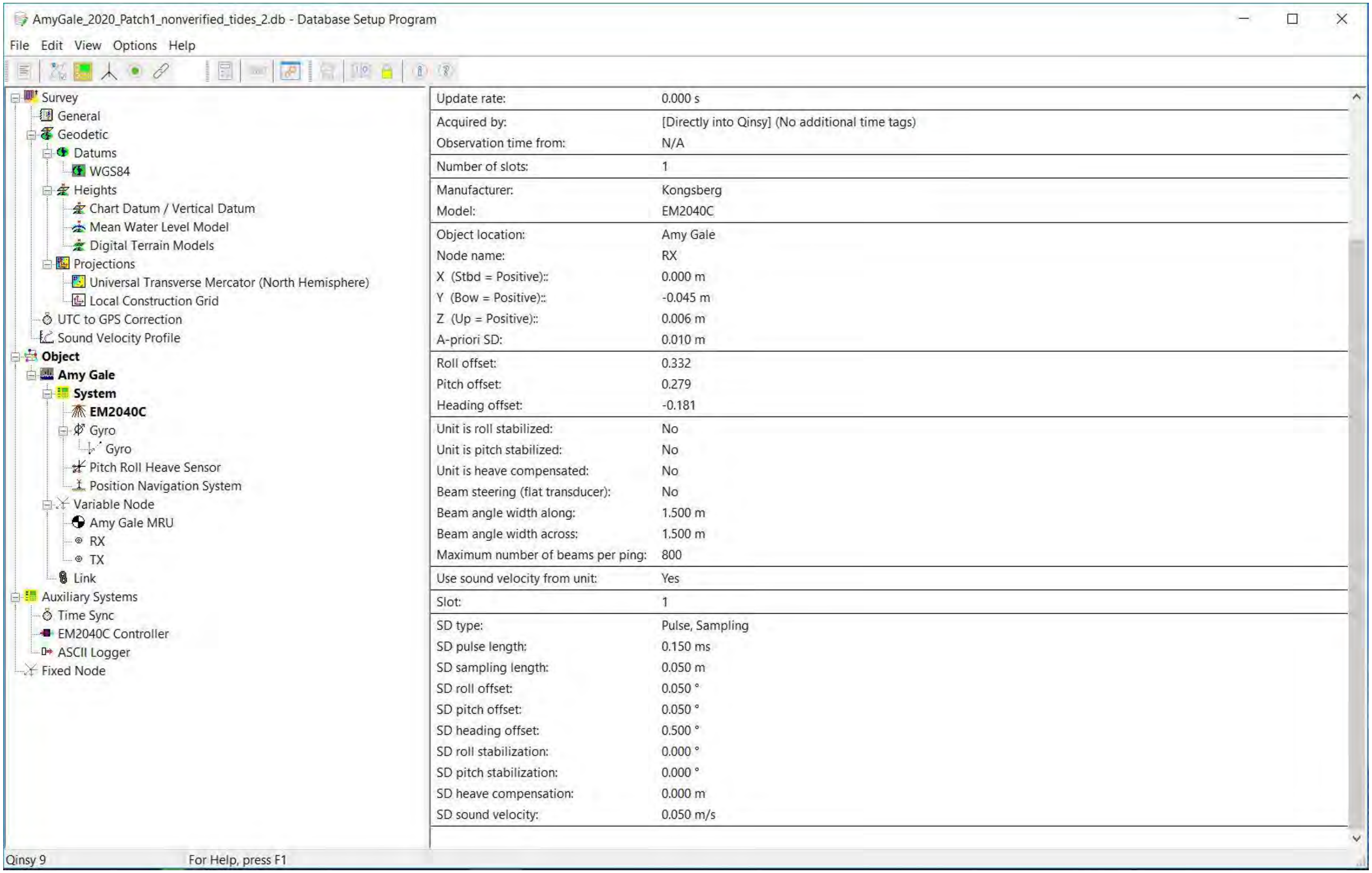
Fixed Node
System: EM2040C
Description: EM2040C
Type: Multibeam Echosounder
Driver: Kongsberg EM2040/EM710/EM302/EM122
Executable and Cmdline: DrvKongsbergEM.exe
Driver specific settings: MANUFACTURER=2;MODEL=2045;RAW_BATHY=1;RAW_SNIP=1;RAW_WCD=1;
Port: 2001
Update rate: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 1
Manufacturer: Kongsberg
Model: EM2040C
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: -0.045 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Roll offset: 0.332
Pitch offset: 0.279
Heading offset: -0.181
Unit is roll stabilized: No
Unit is pitch stabilized: No
Unit is heave compensated: No
Beam steering (flat transducer): No
Beam angle width along: 1.500 m
Beam angle width across: 1.500 m
Maximum number of beams per ping: 800
Use sound velocity from unit: Yes
Slot: 1
SD type: Pulse, Sampling
SD pulse length: 0.150 ms
SD sampling length: 0.050 m
Qinsy 9
For Help, press F1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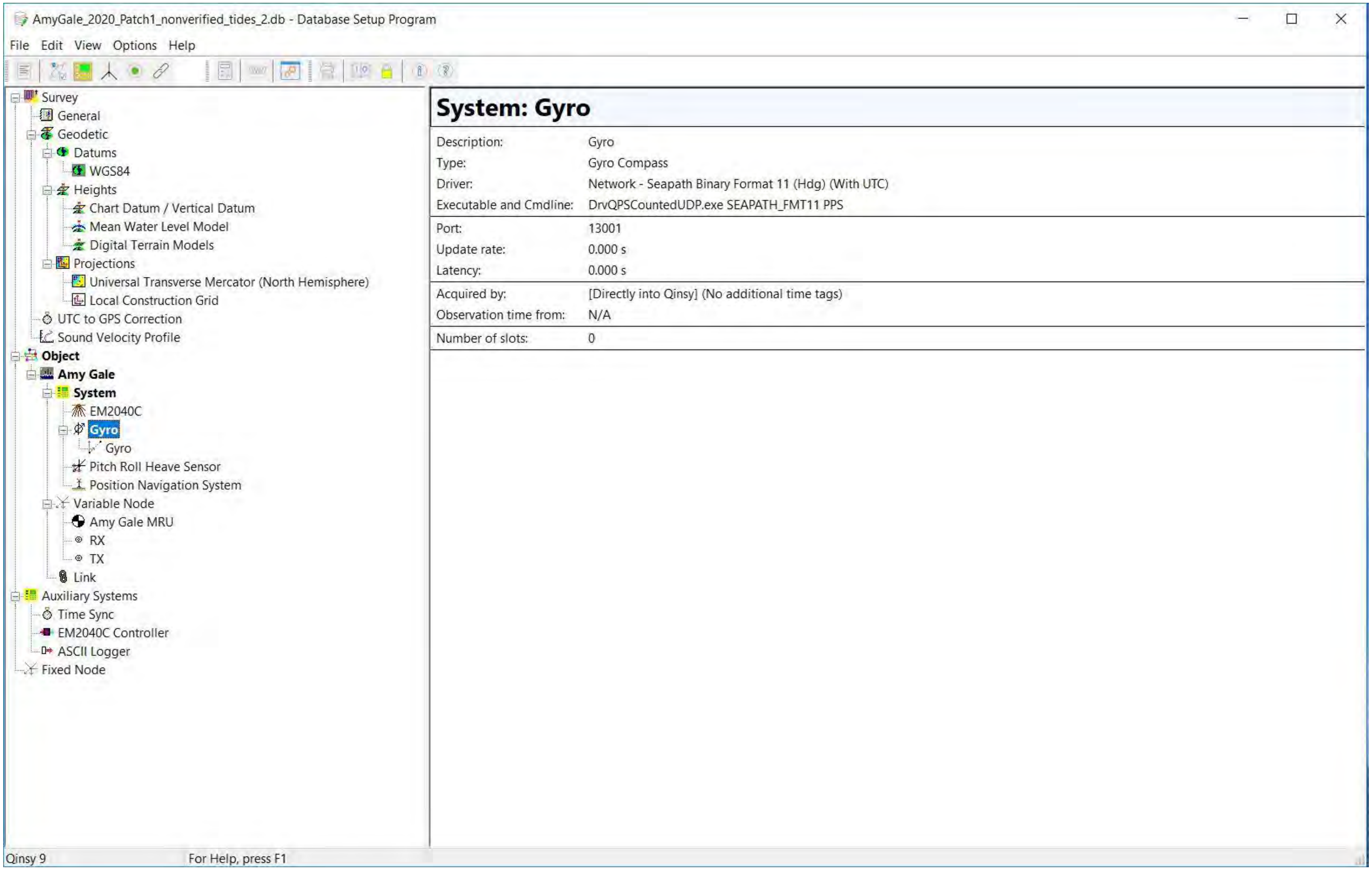
Fixed Node
Update rate: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 1
Manufacturer: Kongsberg
Model: EM2040C
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: -0.045 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Roll offset: 0.332
Pitch offset: 0.279
Heading offset: -0.181
Unit is roll stabilized: No
Unit is pitch stabilized: No
Unit is heave compensated: No
Beam steering (flat transducer): No
Beam angle width along: 1.500 m
Beam angle width across: 1.500 m
Maximum number of beams per ping: 800
Use sound velocity from unit: Yes
Slot: 1
SD type: Pulse, Sampling
SD pulse length: 0.150 ms
SD sampling length: 0.050 m
SD roll offset: 0.050 °
SD pitch offset: 0.050 °
SD heading offset: 0.500 °
SD roll stabilization: 0.000 °
SD pitch stabilization: 0.000 °
SD heave compensation: 0.000 m
SD sound velocity: 0.050 m/s
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
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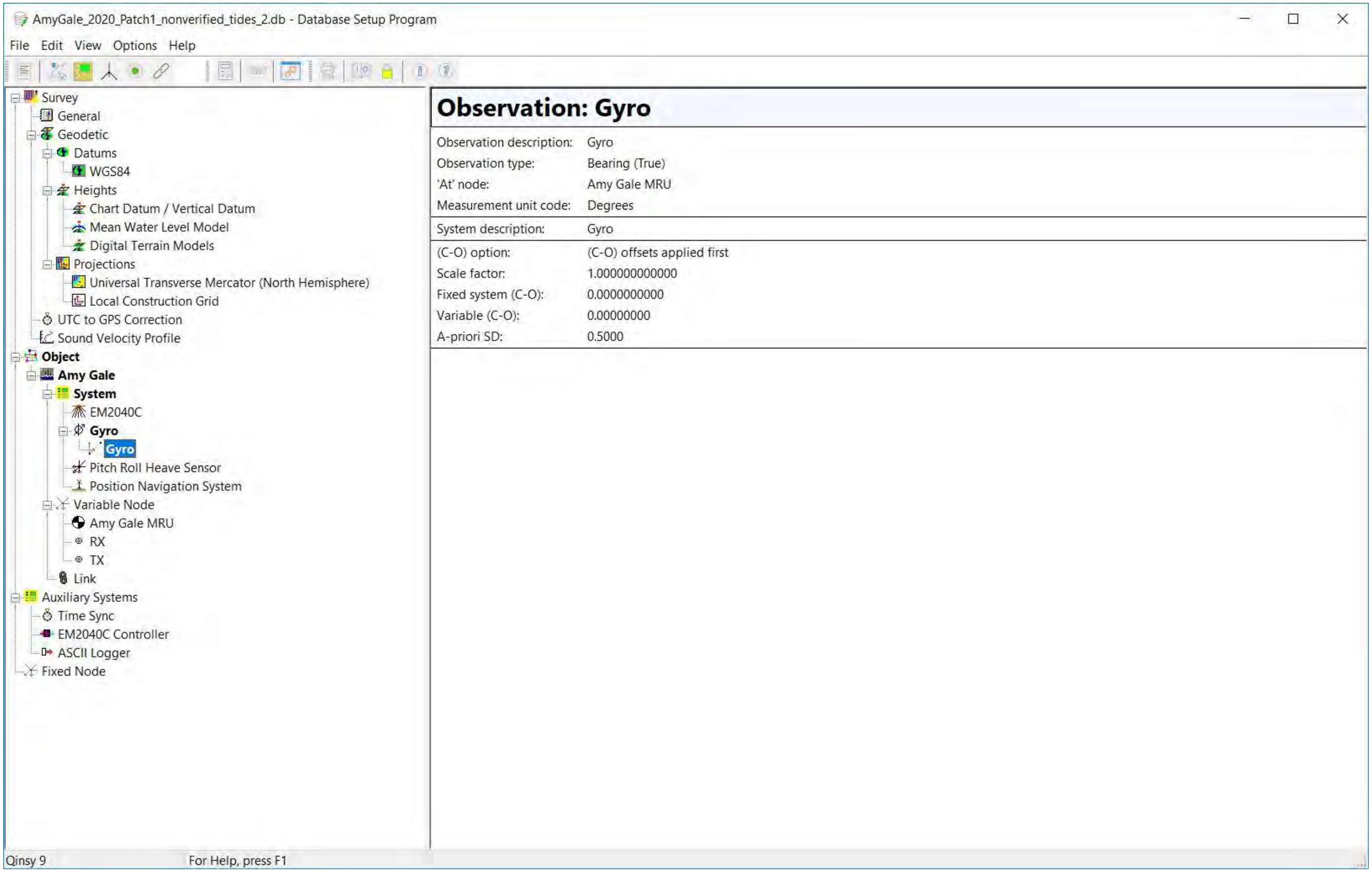
Fixed Node
System: Gyro
Description: Gyro
Type: Gyro Compass
Driver: Network - Seapath Binary Format 11 (Hdg) (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Qinsy 9
For Help, press F1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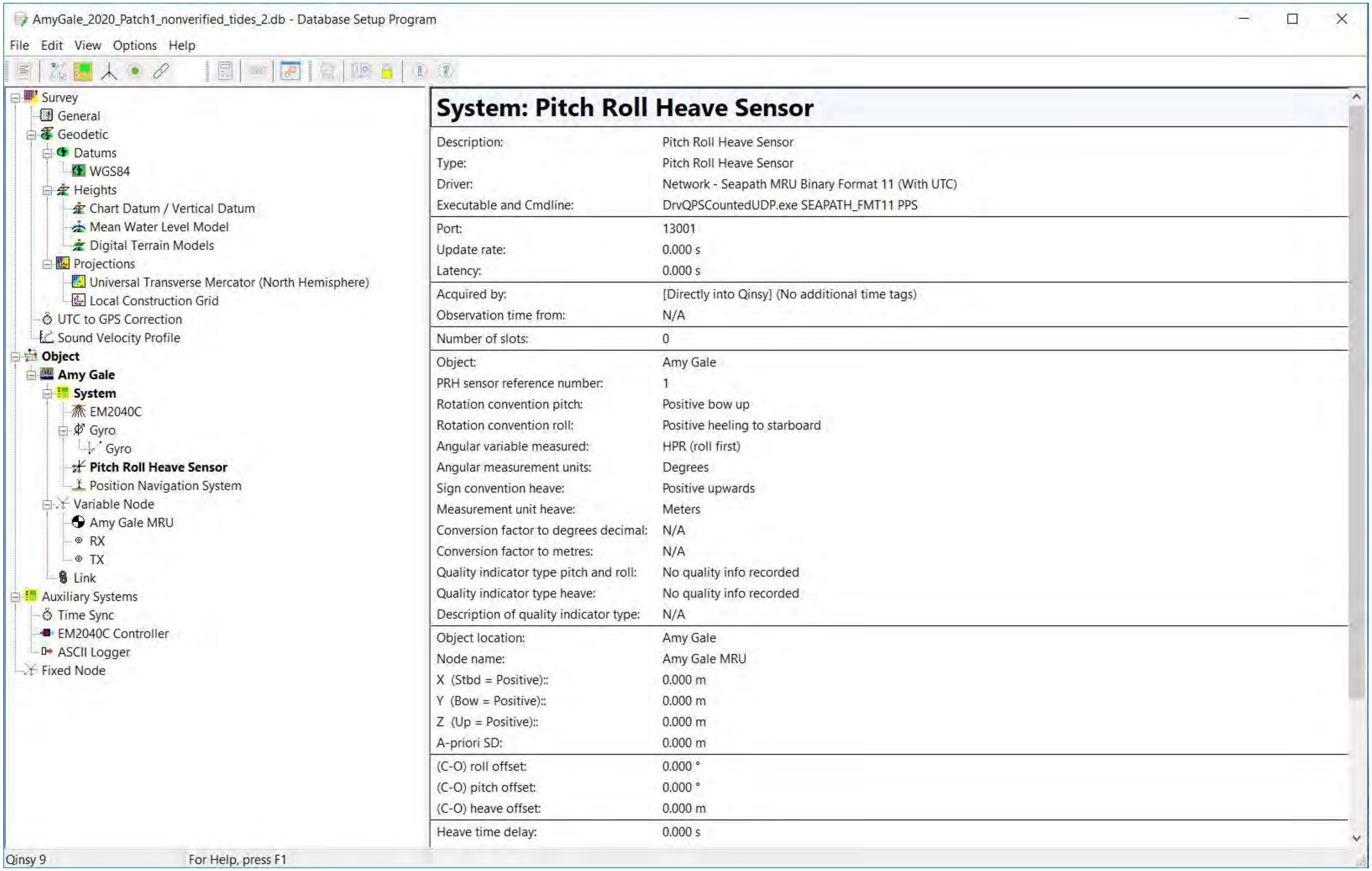
Observation: Gyro
Observation description: Gyro
Observation type: Bearing (True)
'At' node: Amy Gale MRU
Measurement unit code: Degrees
System description: Gyro
(C-O) option: (C-O) offsets applied first
Scale factor: 1.000000000000
Fixed system (C-O): 0.0000000000
Variable (C-O): 0.00000000
A-priori SD: 0.5000
Qinsy 9
For Help, press F1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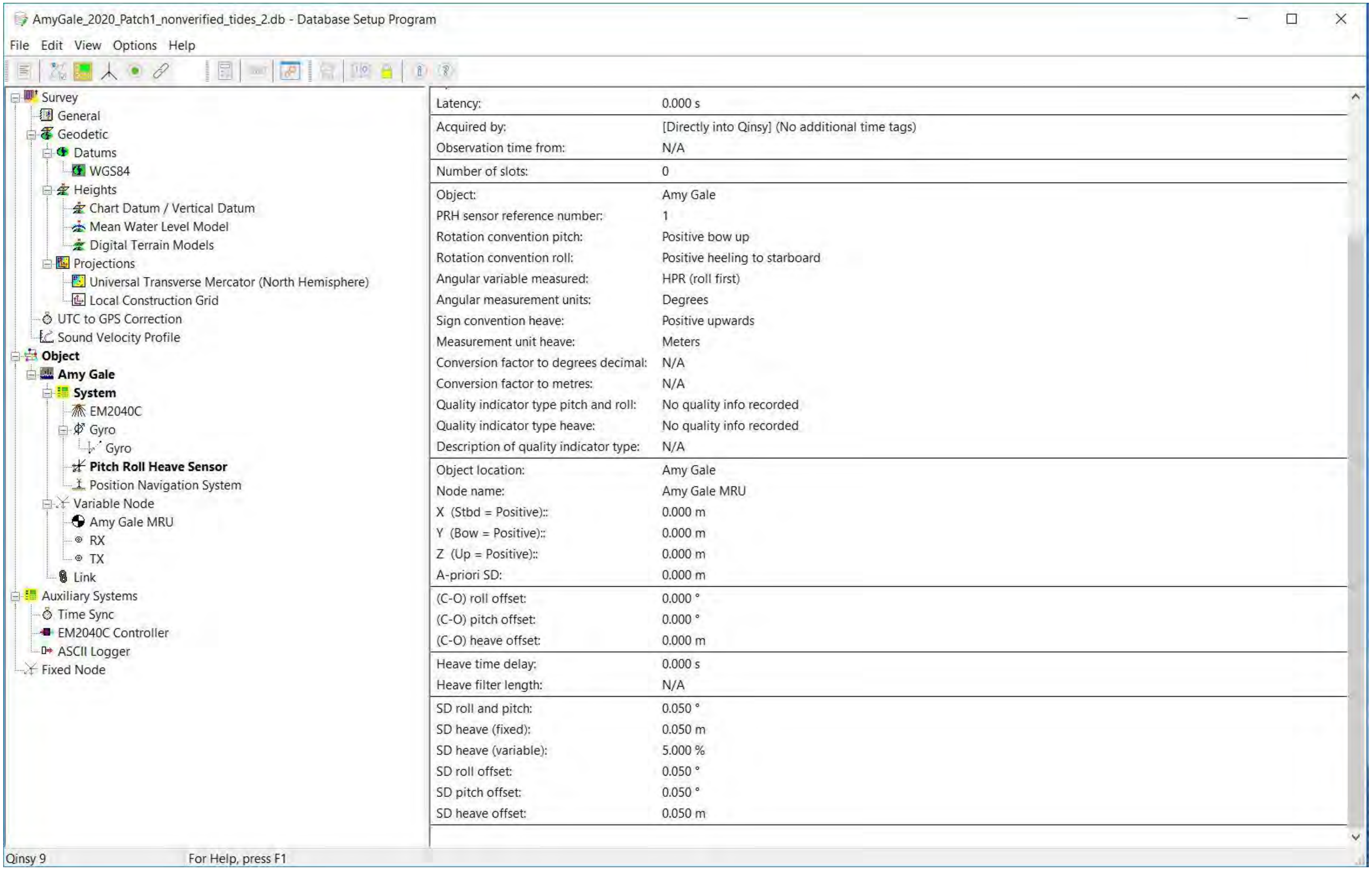
System: Pitch Roll Heave Sensor
Description: Pitch Roll Heave Sensor
Type: Pitch Roll Heave Sensor
Driver: Network - Seapath MRU Binary Format 11 (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Object: Amy Gale
PRH sensor reference number: 1
Rotation convention pitch: Positive bow up
Rotation convention roll: Positive heeling to starboard
Angular variable measured: HPR (roll first)
Angular measurement units: Degrees
Sign convention heave: Positive upwards
Measurement unit heave: Meters
Conversion factor to degrees decimal: N/A
Conversion factor to metres: N/A
Quality indicator type pitch and roll: No quality info recorded
Quality indicator type heave: No quality info recorded
Description of quality indicator type: N/A
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
(C-O) roll offset: 0.000 °
(C-O) pitch offset: 0.000 °
(C-O) heave offset: 0.000 m
Heave time delay: 0.000 s
Qinsy 9
For Help, press F1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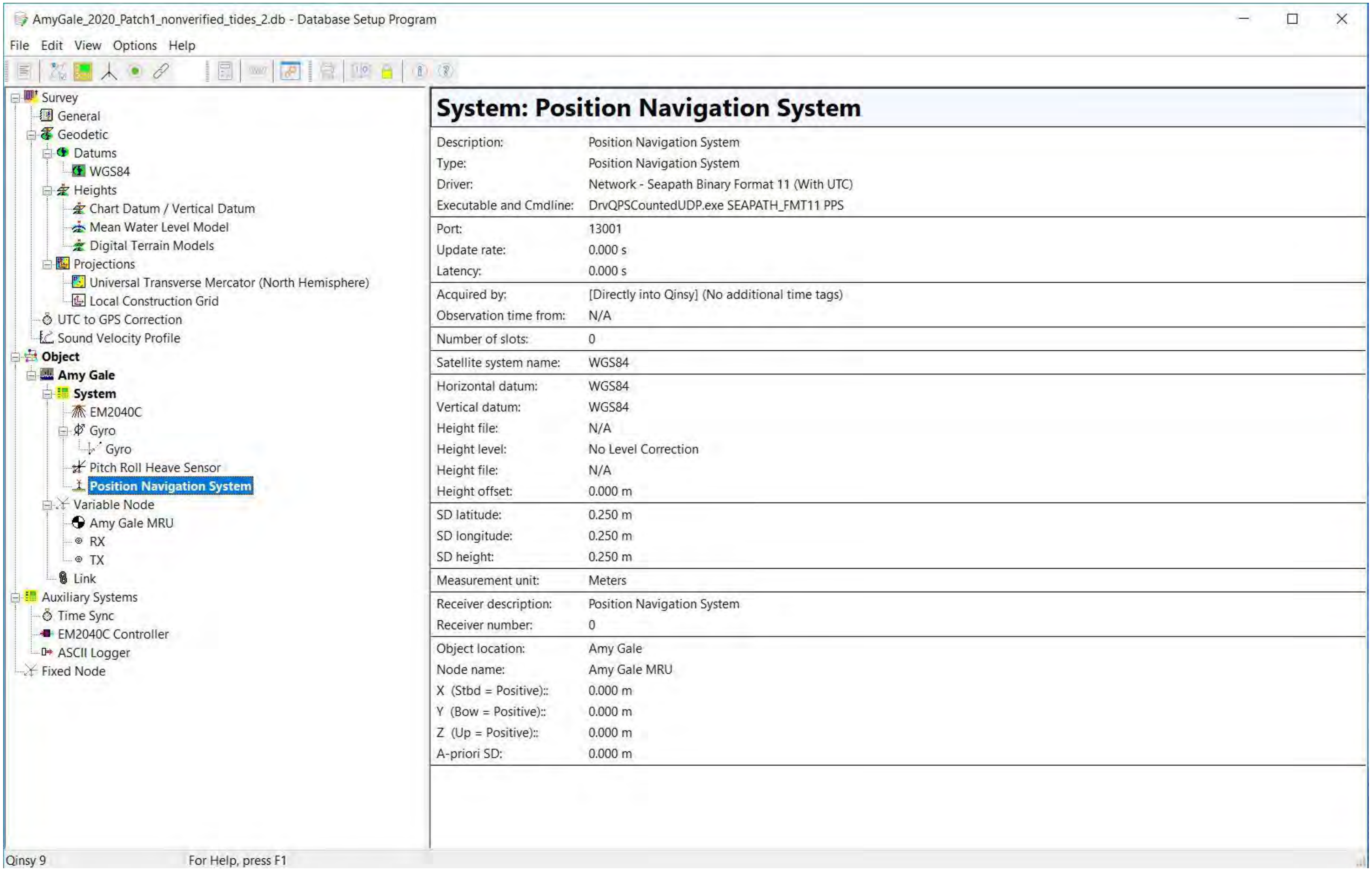
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Object: Amy Gale
PRH sensor reference number: 1
Rotation convention pitch: Positive bow up
Rotation convention roll: Positive heeling to starboard
Angular variable measured: HPR (roll first)
Angular measurement units: Degrees
Sign convention heave: Positive upwards
Measurement unit heave: Meters
Conversion factor to degrees decimal: N/A
Conversion factor to metres: N/A
Quality indicator type pitch and roll: No quality info recorded
Quality indicator type heave: No quality info recorded
Description of quality indicator type: N/A
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
(C-O) roll offset: 0.000 °
(C-O) pitch offset: 0.000 °
(C-O) heave offset: 0.000 m
Heave time delay: 0.000 s
Heave filter length: N/A
SD roll and pitch: 0.050 °
SD heave (fixed): 0.050 m
SD heave (variable): 5.000 %
SD roll offset: 0.050 °
SD pitch offset: 0.050 °
SD heave offset: 0.050 m
Qinsy 9
For Help, press F1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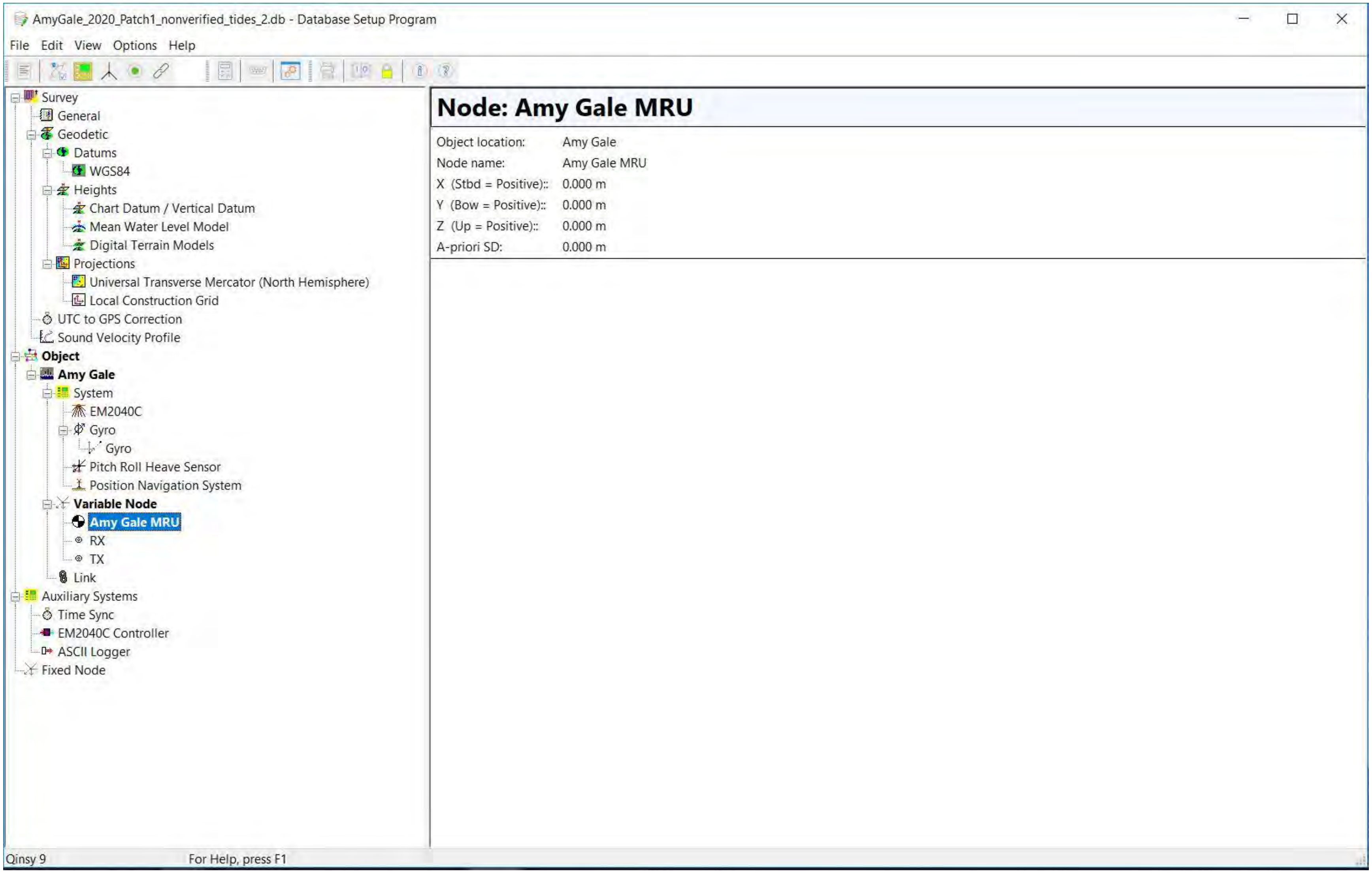
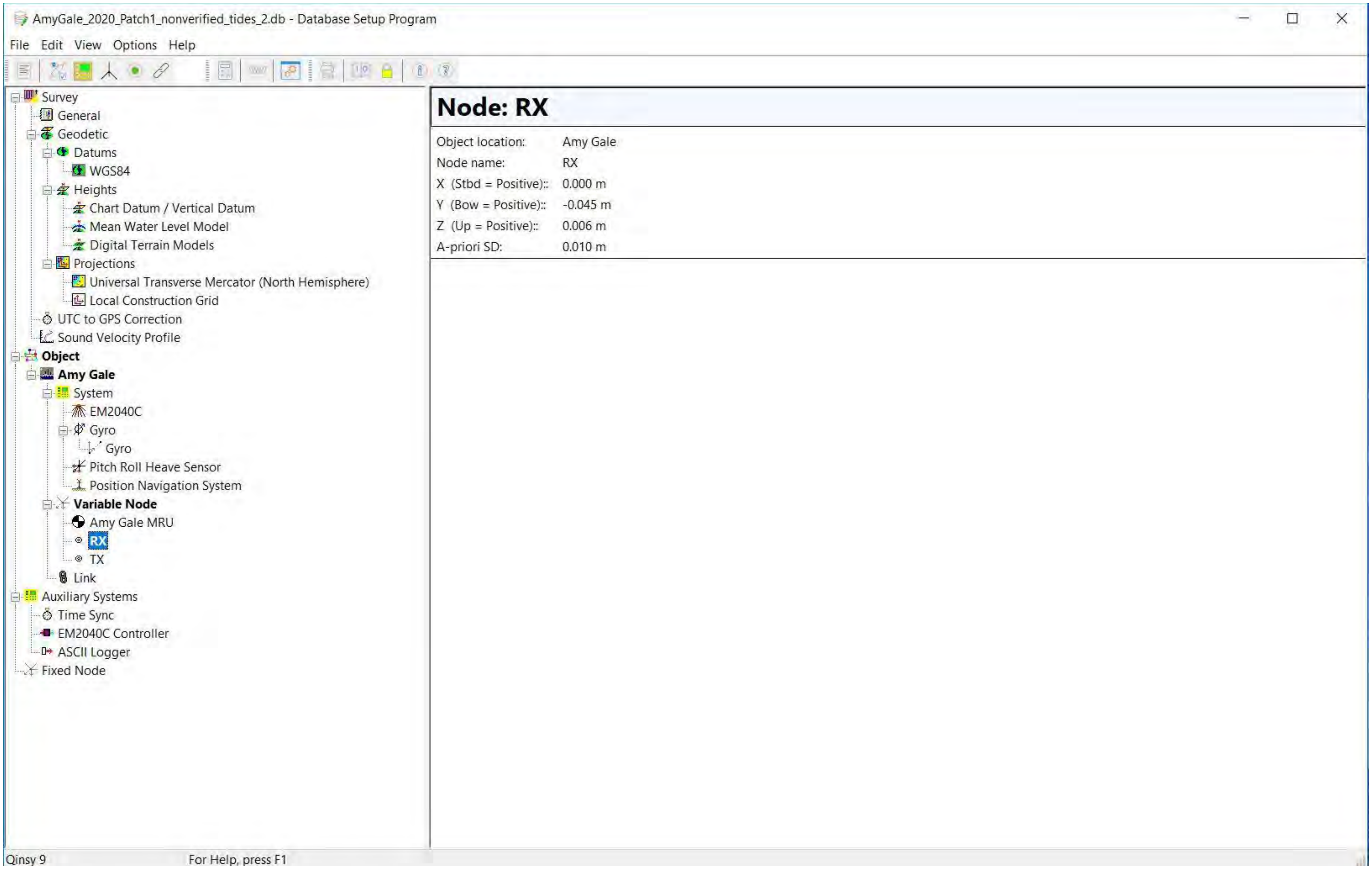
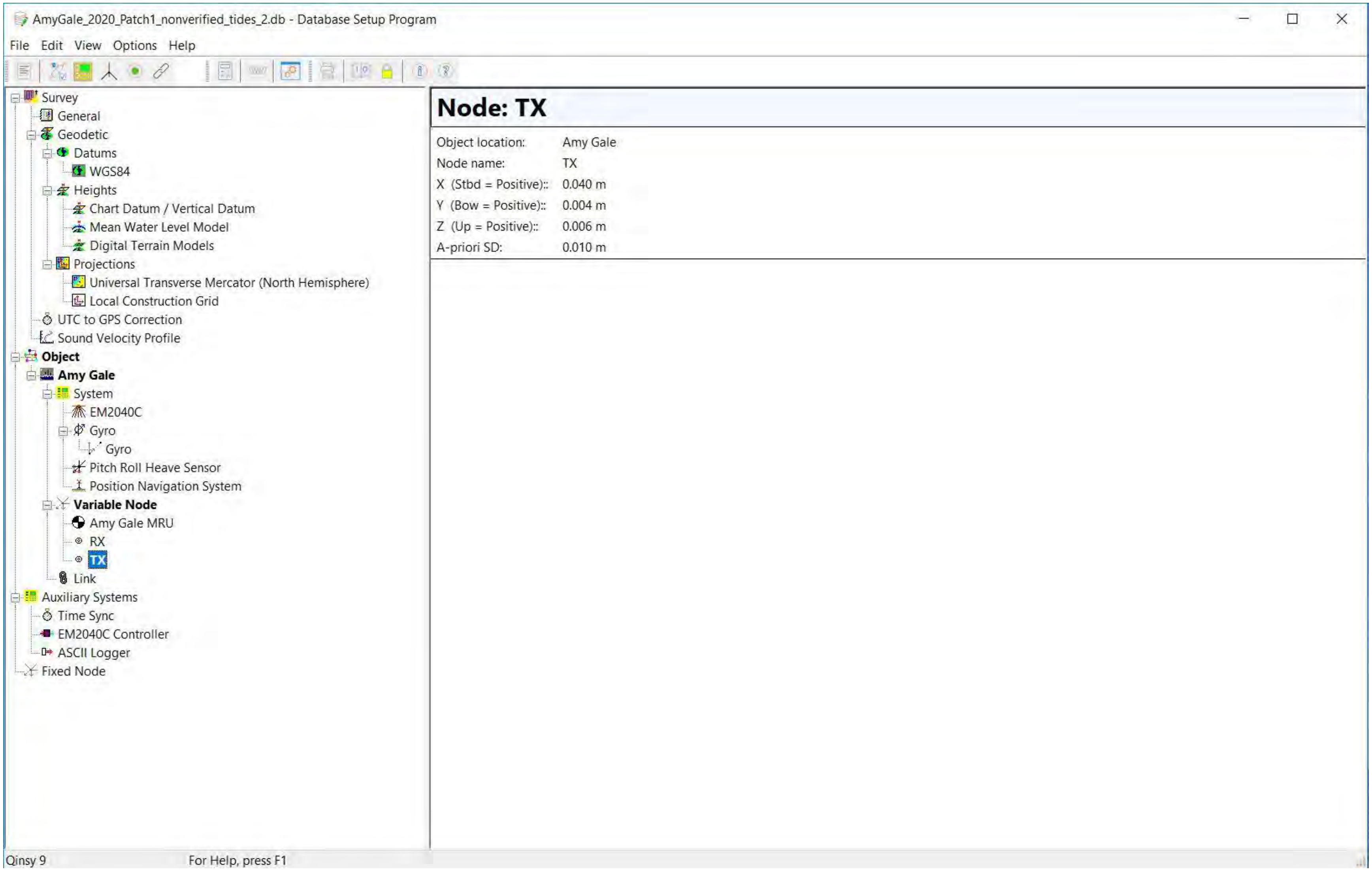
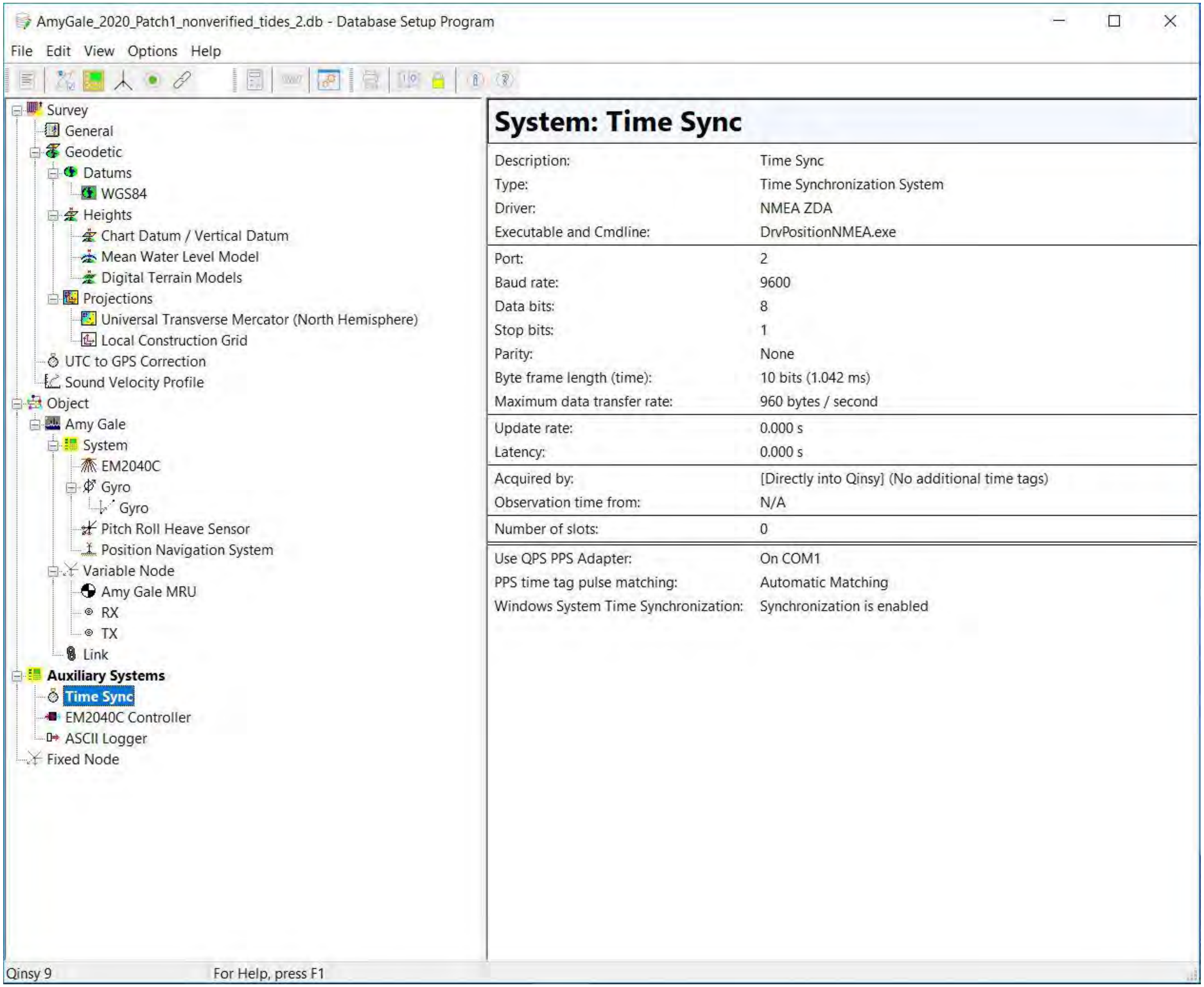
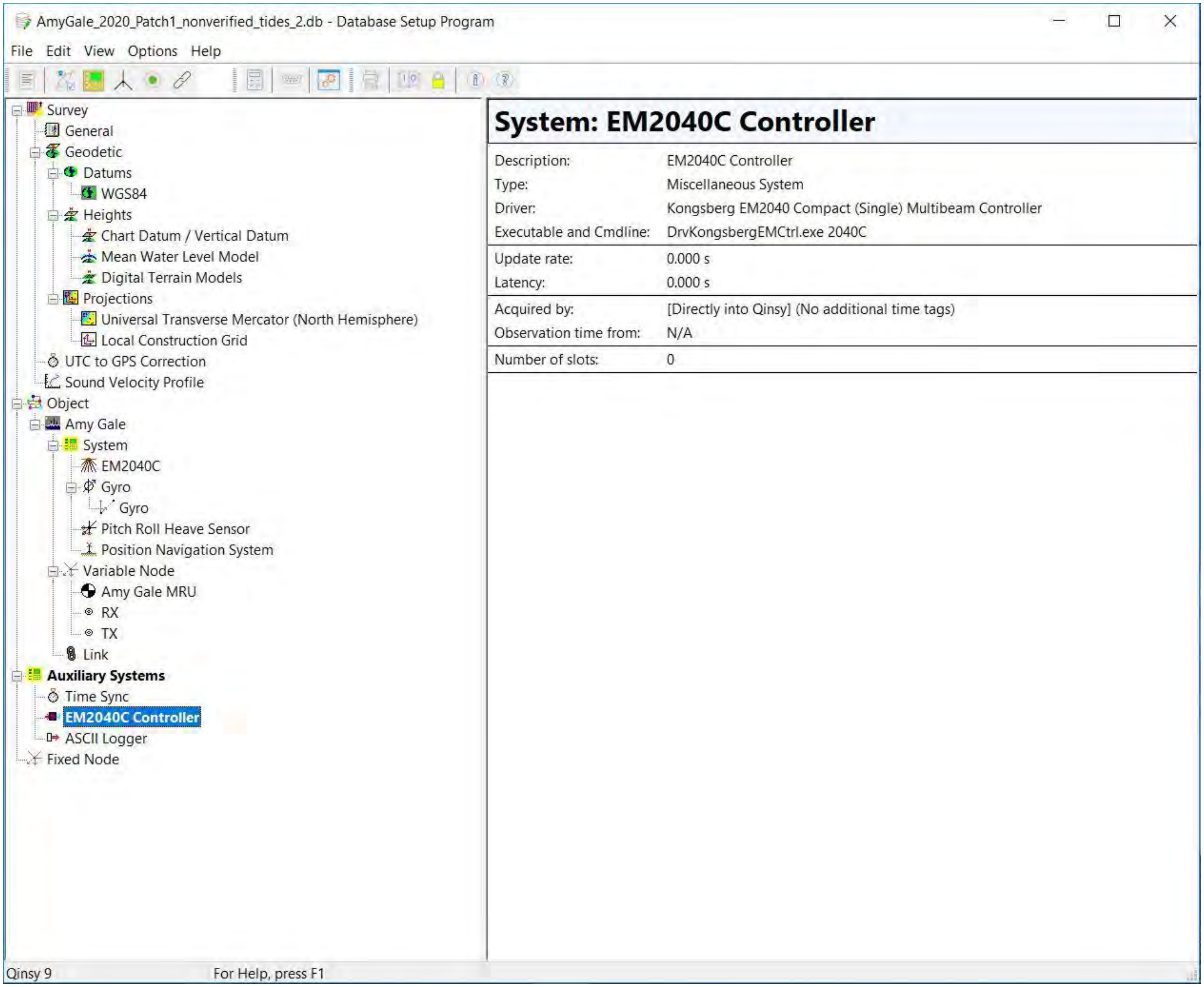
System: Position Navigation System
Description: Position Navigation System
Type: Position Navigation System
Driver: Network - Seapath Binary Format 11 (With UTC)
Executable and Cmdline: DrvQPSCountedUDP.exe SEAPATH_FMT11 PPS
Port: 13001
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Satellite system name: WGS84
Horizontal datum: WGS84
Vertical datum: WGS84
Height file: N/A
Height level: No Level Correction
Height file: N/A
Height offset: 0.000 m
SD latitude: 0.250 m
SD longitude: 0.250 m
SD height: 0.250 m
Measurement unit: Meters
Receiver description: Position Navigation System
Receiver number: 0
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
Qinsy 9
For Help, press F1

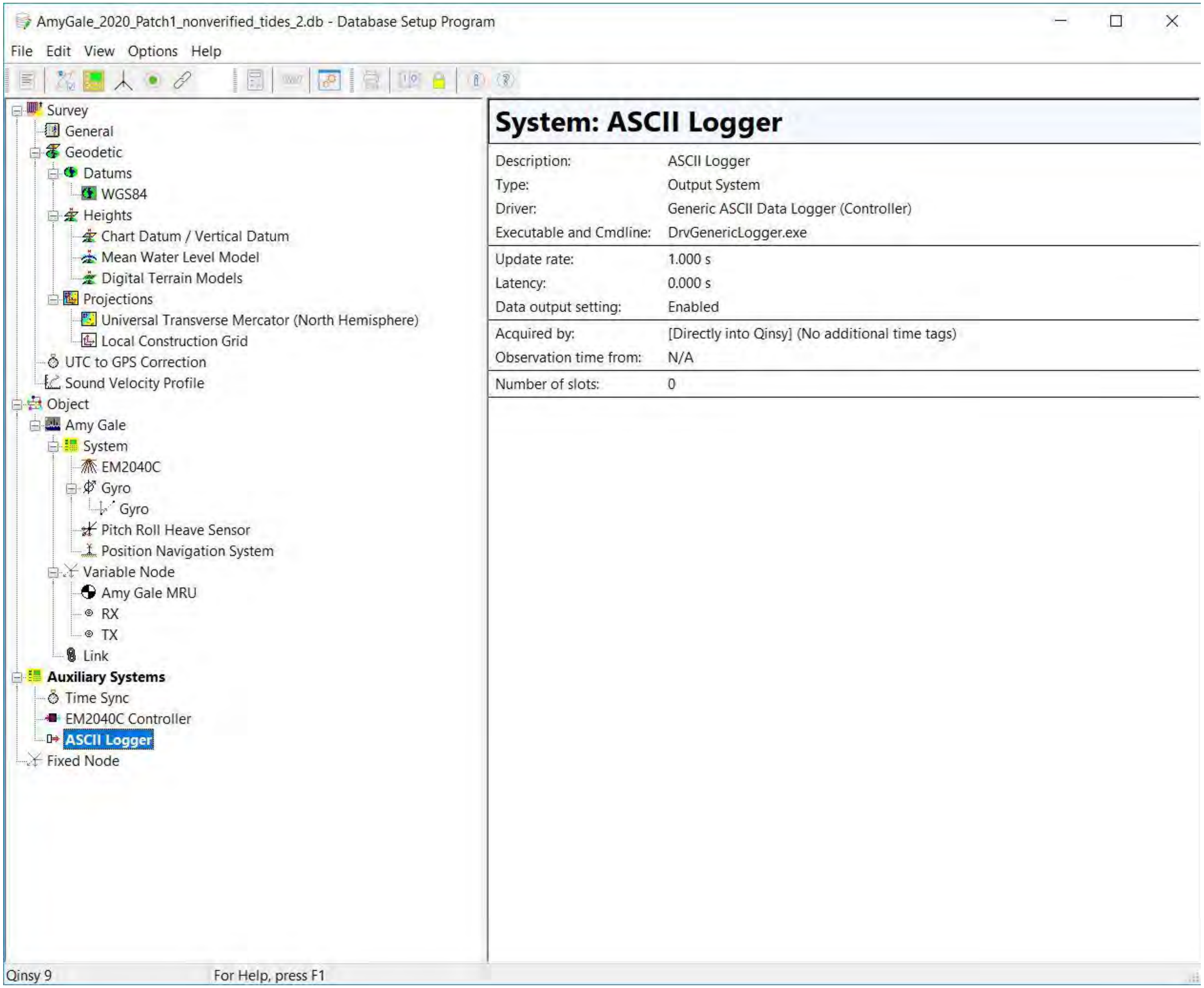

AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Node: Amy Gale MRU
Object location: Amy Gale
Node name: Amy Gale MRU
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: 0.000 m
Z (Up = Positive):: 0.000 m
A-priori SD: 0.000 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Node: RX
Object location: Amy Gale
Node name: RX
X (Stbd = Positive):: 0.000 m
Y (Bow = Positive):: -0.045 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Qinsy 9
For Help, press F1


AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
Node: TX
Object location: Amy Gale
Node name: TX
X (Stbd = Positive):: 0.040 m
Y (Bow = Positive):: 0.004 m
Z (Up = Positive):: 0.006 m
A-priori SD: 0.010 m
Qinsy 9
For Help, press F1

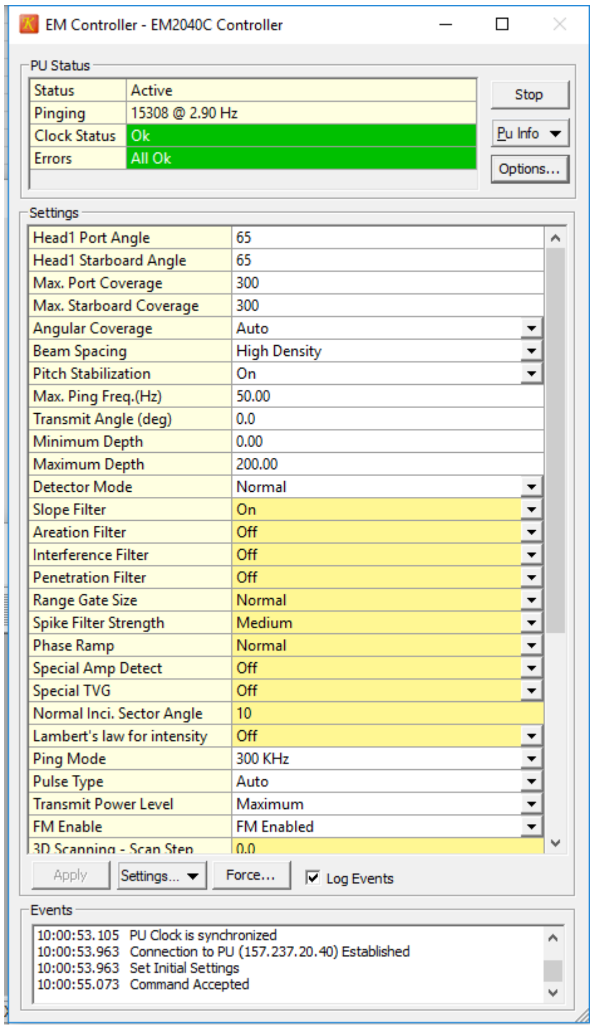

AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
System: Time Sync
Description: Time Sync
Type: Time Synchronization System
Driver: NMEA ZDA
Executable and Cmdline: DrvPositionNMEA.exe
Port: 2
Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: None
Byte frame length (time): 10 bits (1.042 ms)
Maximum data transfer rate: 960 bytes / second
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Use QPS PPS Adapter: On COM1
PPS time tag pulse matching: Automatic Matching
Windows System Time Synchronization: Synchronization is enabled
Qinsy 9
For Help, press F1

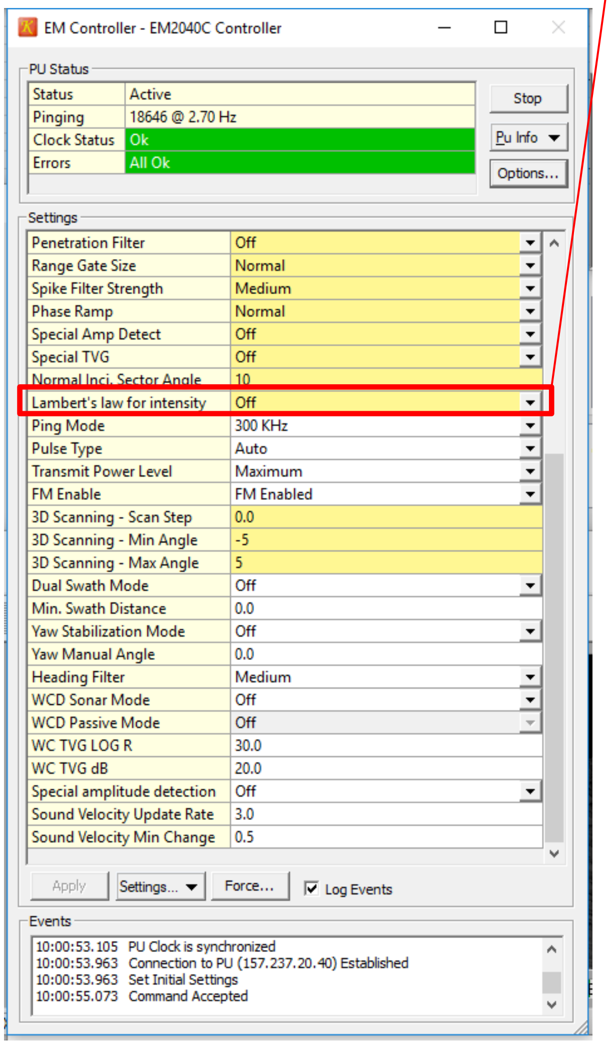

AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
System: EM2040C Controller
Description: EM2040C Controller
Type: Miscellaneous System
Driver: Kongsberg EM2040 Compact (Single) Multibeam Controller
Executable and Cmdline: DrvKongsbergEMCtrl.exe 2040C
Update rate: 0.000 s
Latency: 0.000 s
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Qinsy 9
For Help, press F1

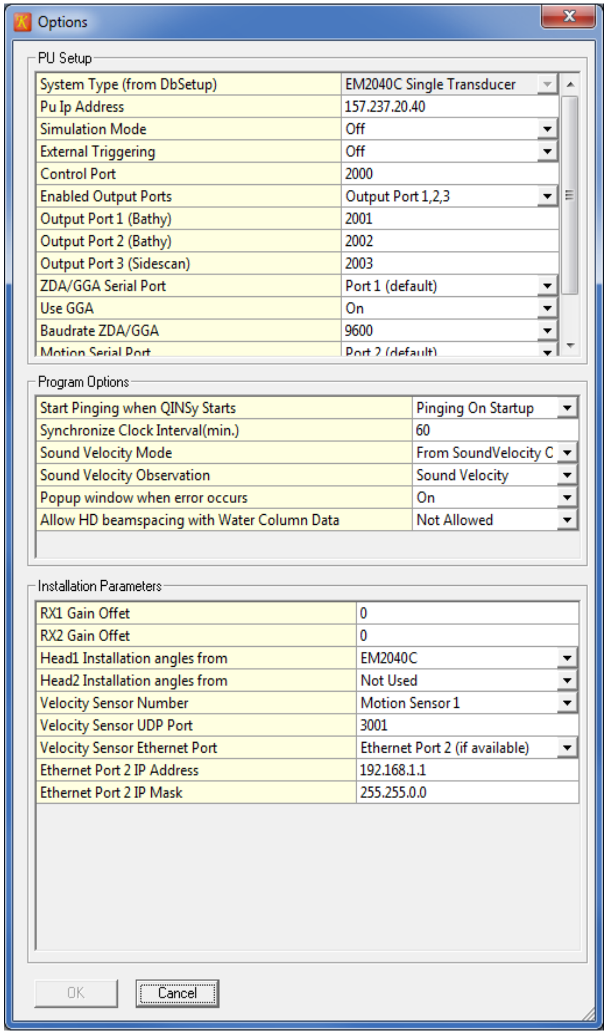

AmyGale_2020_Patch1_nonverified_tides_2.db - Database Setup Program
File Edit View Options Help
Survey
General
Geodetic
Datums
WGS84
Heights
Chart Datum / Vertical Datum
Mean Water Level Model
Digital Terrain Models
Projections
Universal Transverse Mercator (North Hemisphere)
Local Construction Grid
UTC to GPS Correction
Sound Velocity Profile
Object
Amy Gale
System
EM2040C
Gyro
Gyro
Pitch Roll Heave Sensor
Position Navigation System
Variable Node
Amy Gale MRU
RX
TX
Link
Auxiliary Systems
Time Sync
EM2040C Controller
ASCII Logger
Fixed Node
System: ASCII Logger
Description: ASCII Logger
Type: Output System
Driver: Generic ASCII Data Logger (Controller)
Executable and Cmdline: DrvGenericLogger.exe
Update rate: 1.000 s
Latency: 0.000 s
Data output setting: Enabled
Acquired by: [Directly into Qinsy] (No additional time tags)
Observation time from: N/A
Number of slots: 0
Qinsy 9
For Help, press F1

Appendix E – Configuration settings for Qinsy EM controller

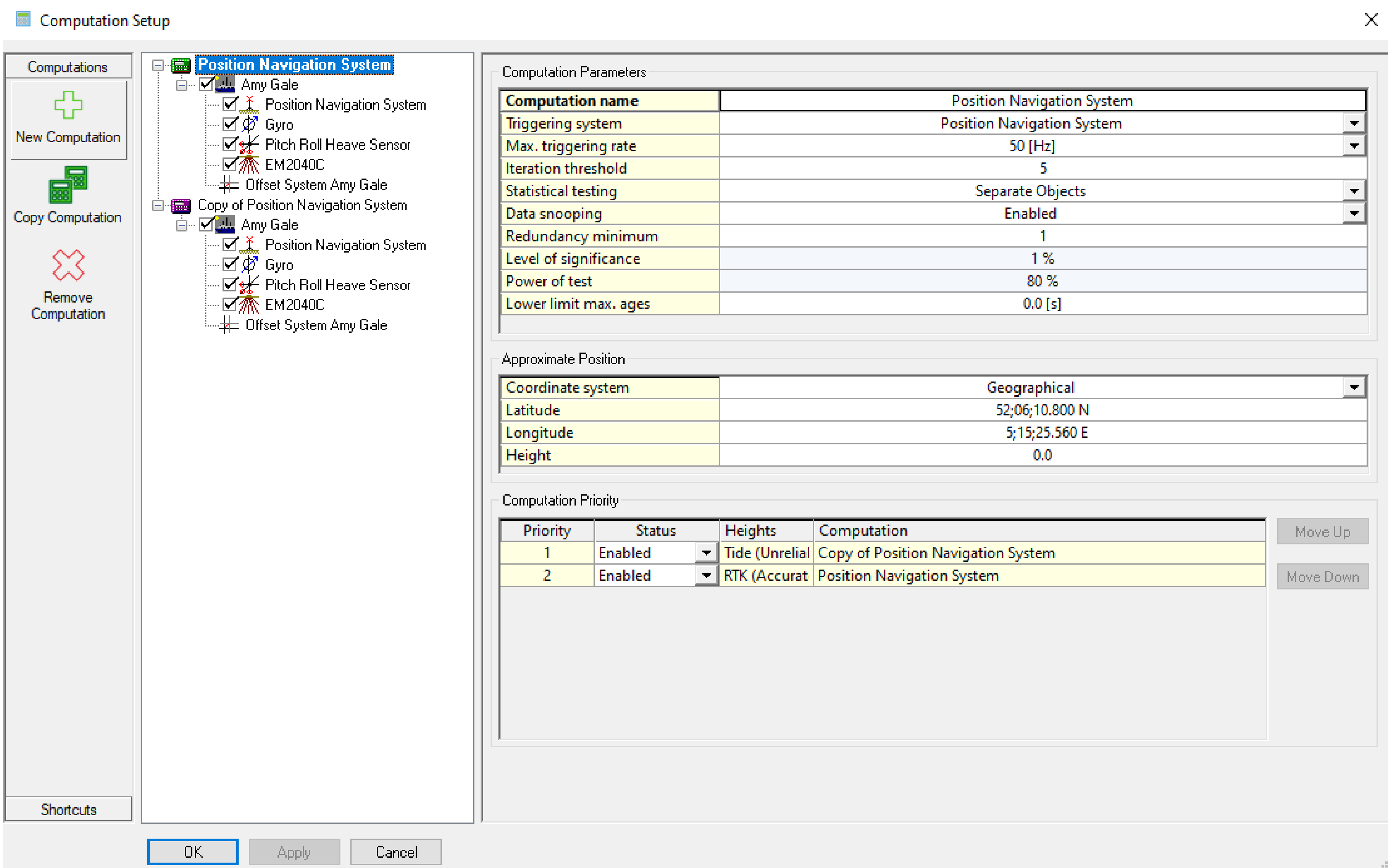
Lambert's law for intensity was turned ON starting 01/25/23. No notable disagreements were found across backscatter datasets collected before and after the change was implemented.

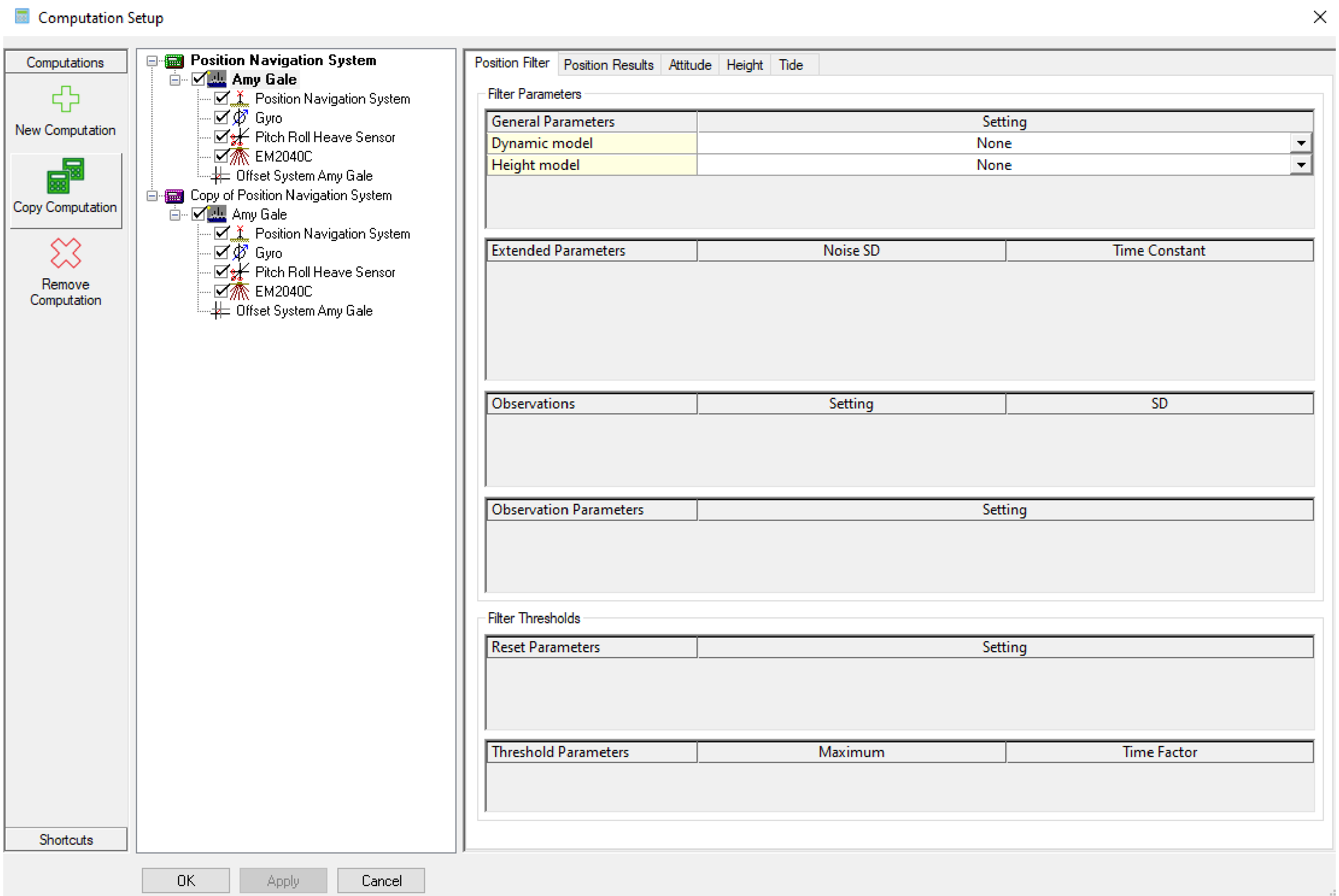


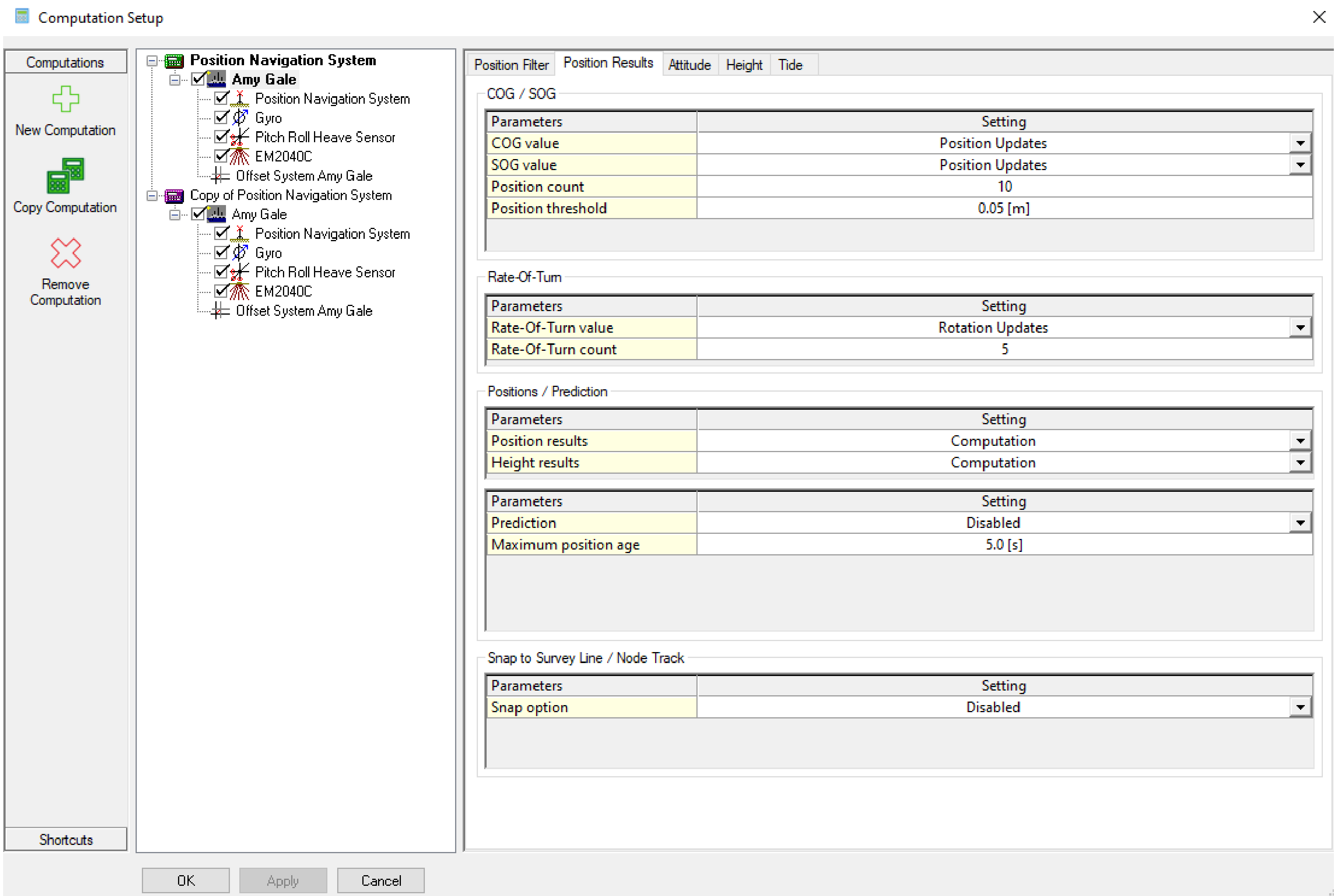


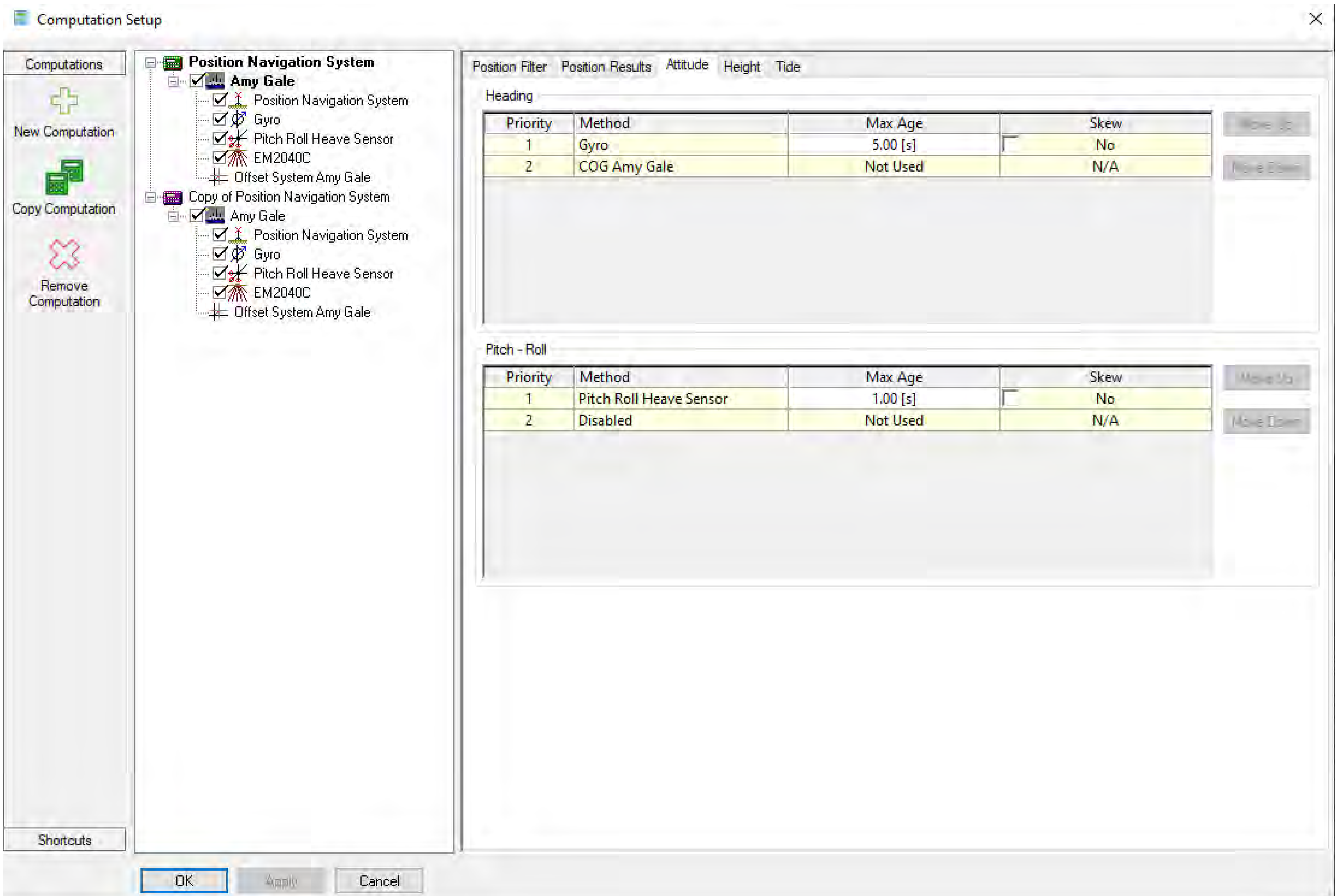


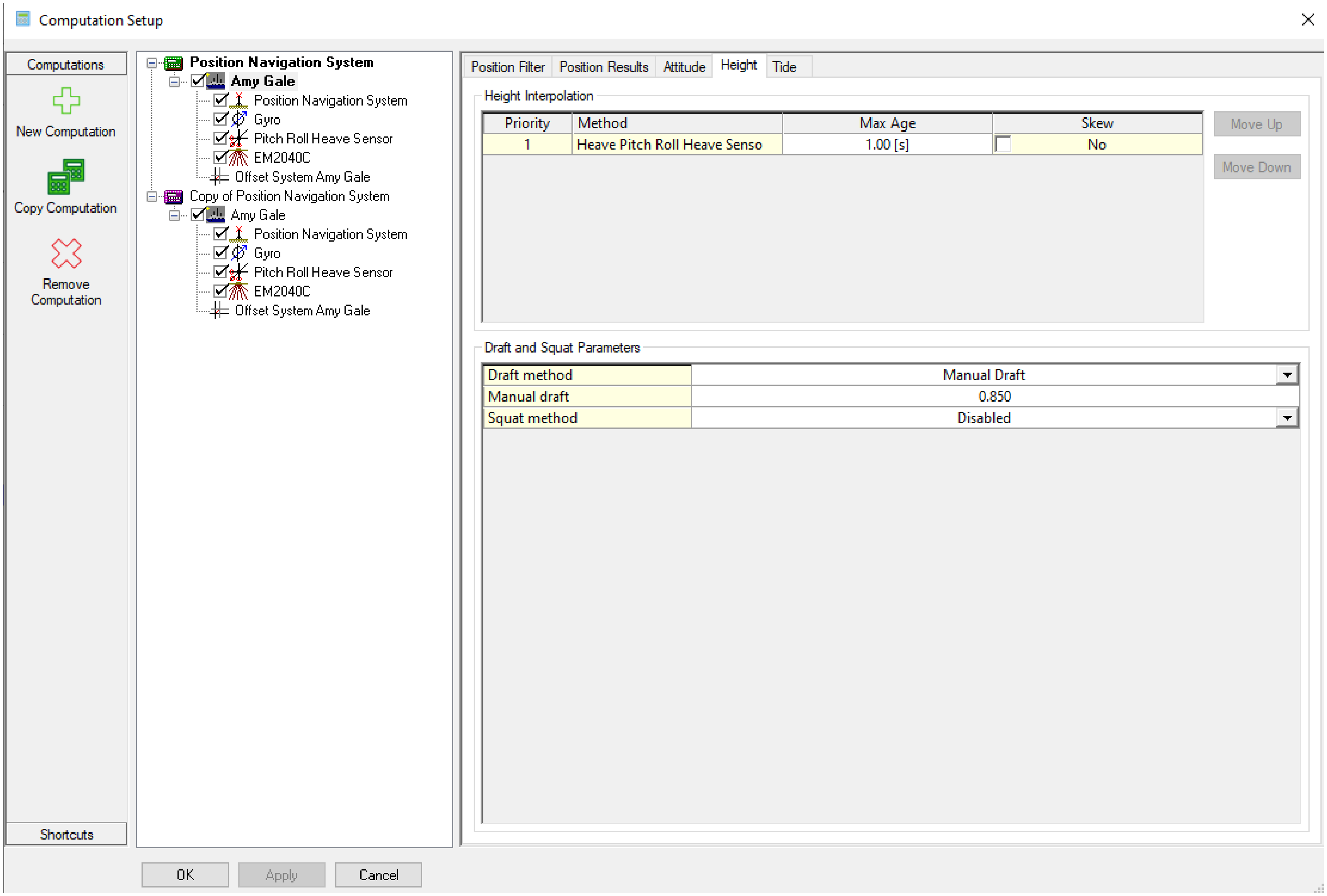
Appendix F – Computation Settings for Qinsy Online

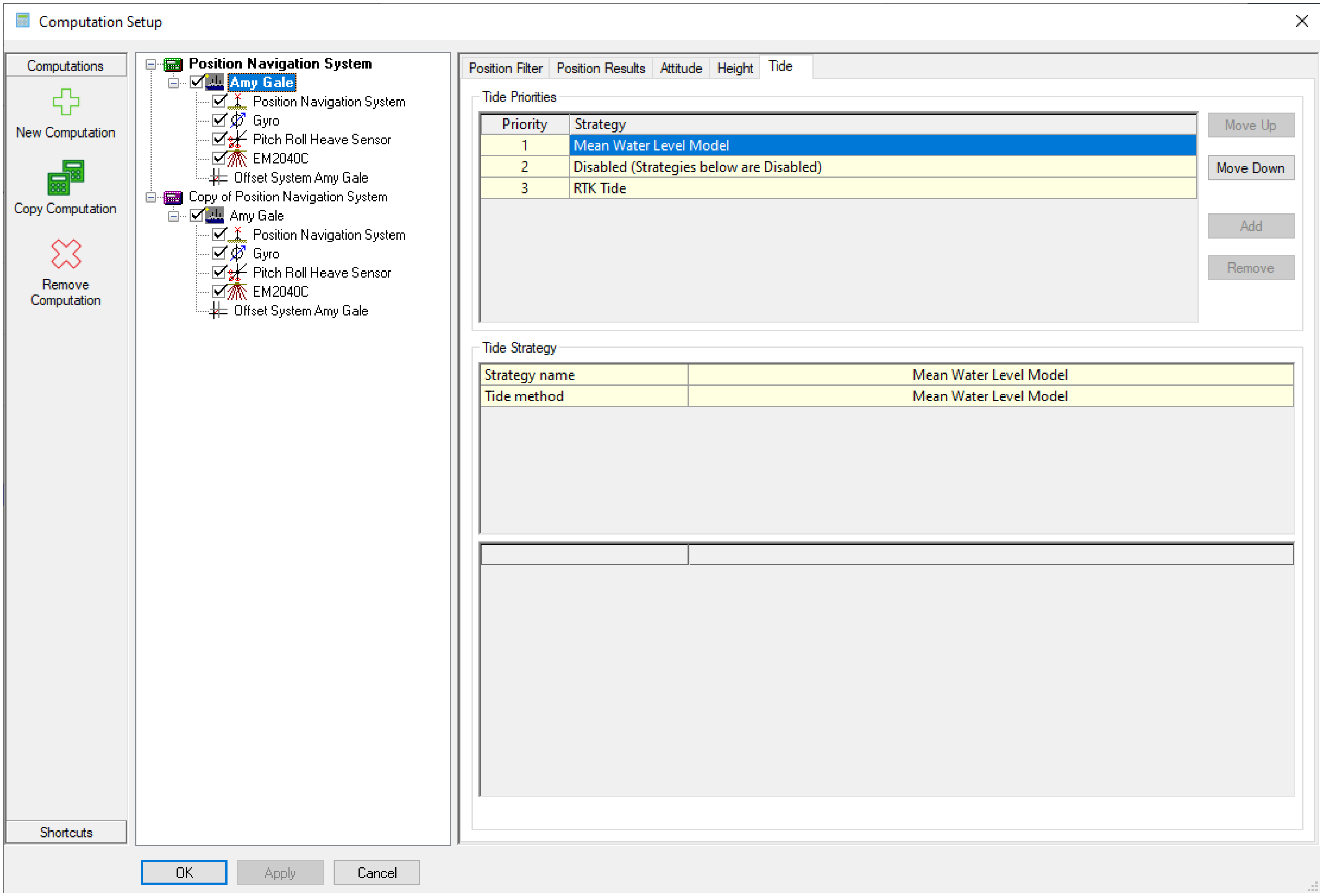


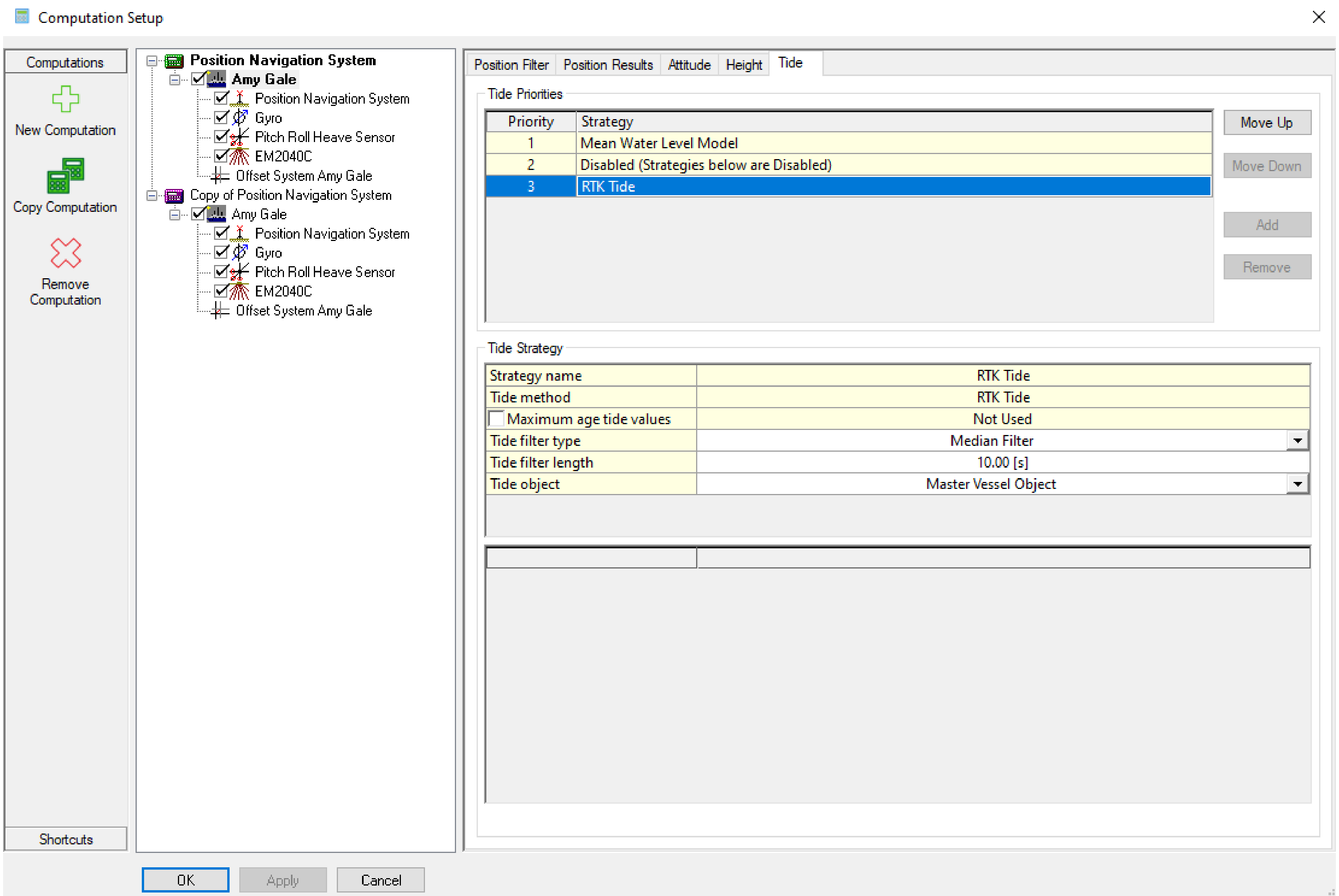

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Filter Parameters
General Parameters
Setting
Dynamic model
None
Height model
None
Extended Parameters
Noise SD
Time Constant
Observations
Setting
SD
Observation Parameters
Setting
Filter Thresholds
Reset Parameters
Setting
Threshold Parameters
Maximum
Time Factor
OK
Apply
Cancel

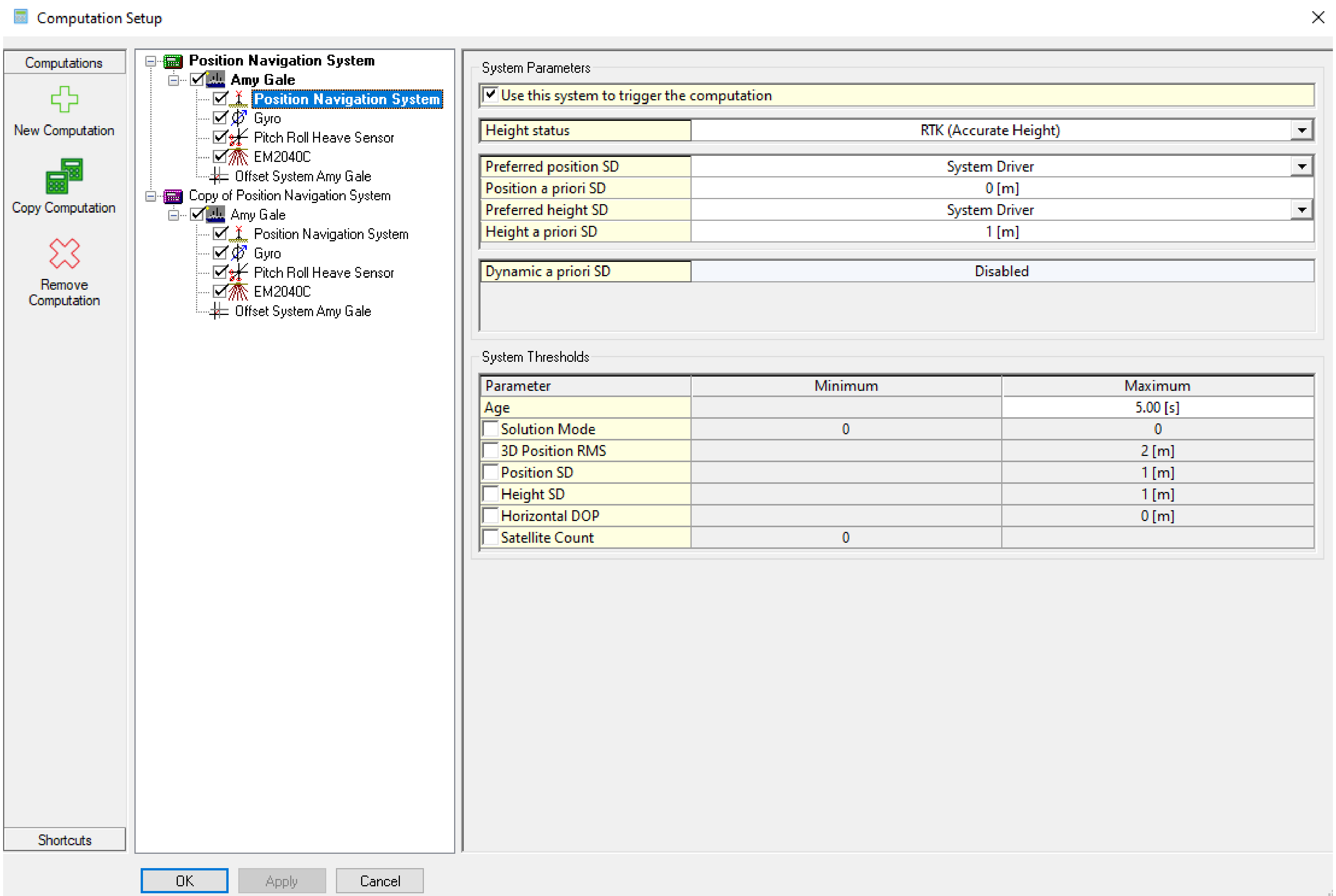

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
COG / SOG
Parameters
Setting
COG value
Position Updates
SOG value
Position Updates
Position count
10
Position threshold
0.05 [m]
Rate-Of-Turn
Parameters
Setting
Rate-Of-Turn value
Rotation Updates
Rate-Of-Turn count
5
Positions / Prediction
Parameters
Setting
Position results
Computation
Height results
Computation
Parameters
Setting
Prediction
Disabled
Maximum position age
5.0 [s]
Snap to Survey Line / Node Track
Parameters
Setting
Snap option
Disabled
OK
Apply
Cancel

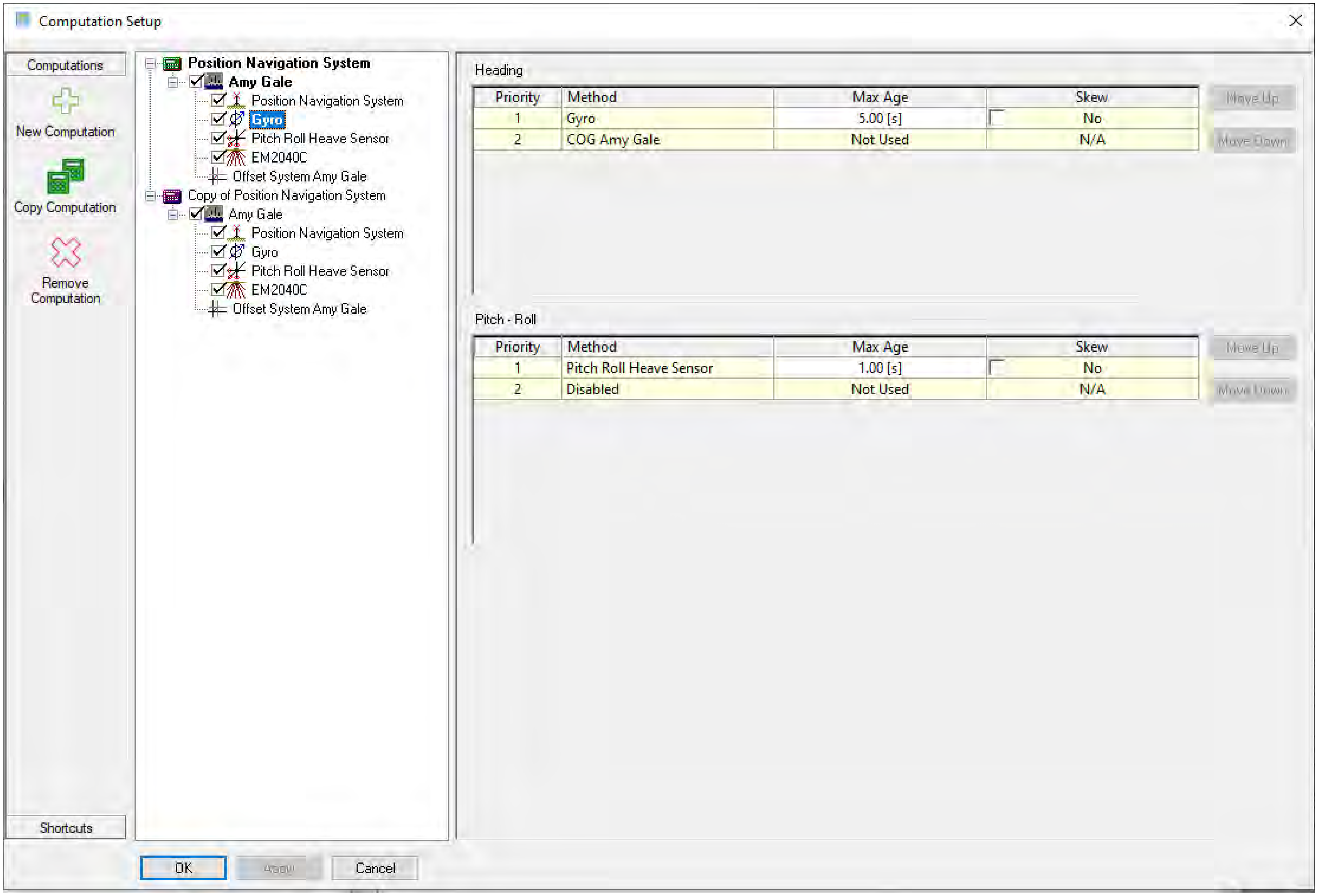

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Heading
Priority
Method
Max Age
Skew
1
Gyro
5.00 [s]
No
2
COG Amy Gale
Not Used
N/A
Pitch - Roll
Priority
Method
Max Age
Skew
1
Pitch Roll Heave Sensor
1.00 [s]
No
2
Disabled
Not Used
N/A
OK
Apply
Cancel

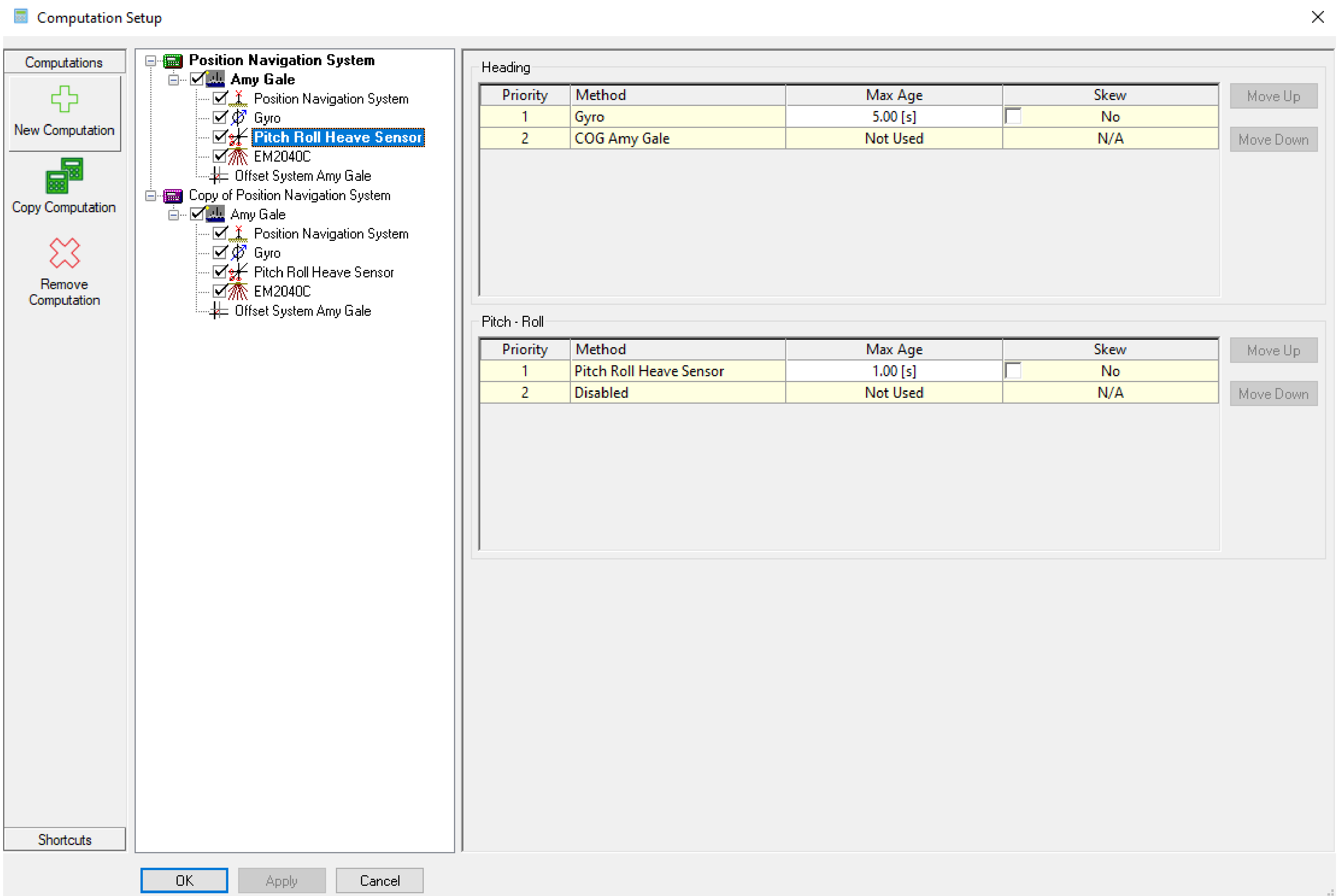

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Height Interpolation
Priority
Method
Max Age
Skew
1
Heave Pitch Roll Heave Senso
1.00 [s]
No
Move Up
Move Down
Draft and Squat Parameters
Draft method
Manual Draft
Manual draft
0.850
Squat method
Disabled
OK
Apply
Cancel

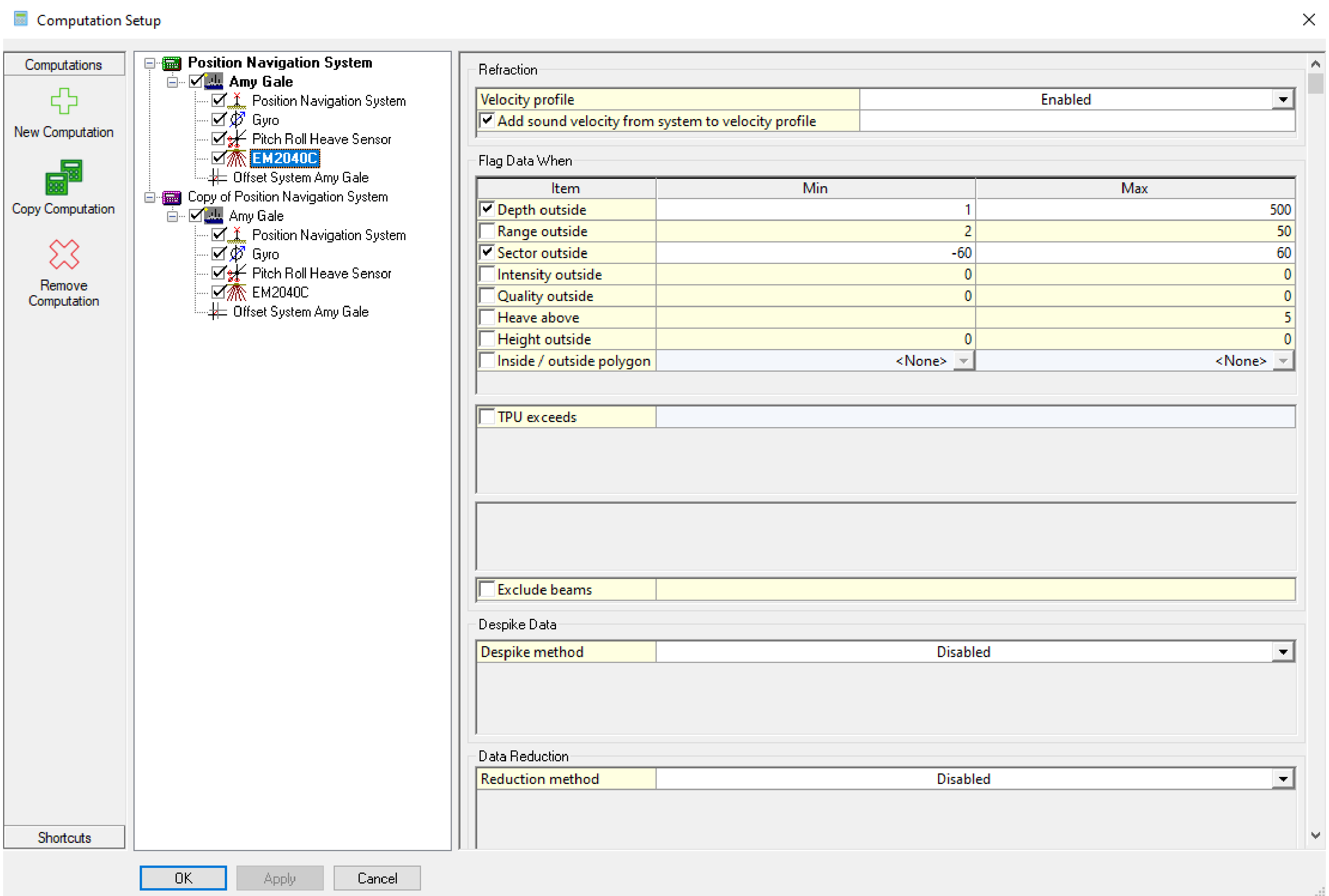

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Tide Priorities
Priority
Strategy
1
Mean Water Level Model
2
Disabled (Strategies below are Disabled)
3
RTK Tide
Move Up
Move Down
Add
Remove
Tide Strategy
Strategy name
Mean Water Level Model
Tide method
Mean Water Level Model
OK
Apply
Cancel

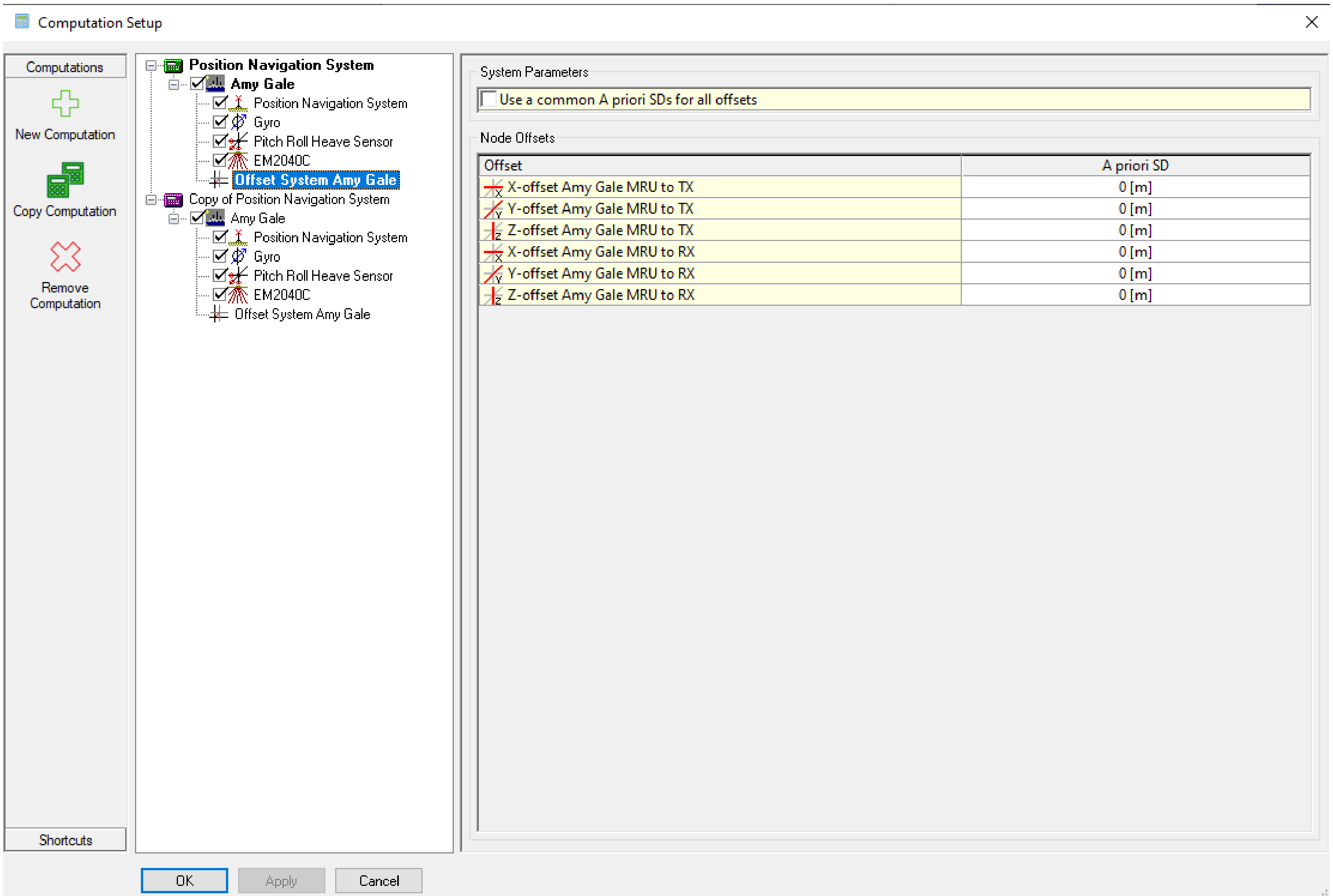

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Tide Priorities
Priority
Strategy
1
Mean Water Level Model
2
Disabled (Strategies below are Disabled)
3
RTK Tide
Move Up
Move Down
Add
Remove
Tide Strategy
Strategy name
RTK Tide
Tide method
RTK Tide
Maximum age tide values
Not Used
Tide filter type
Median Filter
Tide filter length
10.00 [s]
Tide object
Master Vessel Object
OK
Apply
Cancel

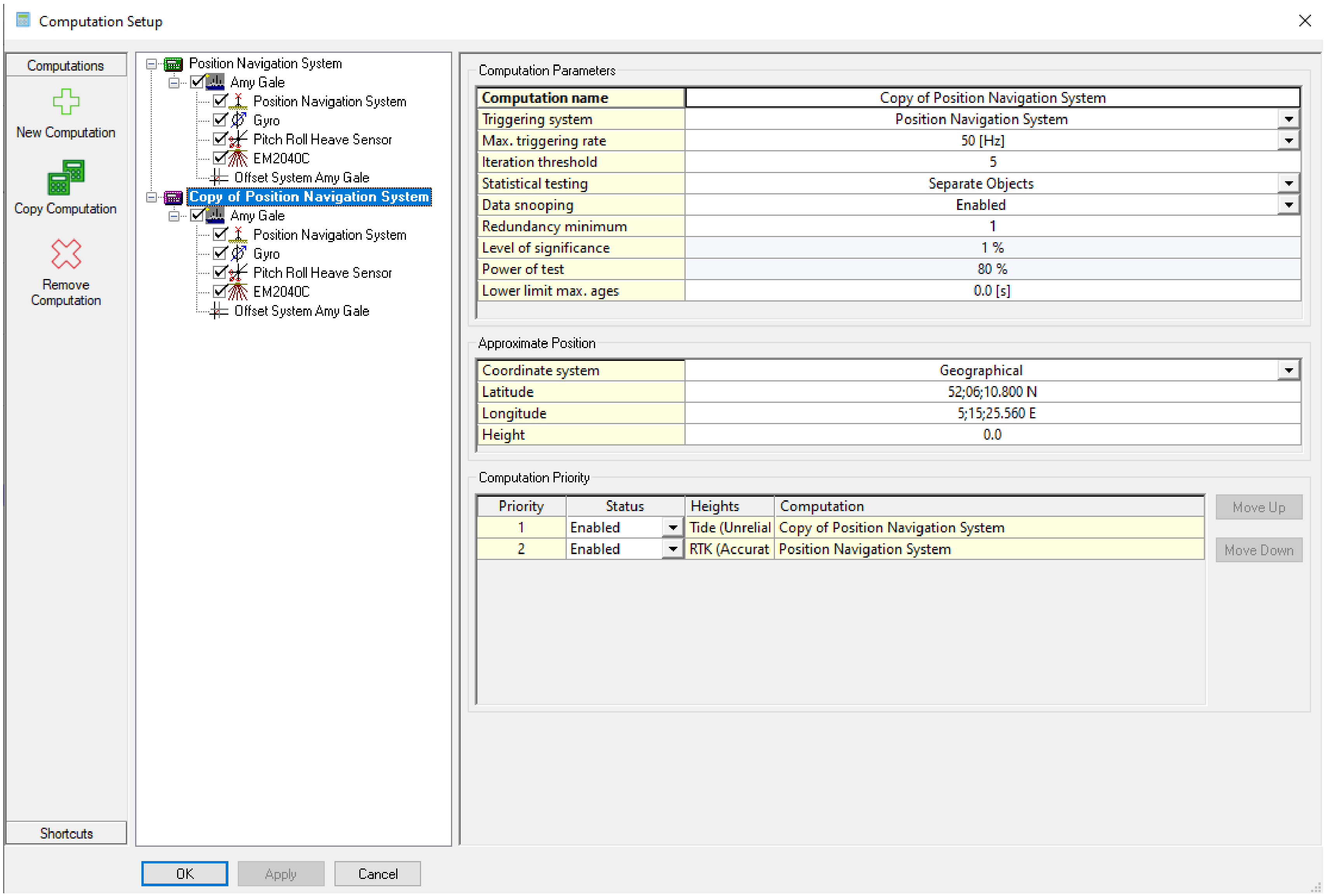

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
System Parameters
Use this system to trigger the computation
Height status
RTK (Accurate Height)
Preferred position SD
System Driver
Position a priori SD
0 [m]
Preferred height SD
System Driver
Height a priori SD
1 [m]
Dynamic a priori SD
Disabled
System Thresholds
Parameter
Minimum
Maximum
Age
5.00 [s]
Solution Mode
0
0
3D Position RMS
2 [m]
Position SD
1 [m]
Height SD
1 [m]
Horizontal DOP
0 [m]
Satellite Count
0
OK
Apply
Cancel

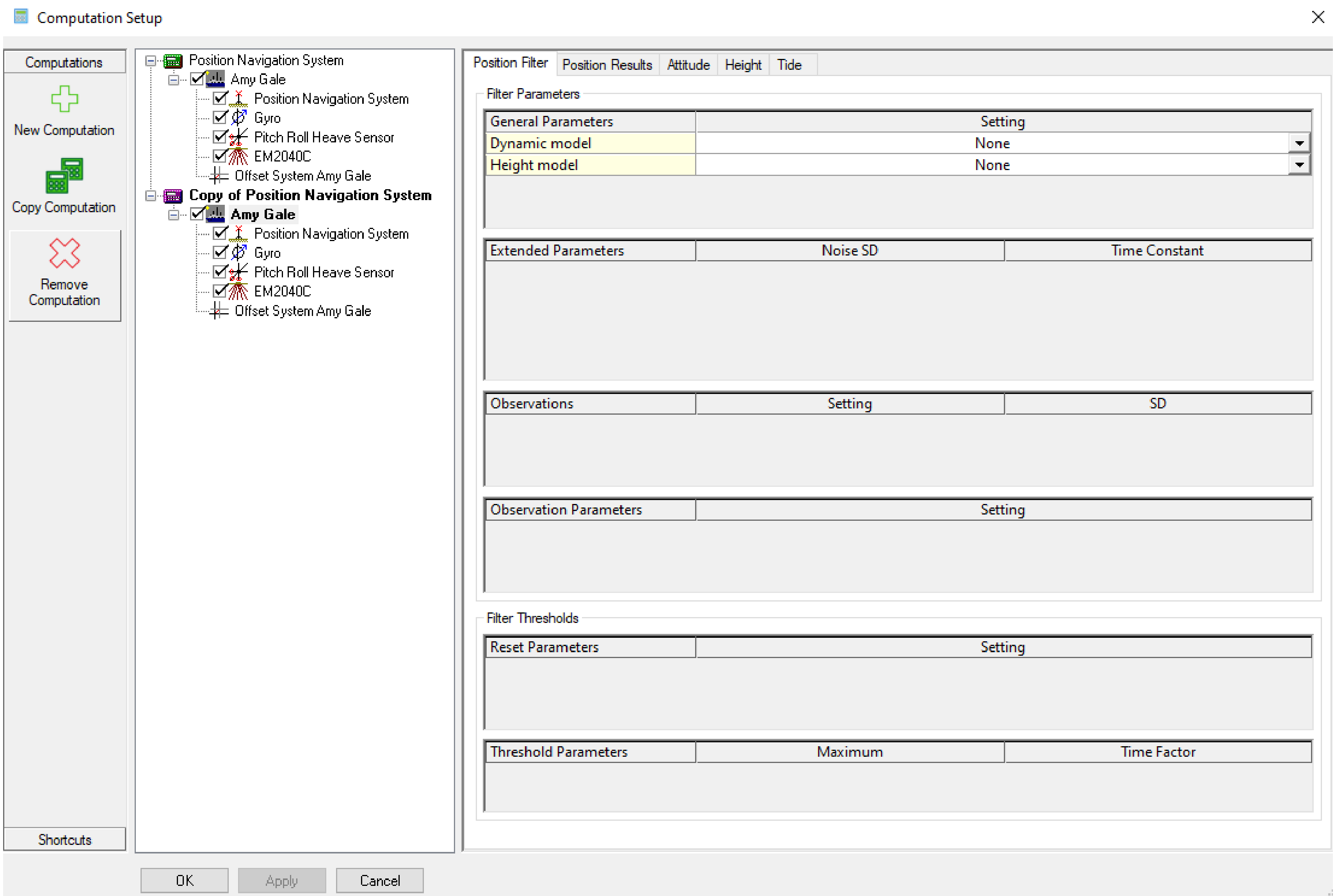

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Heading
Priority | Method | Max Age | Skew
1 | Gyro | 5.00 [s] | No
2 | COG Amy Gale | Not Used | N/A
Move Up
Move Down
Pitch - Roll
Priority | Method | Max Age | Skew
1 | Pitch Roll Heave Sensor | 1.00 [s] | No
2 | Disabled | Not Used | N/A
Move Up
Move Down
OK
Apply
Cancel

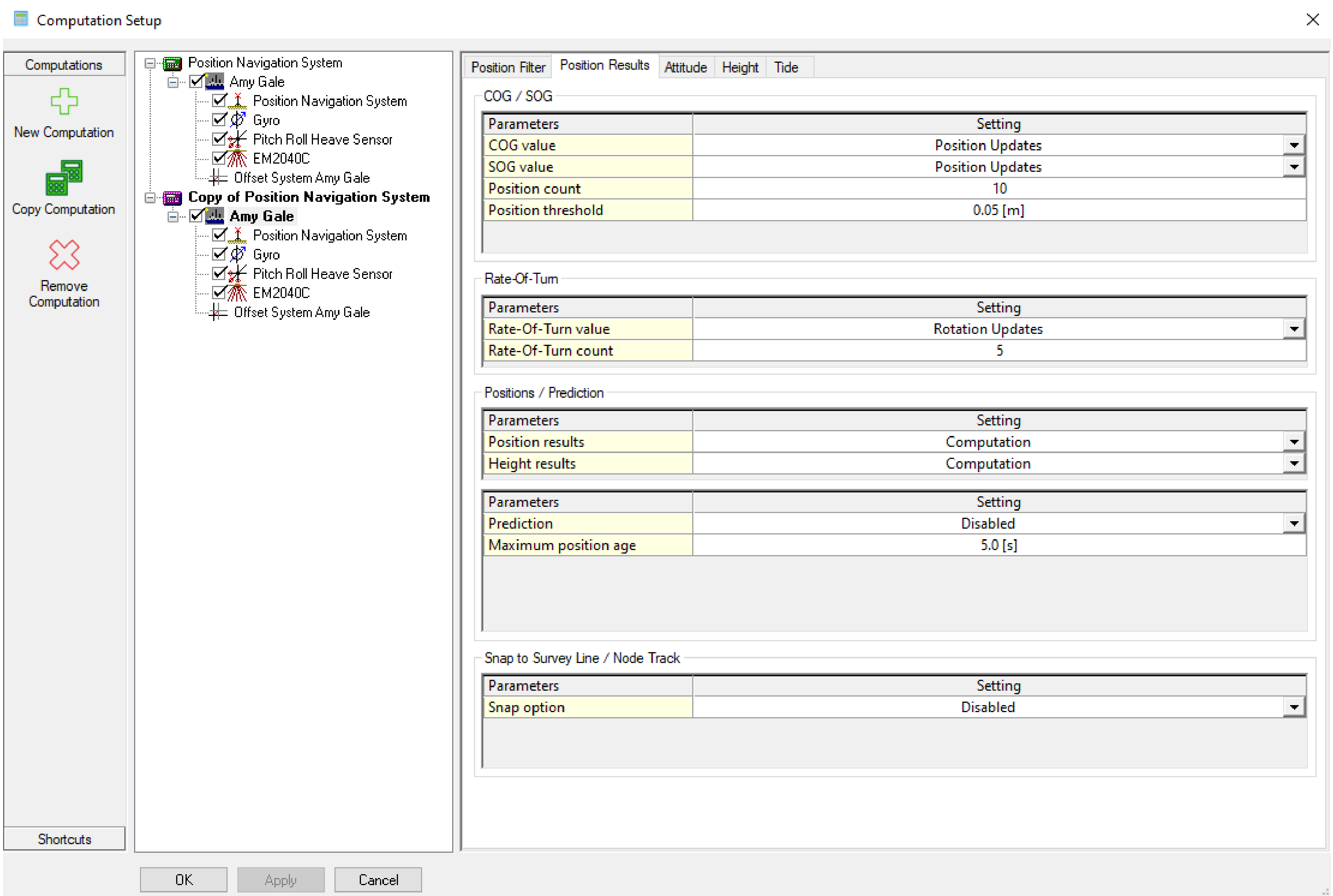

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Heading
Priority
Method
Max Age
Skew
1
Gyro
5.00 [s]
No
2
COG Amy Gale
Not Used
N/A
Move Up
Move Down
Pitch - Roll
Priority
Method
Max Age
Skew
1
Pitch Roll Heave Sensor
1.00 [s]
No
2
Disabled
Not Used
N/A
Move Up
Move Down
OK
Apply
Cancel

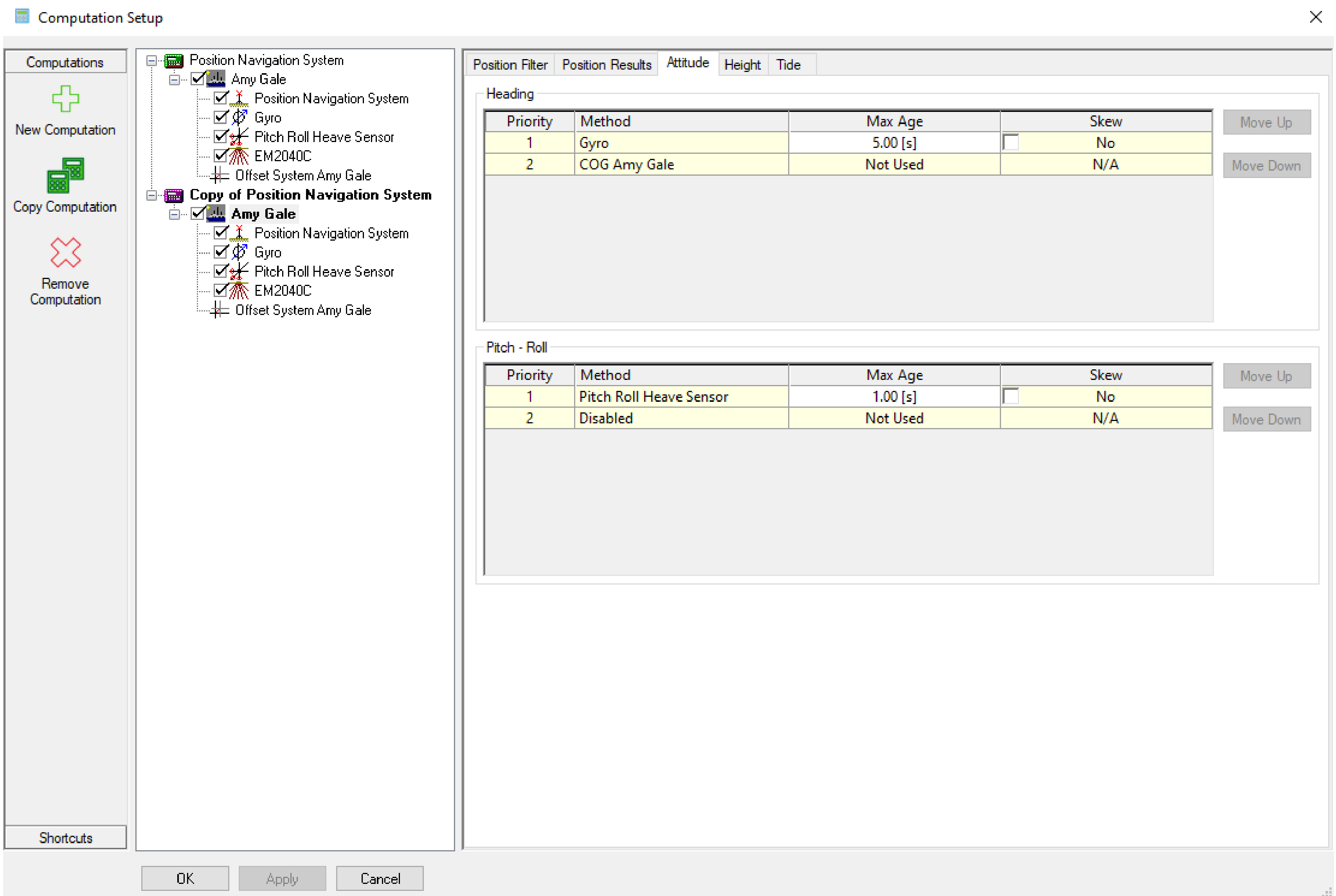

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Refraction
Velocity profile
Enabled
Add sound velocity from system to velocity profile
Flag Data When
Item
Min
Max
Depth outside
1
500
Range outside
2
50
Sector outside
-60
60
Intensity outside
0
0
Quality outside
0
0
Heave above
5
Height outside
0
0
Inside / outside polygon
<None>
<None>
TPU exceeds
Exclude beams
Despike Data
Despike method
Disabled
Data Reduction
Reduction method
Disabled
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
System Parameters
Use a common A priori SDs for all offsets
Node Offsets
Offset
A priori SD
X-offset Amy Gale MRU to TX
0 [m]
Y-offset Amy Gale MRU to TX
0 [m]
Z-offset Amy Gale MRU to TX
0 [m]
X-offset Amy Gale MRU to RX
0 [m]
Y-offset Amy Gale MRU to RX
0 [m]
Z-offset Amy Gale MRU to RX
0 [m]
OK
Apply
Cancel

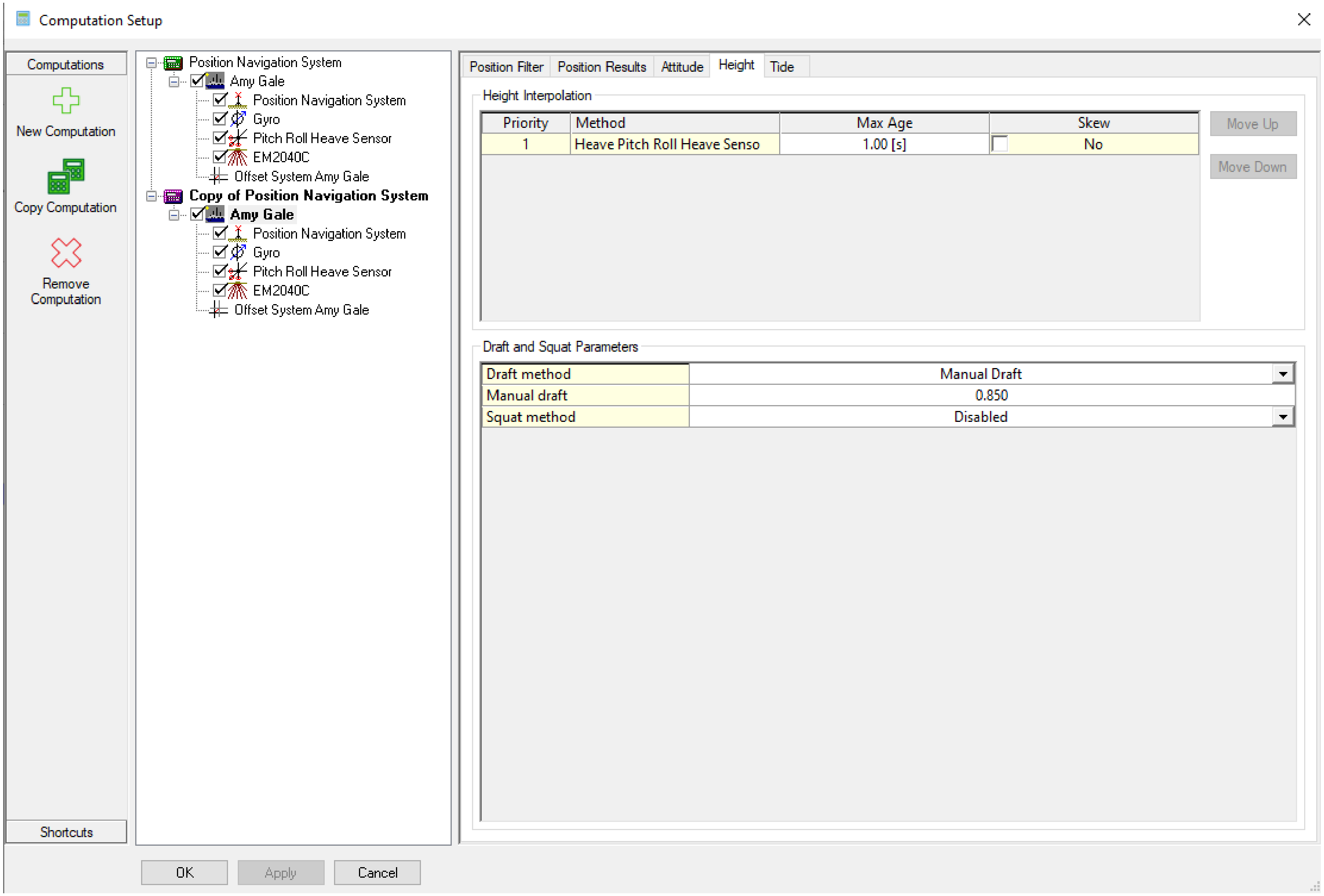

Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Computation Parameters
Computation name
Copy of Position Navigation System
Triggering system
Position Navigation System
Max. triggering rate
50 [Hz]
Iteration threshold
5
Statistical testing
Separate Objects
Data snooping
Enabled
Redundancy minimum
1
Level of significance
1 %
Power of test
80 %
Lower limit max. ages
0.0 [s]
Approximate Position
Coordinate system
Geographical
Latitude
52;06;10.800 N
Longitude
5;15;25.560 E
Height
0.0
Computation Priority
Priority
Status
Heights
Computation
1
Enabled
Tide (Unrelial
Copy of Position Navigation System
2
Enabled
RTK (Accurat
Position Navigation System
Move Up
Move Down
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Filter Parameters
General Parameters
Setting
Dynamic model
None
Height model
None
Extended Parameters
Noise SD
Time Constant
Observations
Setting
SD
Observation Parameters
Setting
Filter Thresholds
Reset Parameters
Setting
Threshold Parameters
Maximum
Time Factor
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
COG / SOG
Parameters
Setting
COG value
Position Updates
SOG value
Position Updates
Position count
10
Position threshold
0.05 [m]
Rate-Of-Turn
Parameters
Setting
Rate-Of-Turn value
Rotation Updates
Rate-Of-Turn count
5
Positions / Prediction
Parameters
Setting
Position results
Computation
Height results
Computation
Parameters
Setting
Prediction
Disabled
Maximum position age
5.0 [s]
Snap to Survey Line / Node Track
Parameters
Setting
Snap option
Disabled
OK
Apply
Cancel



Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Heading
Priority
Method
Max Age
Skew
1
Gyro
5.00 [s]
No
2
COG Amy Gale
Not Used
N/A
Move Up
Move Down
Pitch - Roll
Priority
Method
Max Age
Skew
1
Pitch Roll Heave Sensor
1.00 [s]
No
2
Disabled
Not Used
N/A
Move Up
Move Down
OK
Apply
Cancel


Computation Setup
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Position Filter
Position Results
Attitude
Height
Tide
Height Interpolation
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Heave Pitch Roll Heave Senso
1.00 [s]
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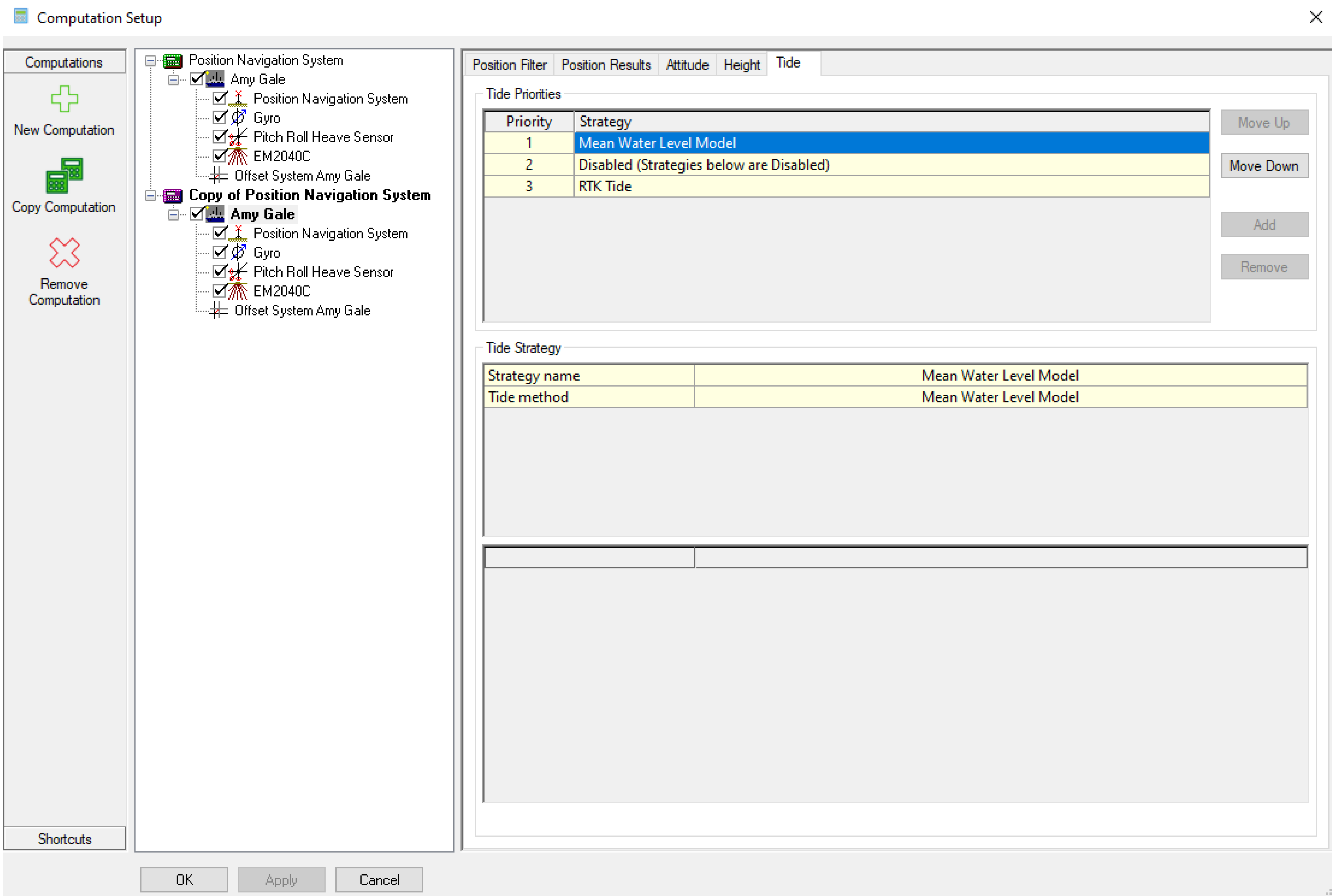
Move Up
Move Down
Draft and Squat Parameters
Draft method
Manual Draft
Manual draft
0.850
Squat method
Disabled
OK
Apply
Cancel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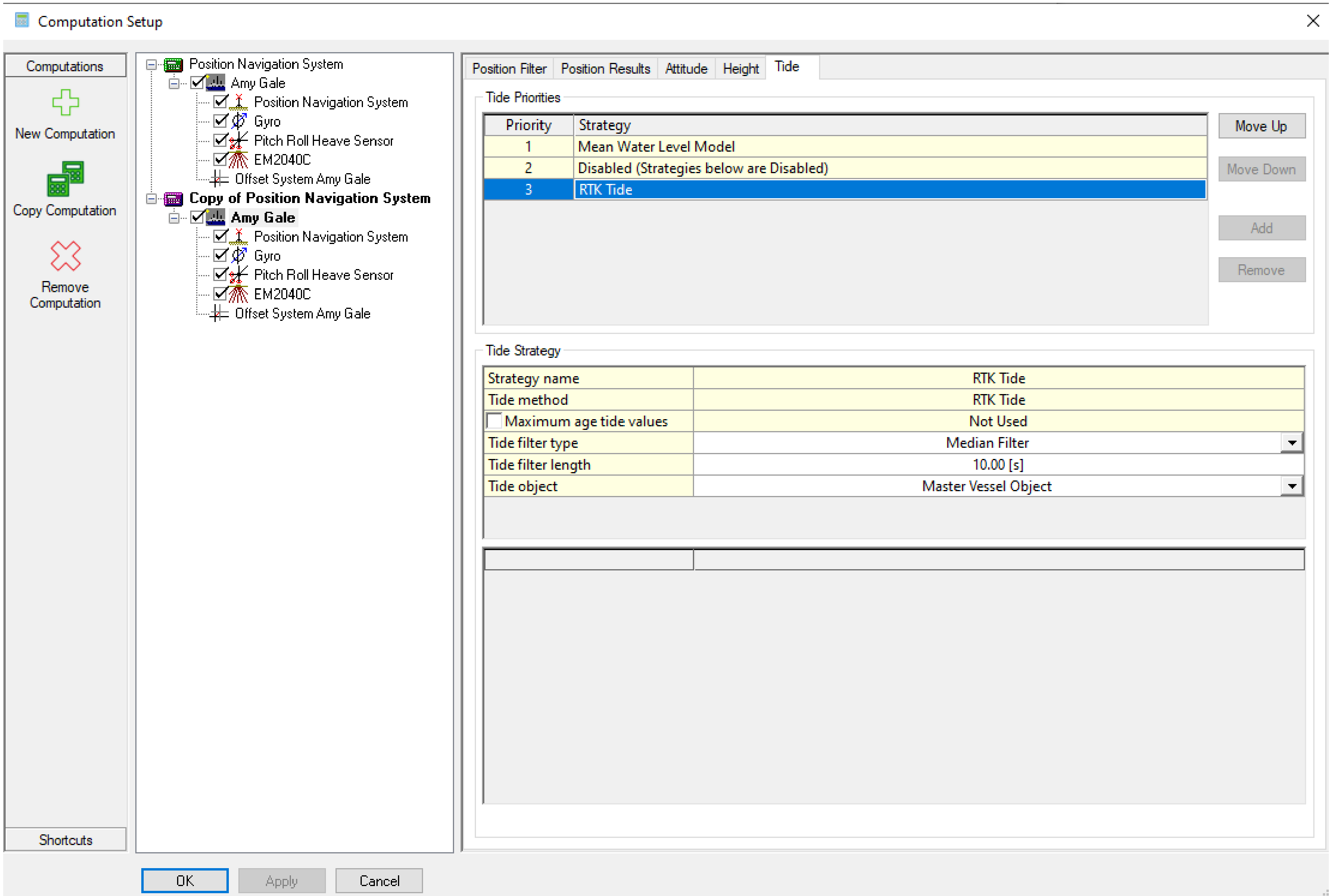
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Tide Priorities
Priority
Strategy
1
Mean Water Level Model
2
Disabled (Strategies below are Disabled)
3
RTK Tide
Move Up
Move Down
Add
Remove
Tide Strategy
Strategy name
Mean Water Level Model
Tide method
Mean Water Level Model
OK
Apply
Cancel


Computation Setup
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Remove Computation
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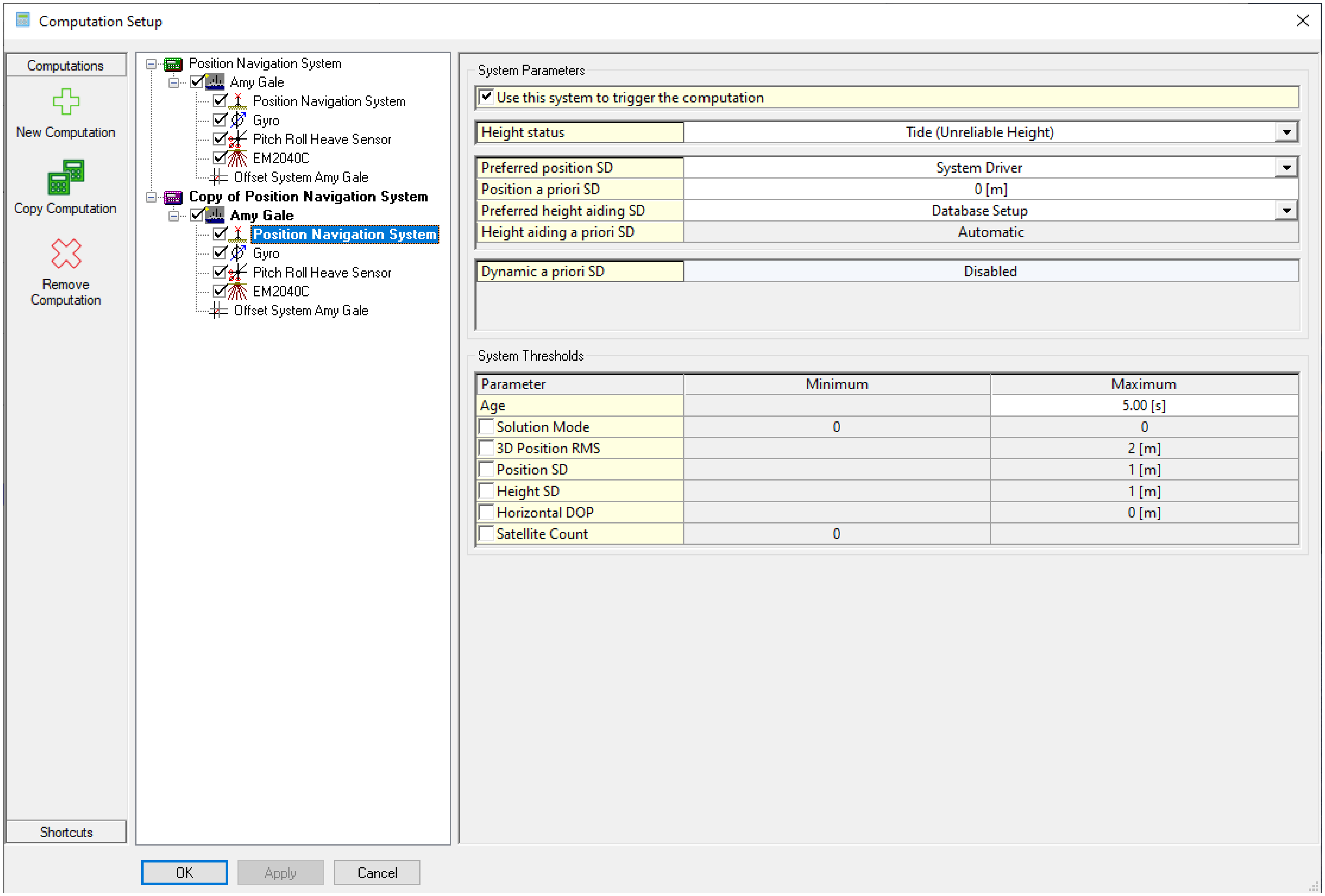
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Position Filter
Position Results
Attitude
Height
Tide
Tide Priorities
Priority
Strategy
1
Mean Water Level Model
2
Disabled (Strategies below are Disabled)
3
RTK Tide
Move Up
Move Down
Add
Remove
Tide Strategy
Strategy name
RTK Tide
Tide method
RTK Tide
Maximum age tide values
Not Used
Tide filter type
Median Filter
Tide filter length
10.00 [s]
Tide object
Master Vessel Object
OK
Apply
Cancel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Computations
New Computation
Copy Computation
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Shortcuts
Position Navigation System
Amy Gale
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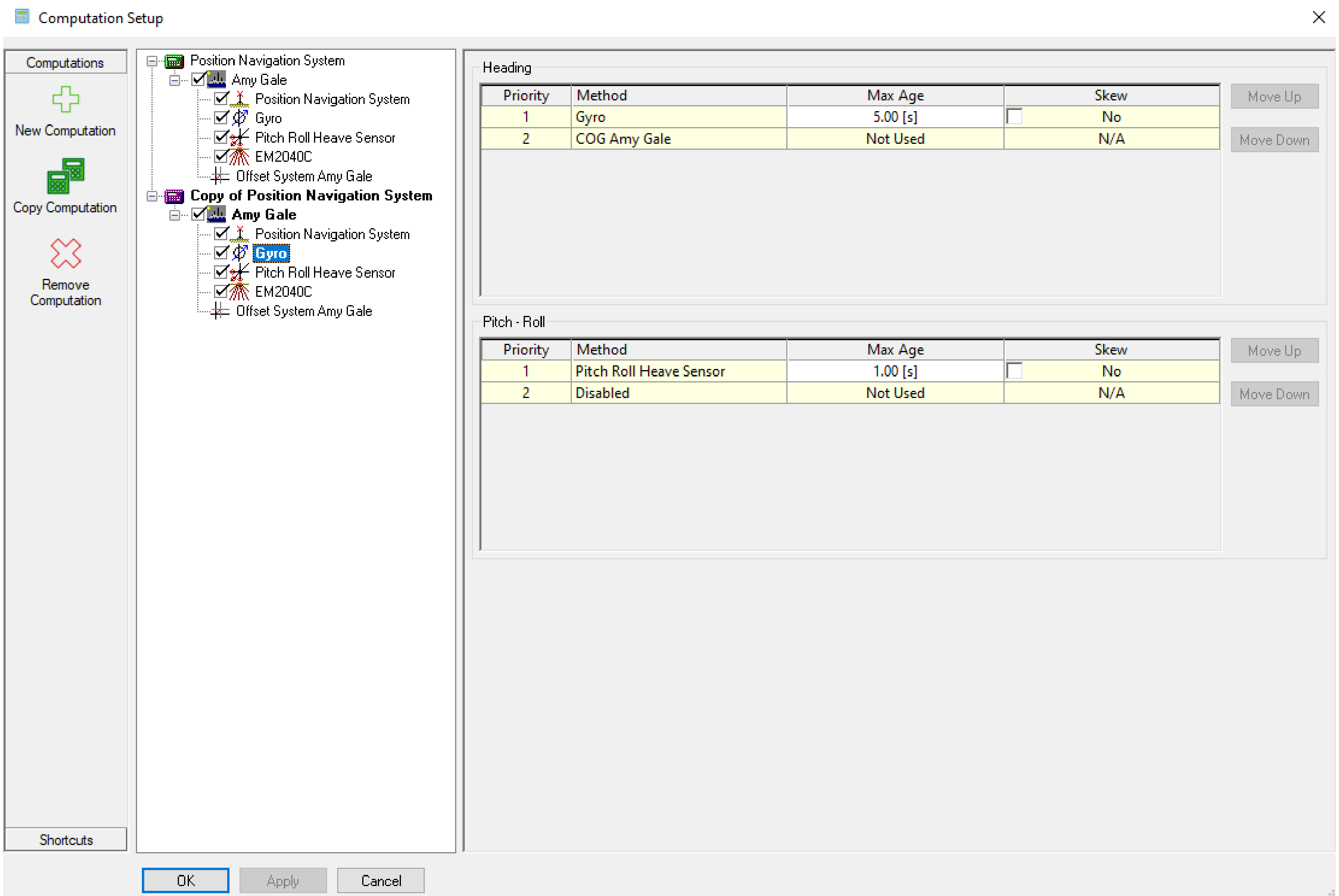
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
System Parameters
Use this system to trigger the computation
Height status
Tide (Unreliable Height)
Preferred position SD
System Driver
Position a priori SD
0 [m]
Preferred height aiding SD
Database Setup
Height aiding a priori SD
Automatic
Dynamic a priori SD
Disabled
System Thresholds
Parameter
Minimum
Maximum
Age
5.00 [s]
Solution Mode
0
0
3D Position RMS
2 [m]
Position SD
1 [m]
Height SD
1 [m]
Horizontal DOP
0 [m]
Satellite Count
0
OK
Apply
Cancel


Computation Setup
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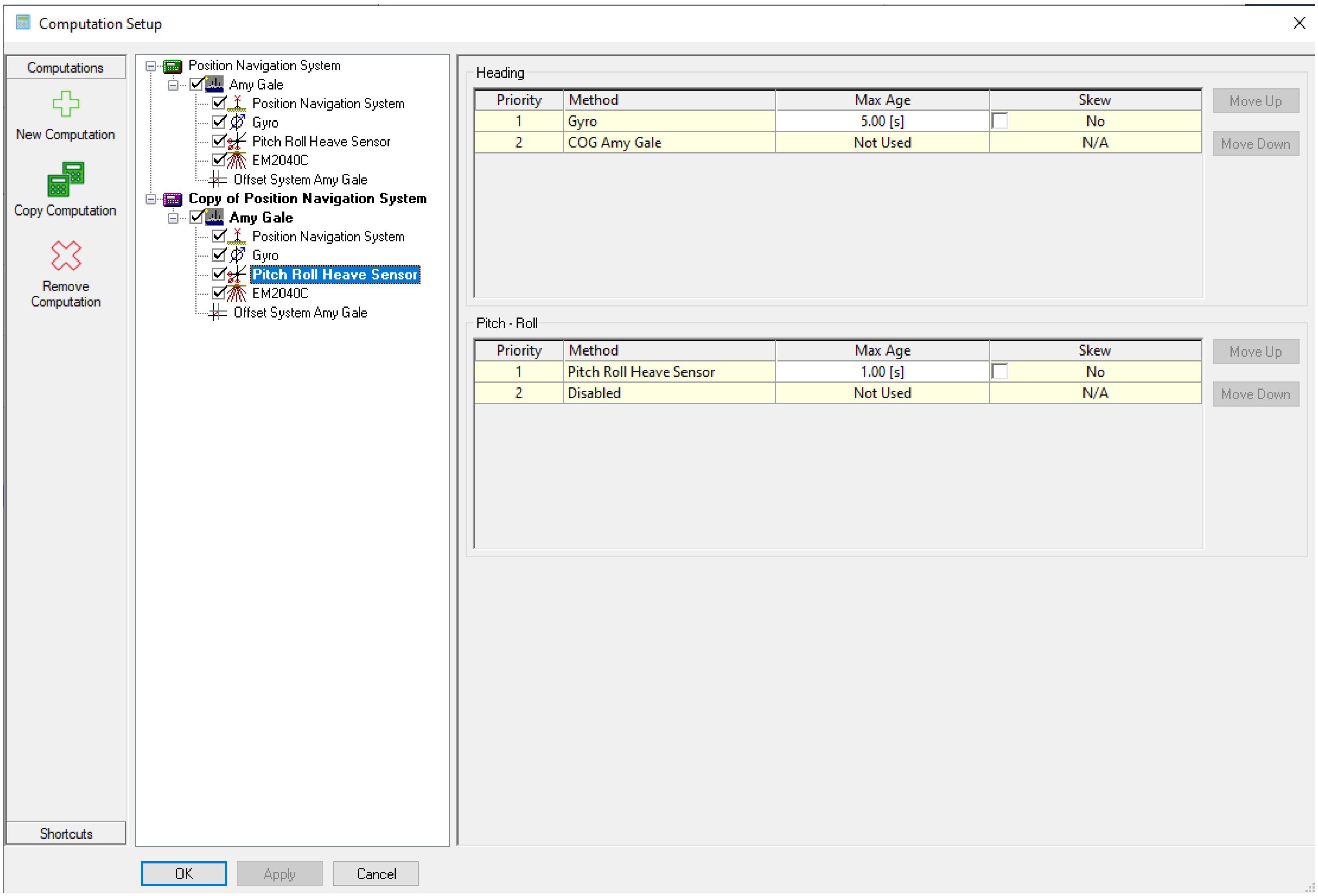
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Heading
Priority | Method | Max Age | Skew
1 | Gyro | 5.00 [s] | No
2 | COG Amy Gale | Not Used | N/A
Move Up
Move Down
Pitch - Roll
Priority | Method | Max Age | Skew
1 | Pitch Roll Heave Sensor | 1.00 [s] | No
2 | Disabled | Not Used | N/A
Move Up
Move Down
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
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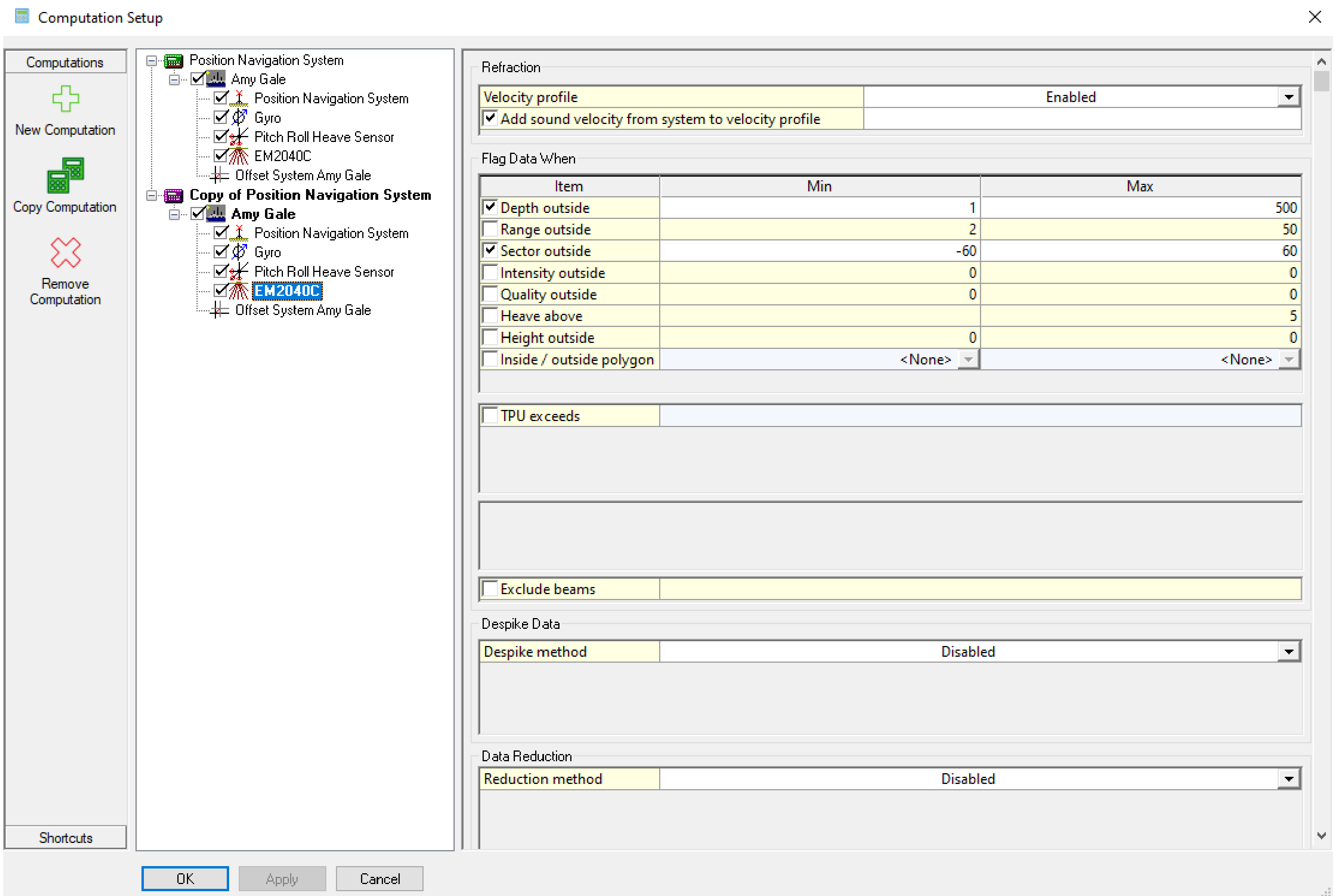
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Heading
Priority
Method
Max Age
Skew
1
Gyro
5.00 [s]
No
2
COG Amy Gale
Not Used
N/A
Move Up
Move Down
Pitch - Roll
Priority
Method
Max Age
Skew
1
Pitch Roll Heave Sensor
1.00 [s]
No
2
Disabled
Not Used
N/A
Move Up
Move Down
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
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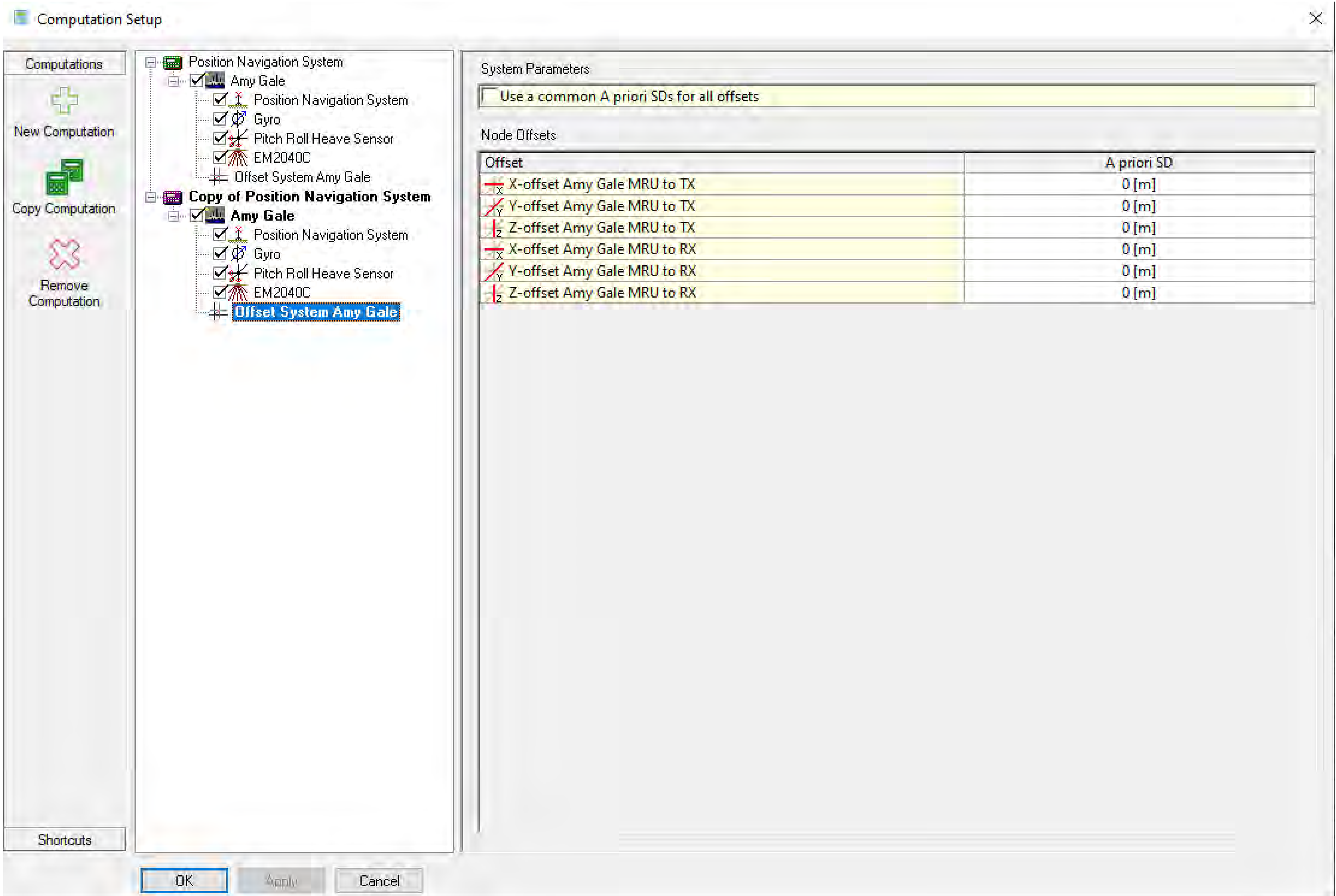
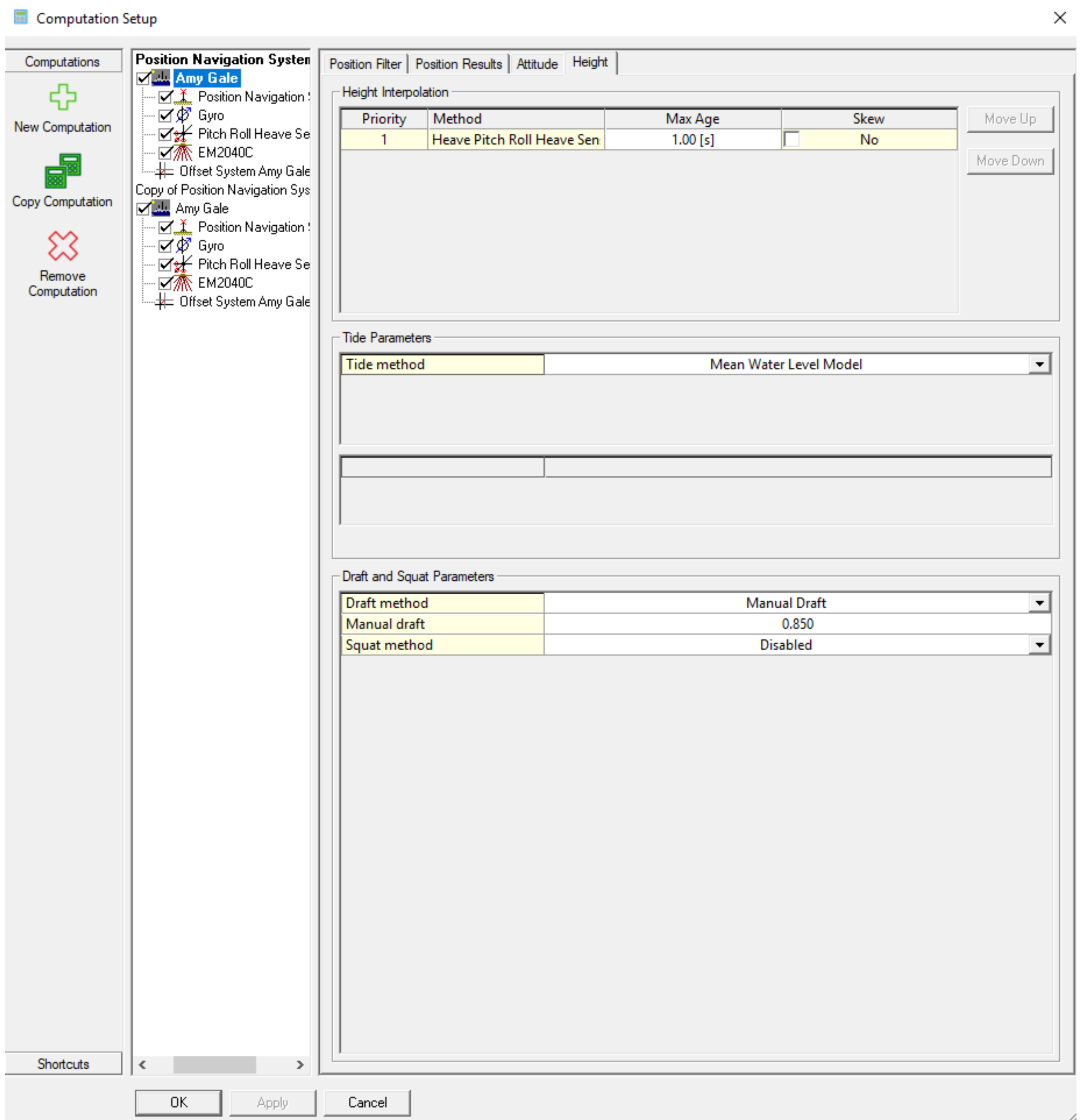
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Refraction
Velocity profile
Enabled
Add sound velocity from system to velocity profile
Flag Data When
Item
Min
Max
Depth outside
1
500
Range outside
2
50
Sector outside
-60
60
Intensity outside
0
0
Quality outside
0
0
Heave above
5
Height outside
0
0
Inside / outside polygon
<None>
<None>
TPU exceeds
Exclude beams
Despike Data
Despike method
Disabled
Data Reduction
Reduction method
Disabled
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
Copy of Position Navigation System
Amy Gale
Position Navigation System
Gyro
Pitch Roll Heave Sensor
EM2040C
Offset System Amy Gale
System Parameters
Use a common A priori SDs for all offsets
Node Offsets
Offset
A priori SD
X-offset Amy Gale MRU to TX
0 [m]
Y-offset Amy Gale MRU to TX
0 [m]
Z-offset Amy Gale MRU to TX
0 [m]
X-offset Amy Gale MRU to RX
0 [m]
Y-offset Amy Gale MRU to RX
0 [m]
Z-offset Amy Gale MRU to RX
0 [m]
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
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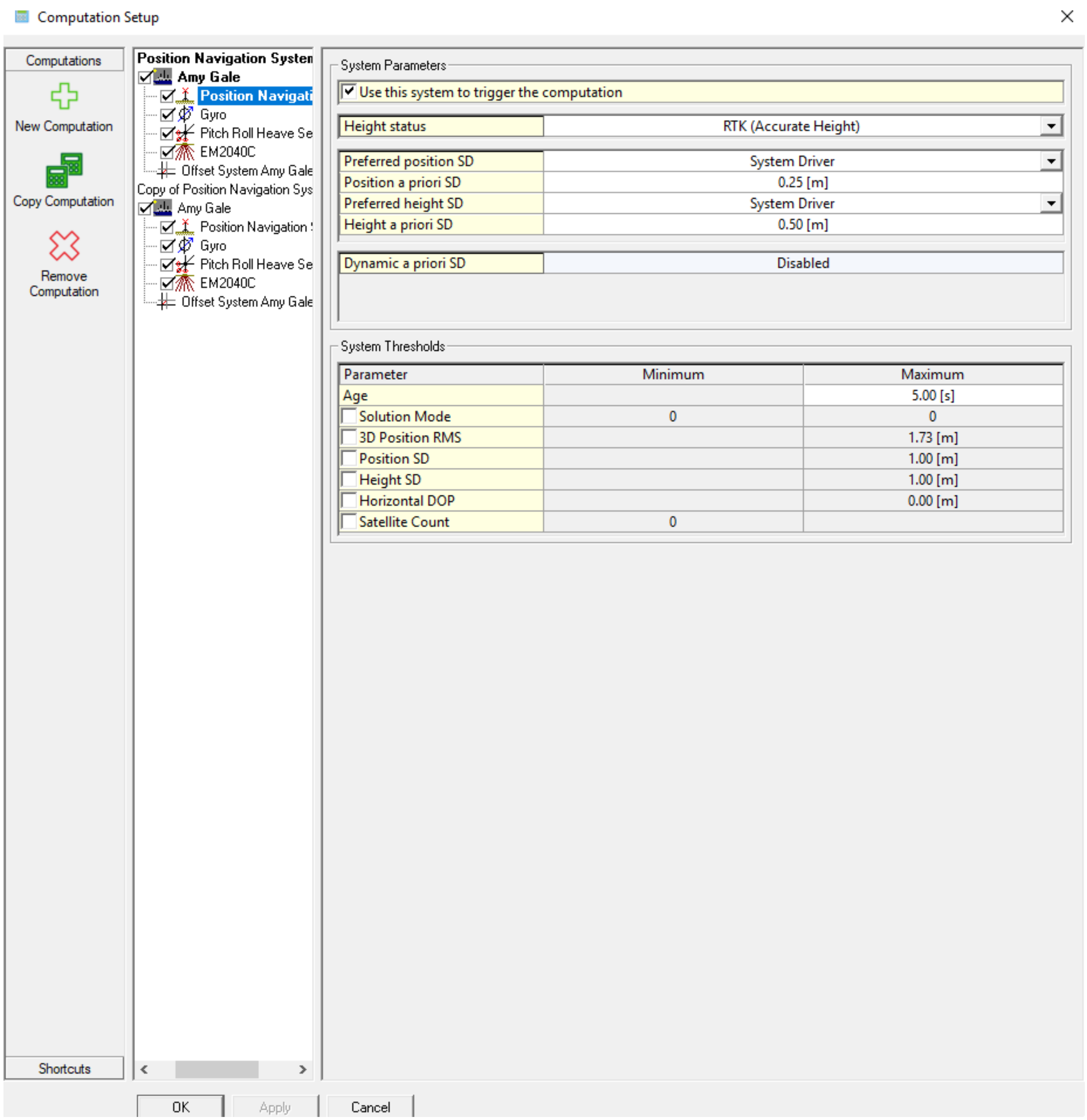
Offset System Amy Gale
Copy of Position Navigation Sys
Position Filter
Position Results
Attitude
Height
Height Interpolation
Priority
Method
Max Age
Skew
1
Heave Pitch Roll Heave Sen
1.00 [s]
No
Move Up
Move Down
Tide Parameters
Tide method
Mean Water Level Model
Draft and Squat Parameters
Draft method
Manual Draft
Manual draft
0.850
Squat method
Disabled
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
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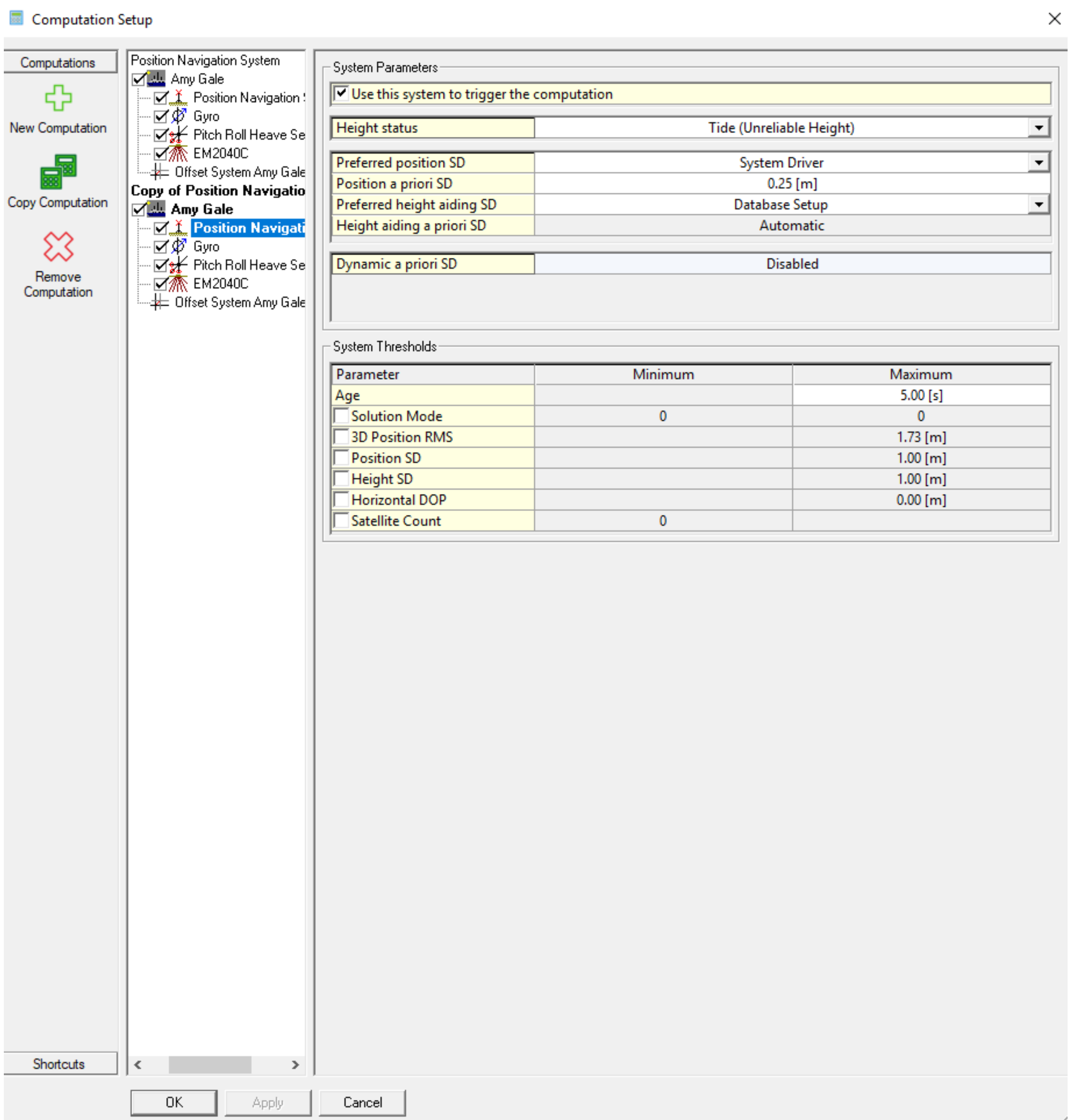
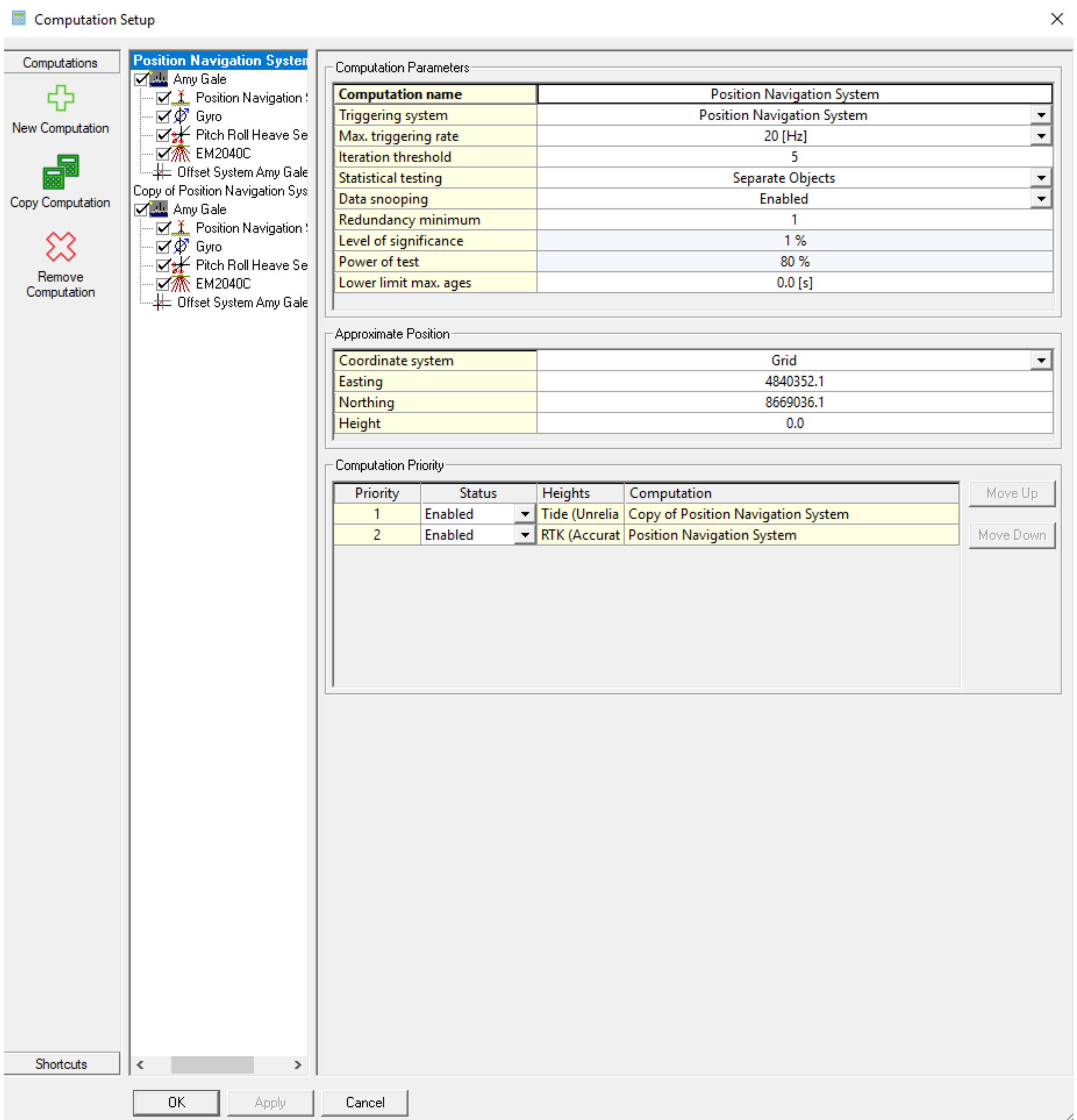
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Copy of Position Navigation Sys
Amy Gale
Position Navigation S
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
System Parameters
Use this system to trigger the computation
Height status
RTK (Accurate Height)
Preferred position SD
System Driver
Position a priori SD
0.25 [m]
Preferred height SD
System Driver
Height a priori SD
0.50 [m]
Dynamic a priori SD
Disabled
System Thresholds
Parameter
Minimum
Maximum
Age
5.00 [s]
Solution Mode
0
0
3D Position RMS
1.73 [m]
Position SD
1.00 [m]
Height SD
1.00 [m]
Horizontal DOP
0.00 [m]
Satellite Count
0
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Copy of Position Navigatio
Amy Gale
Position Navigati
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
System Parameters
Use this system to trigger the computation
Height status: Tide (Unreliable Height)
Preferred position SD: System Driver
Position a priori SD: 0.25 [m]
Preferred height aiding SD: Database Setup
Height aiding a priori SD: Automatic
Dynamic a priori SD: Disabled
System Thresholds
Parameter | Minimum | Maximum
Age | | 5.00 [s]
Solution Mode | 0 | 0
3D Position RMS | | 1.73 [m]
Position SD | | 1.00 [m]
Height SD | | 1.00 [m]
Horizontal DOP | | 0.00 [m]
Satellite Count | 0 |
OK
Apply
Cancel


Computation Setup
Computations
New Computation
Copy Computation
Remove Computation
Shortcuts
Position Navigation System
Amy Gale
Position Navigation
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Copy of Position Navigation Sys
Amy Gale
Position Navigation
Gyro
Pitch Roll Heave Se
EM2040C
Offset System Amy Gale
Computation Parameters
Computation name
Position Navigation System
Triggering system
Position Navigation System
Max. triggering rate
20 [Hz]
Iteration threshold
5
Statistical testing
Separate Objects
Data snooping
Enabled
Redundancy minimum
1
Level of significance
1 %
Power of test
80 %
Lower limit max. ages
0.0 [s]
Approximate Position
Coordinate system
Grid
Easting
4840352.1
Northing
8669036.1
Height
0.0
Computation Priority
Priority
Status
Heights
Computation
1
Enabled
Tide (Unrelia
Copy of Position Navigation System
2
Enabled
RTK (Accurat
Position Navigation System
Move Up
Move Down
OK
Apply
Cancel

Appendix G – Crossline surface difference test statistical plots

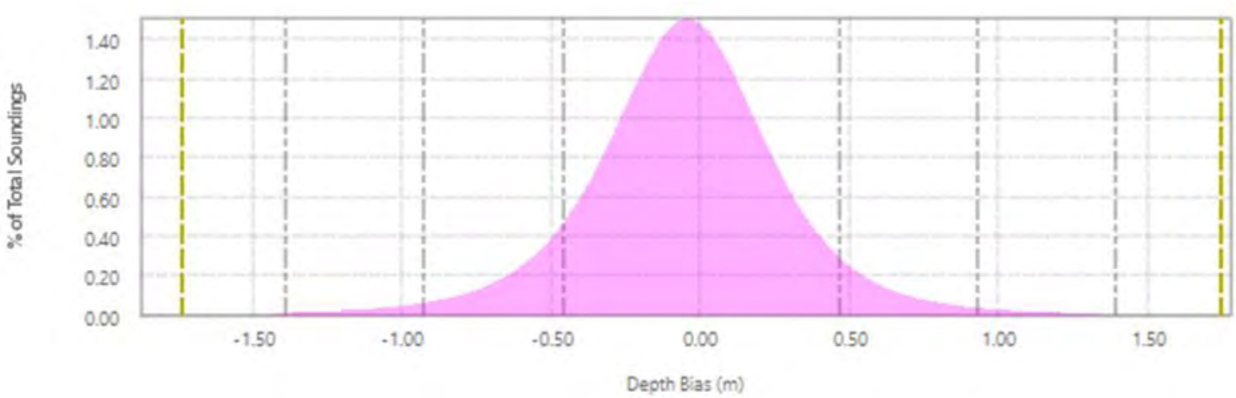
<u>Plots (histogram, scatter, and uncertainty)</u>

Key for plots:

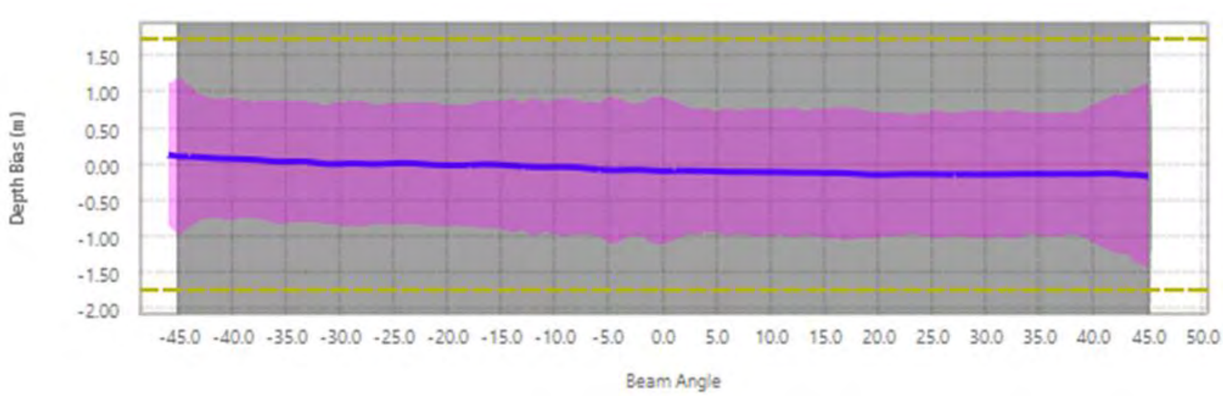
- Gray dots represent difference in depth between the crossline and the reference surface for individual beam angles or beam numbers
- Purple areas represent the 95% confidence interval (2 standard deviations) based on normal distribution (see histogram)
- Yellow dashed lines represent limit of IHO Order 1 test vertical tolerance
- Gray dashed lines on histogram represent ±sigma 1, 2, and 3
- Blue lines represent the mean value

SECTION 1: Crossline statistical plots for 2022 Mainscheme (W00649)

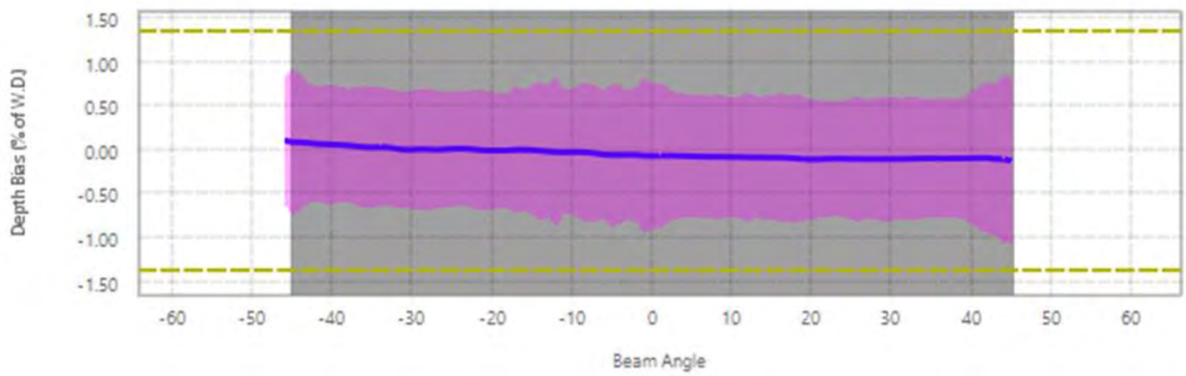
<u>Histogram</u>



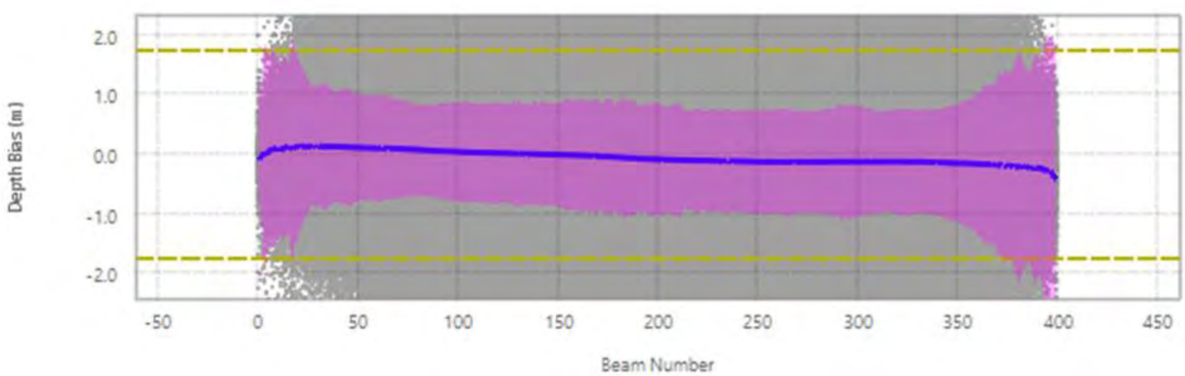
<u>Scatter: Depth Bias (m) vs. Beam Angle (Degrees from Nadir)</u>



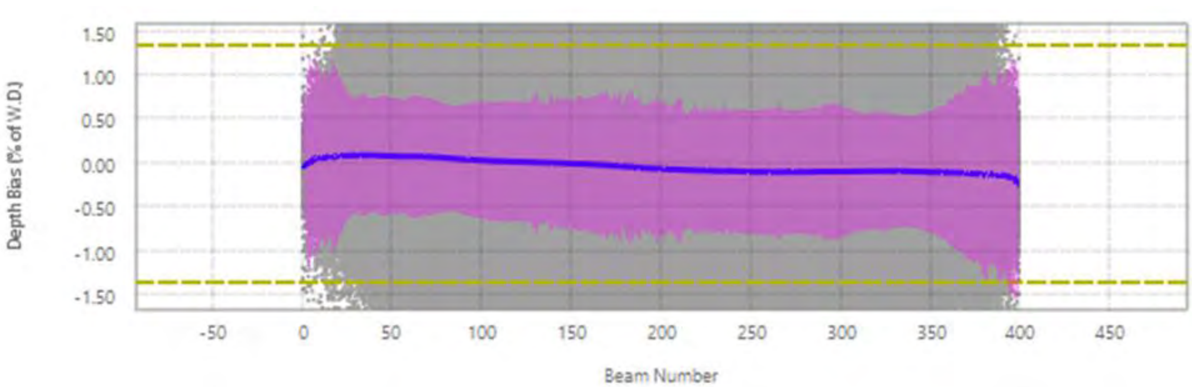
Scatter: Depth Bias (% Water Depth) vs Beam Angle (Degrees from Nadir)



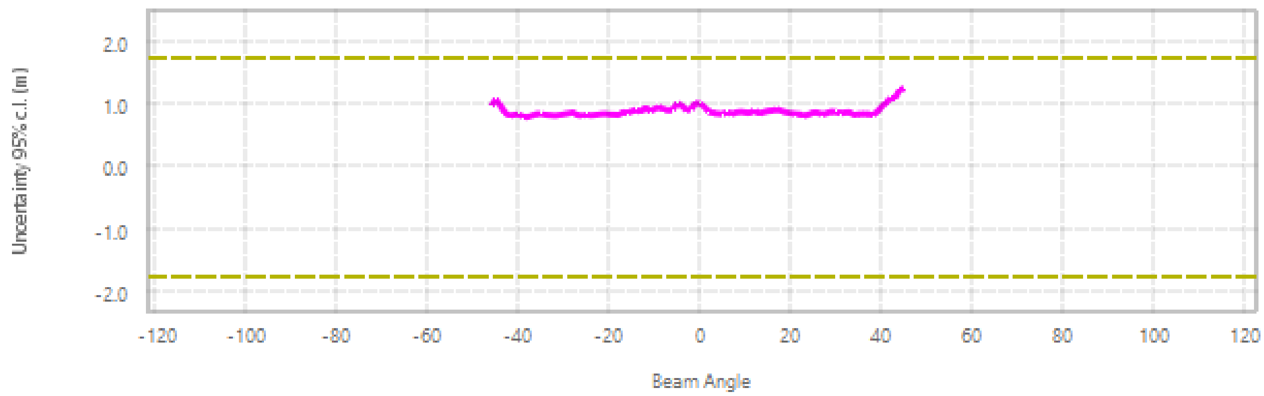
Scatter: Depth Bias (m) vs Beam Number



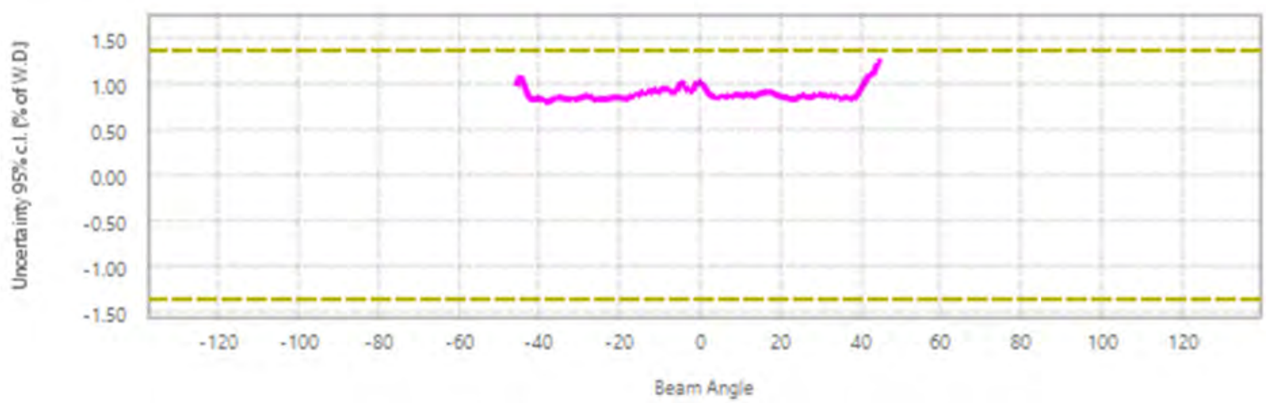
Scatter: Depth Bias (% Water Depth) vs Beam Number



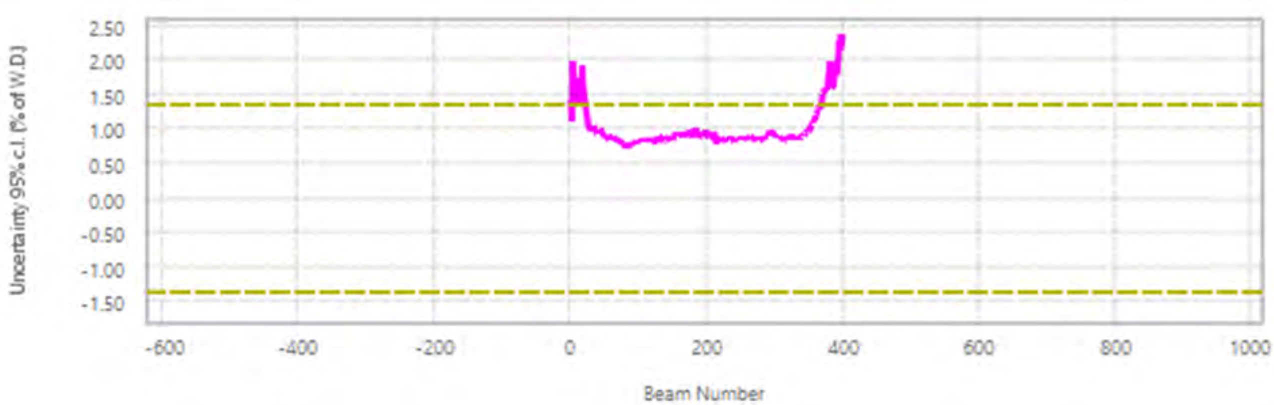
Uncertainty: Depth Bias (m) vs Beam Angle (Degrees from Nadir)



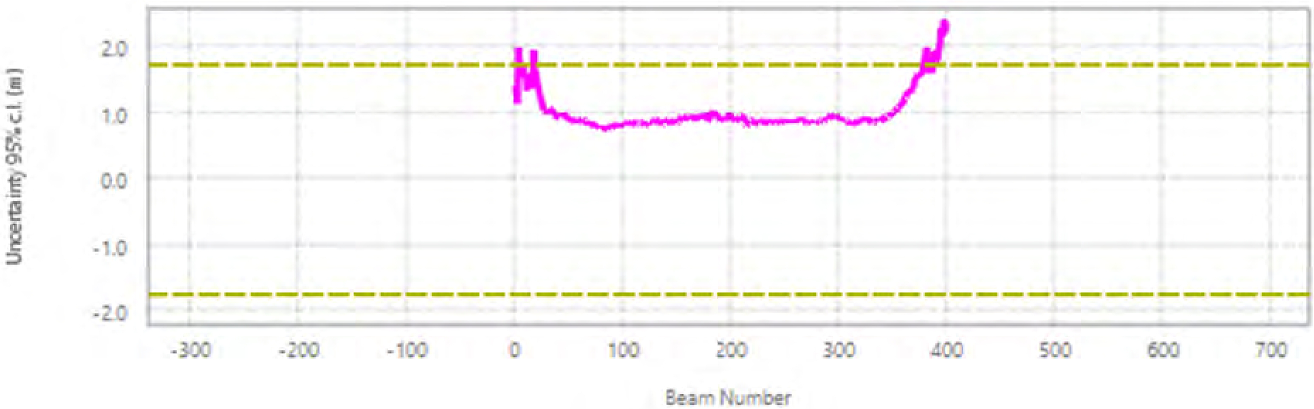
Uncertainty: Depth Bias (% Water Depth) vs Beam Angle (Degrees from Nadir)



Uncertainty: Depth Bias (% Water Depth) vs Beam Number



Uncertainty: Depth Bias (m) vs Beam Number



Appendix H – Modified CMECS Classification Scheme Used by MCMI

Modified CMECS Substrate Group	CMECS Substrate SubGroup	Modified CMECS Substrate Groups for 7-Class Textural Model	Modified CMECS Substrate Groups for 4-Class Textural Model
Bedrock/rocky		Bedrock/rocky (confirmed with video)	Bedrock/rocky
Gravel	Boulder	Gravel/gravel mixes (samples containing ≥ 30% gravel)	Gravel/gravel mixes/gravelly/slightly gravelly
	Cobble		
	Pebble		
	Granule		
Gravel Mixes	Sandy Gravel		
	Muddy Sandy Gravel		
	Muddy Gravel		
Gravelly	Gravelly Sand	Gravelly medium-coarse sand (includes samples with 5-30% gravel and samples with >90% sand with a mean phi size < 2, even if gravel content is up to 5%)	
	Gravelly Muddy Sand		
	Gravelly Mud		
Sand	Very Coarse Sand		
	Coarse Sand		
	Medium Sand		
	Fine Sand	Fine sand (samples having 0-5% gravel, ≥ 90% sand, and a mean phi size between 2 and 4)	Fine and (fine sand + muddy sand)
	Very Fine Sand		
Muddy Sand	Silty Sand	Muddy sand (silty sand + clayey sand + muddy sand; Folk, 1974)	
	Silty-Clayey Sand		
	Clayey Sand		
Sandy Mud	Sandy Silt	Mud (sandy mud + silt + clay)	Mud
	Sandy Silt-Clay		
	Sandy Clay		
Mud	Silt		
	Silt-Clay		
	Clay		
Slightly Gravelly	Slightly Gravelly Sand	Slightly gravelly sand-mud mixtures (0.01-5% gravel, excluding samples with > 90% sand)	Gravel/gravel mixes/gravelly/slightly gravelly
	Slightly Gravelly Muddy Sand		
	Slightly Gravelly Sandy Mud		
	Slightly Gravelly Mud		