V0

NOAA Hydrographic Processing Workflow

T. Faulkes & G. Masetti

Canberra, June 18-20 2019

NOAA HEADQUARTERS ORGANIZATION

Office of Coast Survey

CORPORATE FUNCTIONS

Deputy Assistant Secretary for International Fisheries
Andrew Lawler

Military Liaisons

U.S. Coast Guard Liaison
CAPT Kurt Zegowitz, NOAA Corps

Liaison to the Oceanographer of the Navy
CDR Jason Mansour, NOAA Corps

Federal Coordinator for Meterology
Michael Bonadonna

Assistant Secretary of Commerce for Environmental Observation and Prediction, Performing the duties of Under Secretary of Commerce for Oceans and Atmosphere
Dr. Neil Jacobs

Assistant Secretary of Commerce for Oceans and Atmosphere and Deputy NOAA Administrator
RDML Timothy Gallaudet, Ph.D., USN Ret.

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Benjamin Friedman

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LINE OFFICES

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NESDIS

Assistant Administrator National Environmental Satellite, Data & Information Service
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Deputy Assistant Administrator
Mark S. Paese

OAR

Assistant Administrator Oceanic & Atmospheric Research
Craig McLean

Deputy Assistant Administrator for Laboratories & Cooperative Institutes
Dr. Gary Matlock

Deputy Assistant Administrator for Programs & Administration
Ko Barrett

NWS

Assistant Administrator National Weather Service
Dr. Louis Uccellini

Deputy Assistant Administrator
Mary Erickson

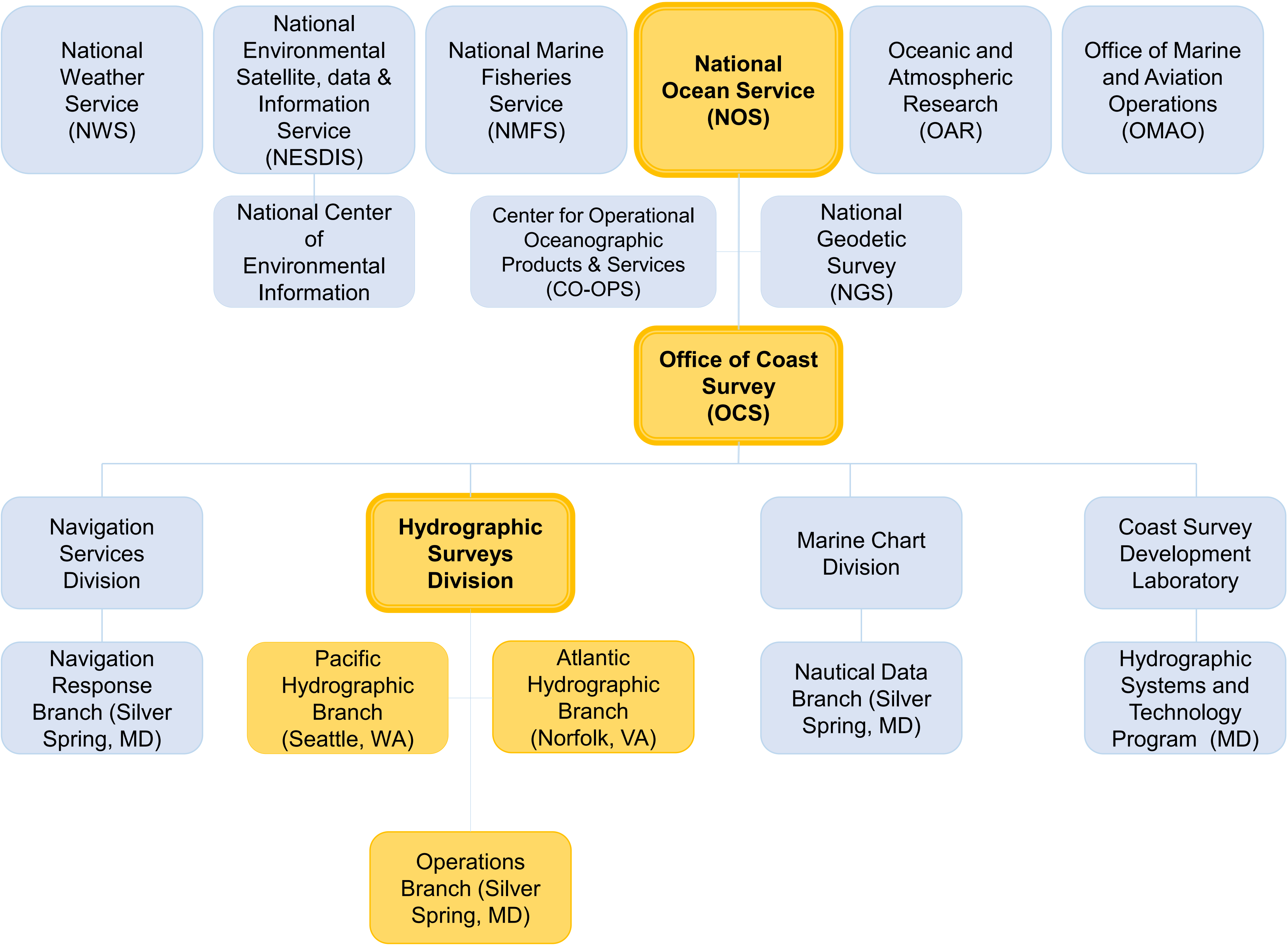
OMAO

Director Office of Marine & Aviation Operations & Director, NOAA Corps
RADM Michael Silah

Deputy Director for Operations and Deputy Director, NOAA Corps
RDML Nancy Hann

Deputy Assistant Administrator for Programs and Administration
Gary Reisner

Key: (A) = Acting Last updated 06/03/19


National Weather Service (NWS)
National Environmental Satellite, data & Information Service (NESDIS)
National Marine Fisheries Service (NMFS)
National Ocean Service (NOS)
Oceanic and Atmospheric Research (OAR)
Office of Marine and Aviation Operations (OMAO)
National Center of Environmental Information
Center for Operational Oceanographic Products & Services (CO-OPS)
National Geodetic Survey (NGS)
Office of Coast Survey (OCS)
Navigation Services Division
Hydrographic Surveys Division
Marine Chart Division
Coast Survey Development Laboratory
Navigation Response Branch (Silver Spring, MD)
Pacific Hydrographic Branch (Seattle, WA)
Atlantic Hydrographic Branch (Norfolk, VA)
Nautical Data Branch (Silver Spring, MD)
Hydrographic Systems and Technology Program (MD)
Operations Branch (Silver Spring, MD)

PING-TO-CHART (VERY SIMPLIFIED)

HQ

Project Planning
(instructions,
assignments)

Field

Survey deliverables
(grids, features, etc.)

Hydro
Branches

Processing Branch deliverables
(grids, features, reports,
CATZOC, etc.)

Marine
Chart
Division

Chart Products!

All data and charts are open and free to the public!

National Center for Environmental Information (NCEI)

Data archive and public access

National Bathymetric Source (NBS)

HYDROGRAPHIC SURVEYS SPECIFICATIONS AND DELIVERABLES

March 2019

HSSD

Specs

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Ocean Service

OSI OCEAN SURVEYS

FUGRO

DAVID EVANS AND ASSOCIATES INC.

leidos

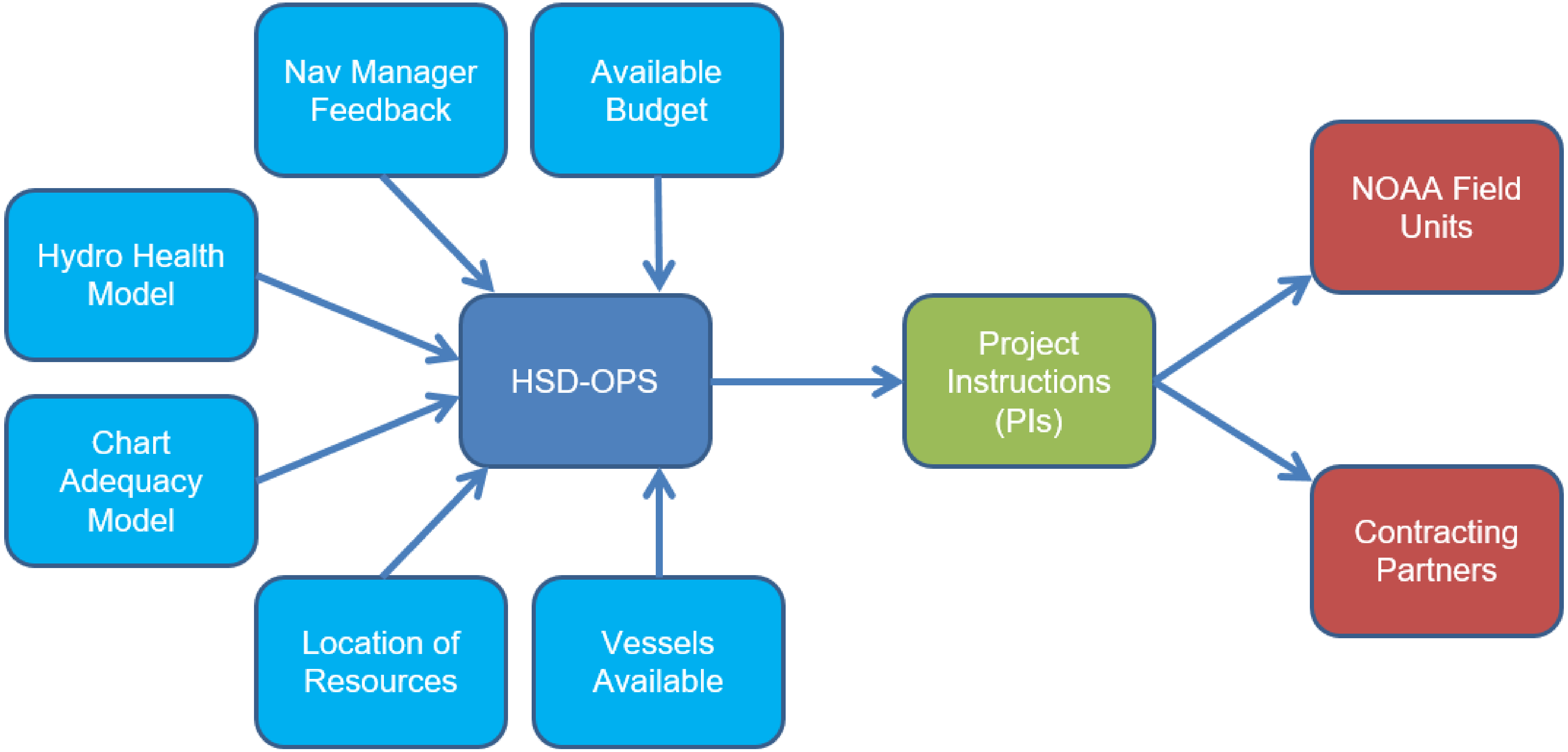
eTrac

OCEANEERING®

Williamson & ASSOCIATES GEOPHYSICS + OCEAN ENGINEERING

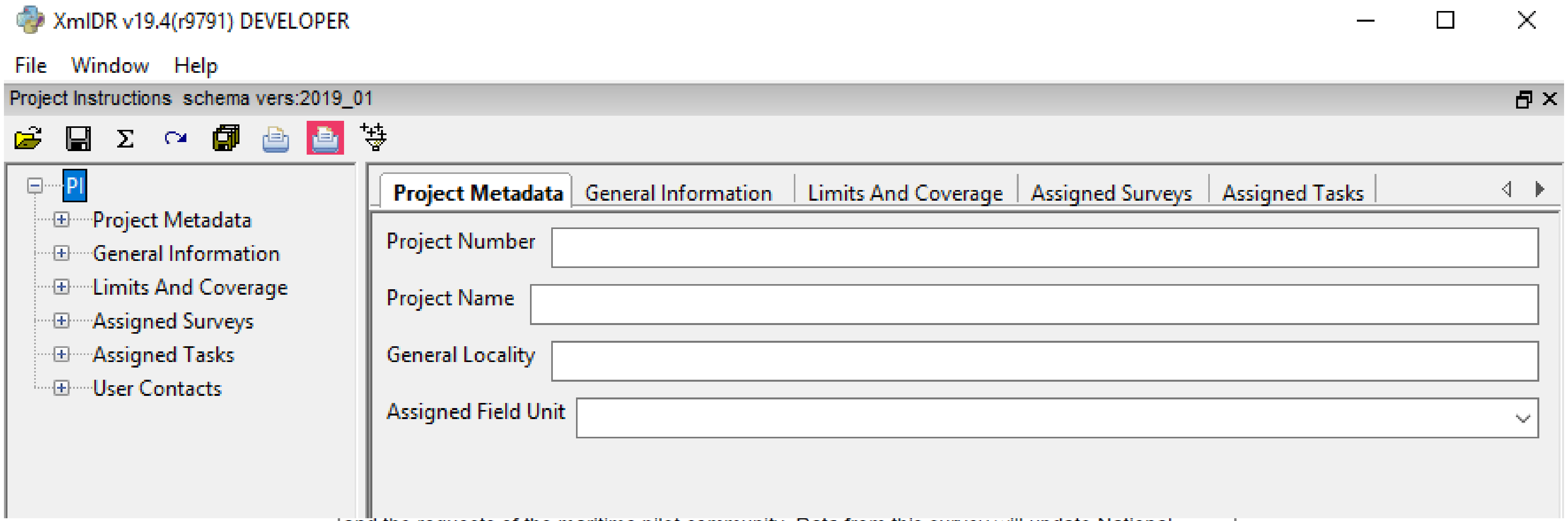
TERRASOND

Where do these projects come from?



Hydrographic Survey Project Instructions

Project Name:	Tracy and Endicott Arms



and the requests of the maritime pilot community. Data from this survey will update National Ocean Service (NOS) nautical charting products. Survey data from this project is intended to supersede all prior survey data in the common area.

Supporting Documents:
Please refer to the following support documents.

Data Acquisition

- Planning
- Execution
- Processing & Quality Control
- Final Review & Submission

Data Acquisition → Planning

following the four classifications of coverage in Section 5.2.2. Specific requirements of each coverage classification are given below in Sections 5.2.2.2, 5.2.2.3, 5.2.2.4, and 5.2.2.5.

1. **Object Detection Coverage** is assigned for critical under keel clearance areas and may be accomplished with either:

   Option A) 100% bathymetric bottom coverage with multibeam sonars with object detection multibeam developments (i.e., 50 cm grid resolution in 0-20 m depth range) of contacts and features or

   Option B) 200% side scan sonar coverage with concurrent multibeam bathymetry collection with object detection multibeam developments (i.e., 50 cm grid resolution in 0-20 m depth range) of contacts and features. Bathymetric splits, where appropriate, are required (Section 5.2.2.1).

2. **Complete Coverage** may be accomplished with either:

   Option A) 100% bathymetric bottom coverage with multibeam sonars with complete coverage multibeam developments (i.e., 1 m grid resolution in 0-20 m depth range) of contacts and features, or


NOAA
S 221


RA-3
2803

Data Acquisition → Execution

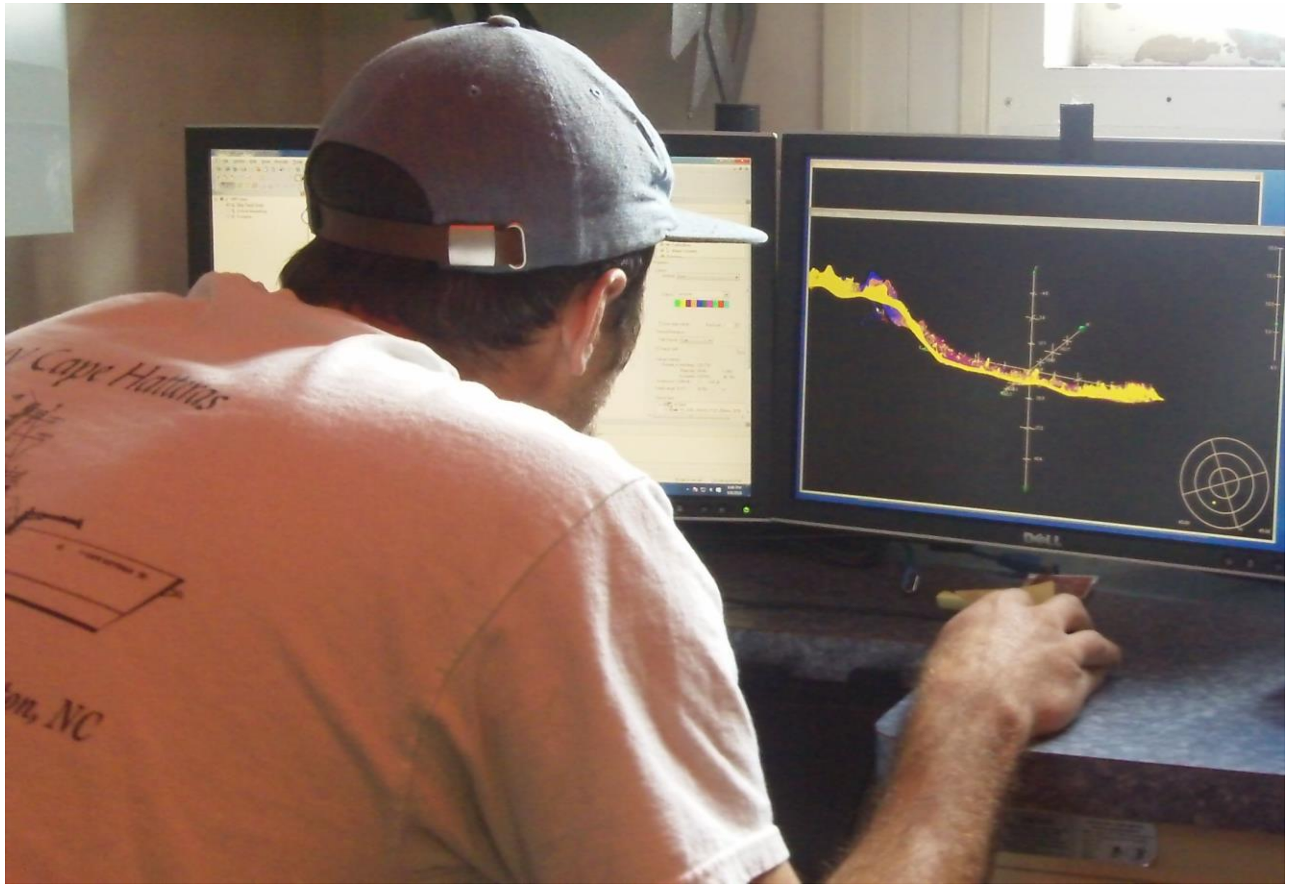
- Hypack, Kongsberg, and Reson formats are all used for raw MBES collection.
- Applanix POSMV used for positioning, altitude, and motion data.
- Klein SonarPro, Discover, and Discover 2 are used for SSS.
- CARIS Notebook for shoreline data acquisition.

DATA ACQUISITION → EXECUTION

Pydro Tools for Acquisition:

- Sound Speed Manager
  - Rolls-Royce Moving Vessel Profiler
  - Seabird CTD
  - XBT

Data Acquisition → Processing and Quality Control



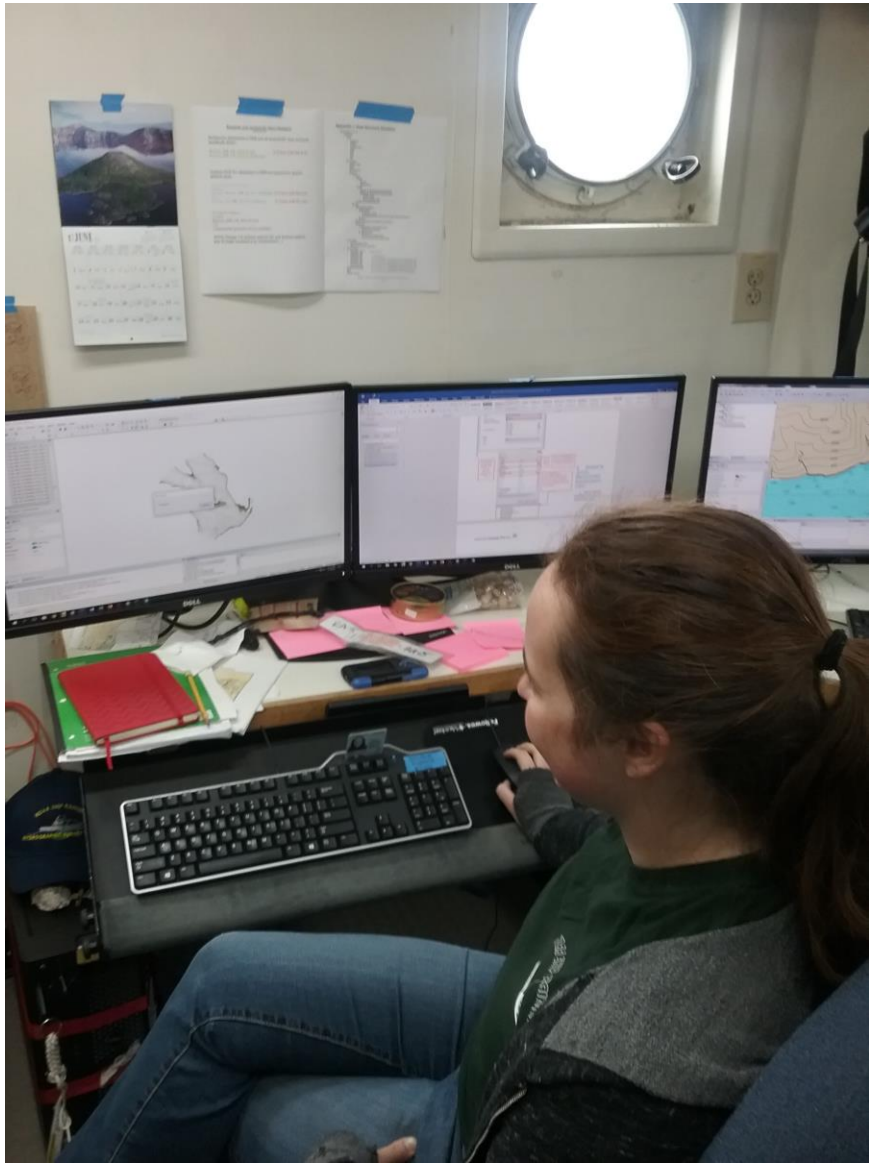
- CARIS for MBES, SSS, and feature processing
- QPS FMGT for MBES Backscatter
- Applanix POSPac for post processing positioning and altitude data

Data Acquisition → Processing and Quality Control

Pydro Tools for Processing:

- Charlene
- Shoreline Attribution Machine (SHAM)
- Tidal Constituent and Residual Interpolation (TCARI)

DATA ACQUISITION ⟶ PROCESSING AND QUALITY CONTROL



Pydro Tools for Quality Control:

- POSPac AutoQC
- QC Tools

Data Acquisition → Final Review & Submission

Reports:

- Data Acquisition and Processing Reports (DAPR)
  - Project level report-- details all equipment, systems, and processing used in the acquisition and processing of the hydrographic data
- Horizontal and Vertical Control Reports (HVCR)
  - Project level report – tide and water level and horizontal control activities are captured

Data Acquisition → Final Review & Submission

Reports:

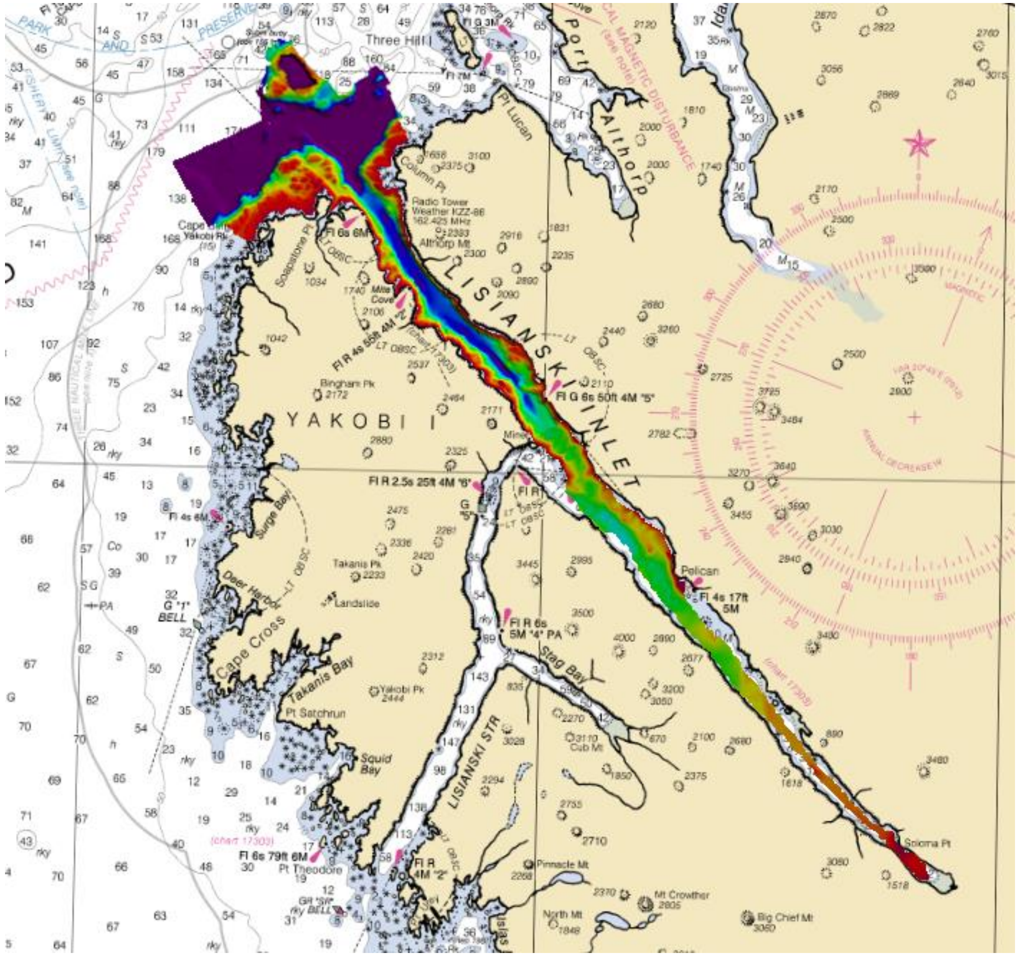
- Descriptive Report (DR)
  - Survey level report– helps cartographers process and evaluate the survey, assist the compilers in producing and revising charts, documents various specifications and attributes of the survey and its by-products, provides legal description of survey standards, methods, and results.

XML DR

Data Acquisition → Final Review & Submission

Most important final deliverables:

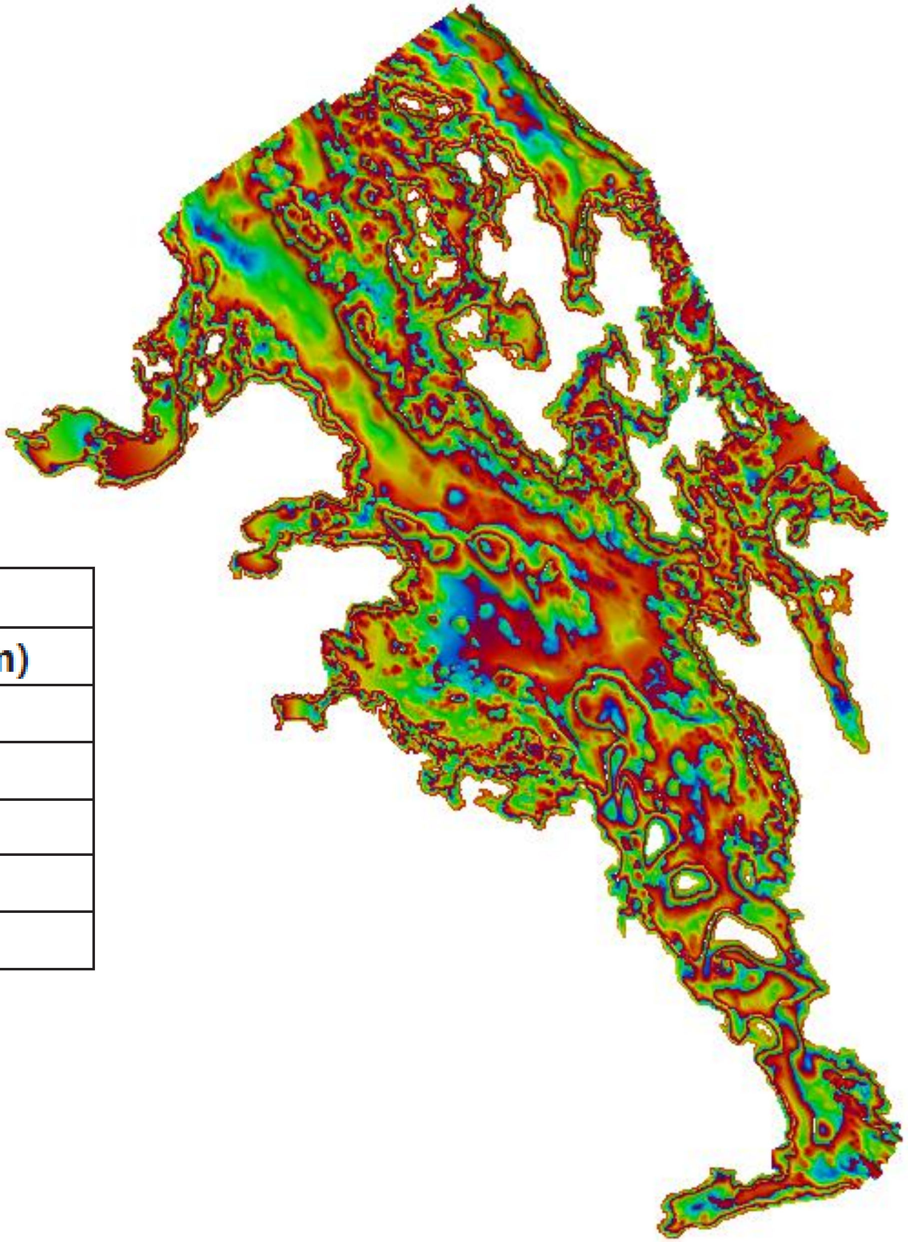
- Gridded surfaces
- Final feature files



QC Tools

Complete Coverage

Single Resolution Surfaces	
Depth Range (m)	Resolution (m)
0-20	1
18-40	2
36-80	4
72-160	8
144-320	16



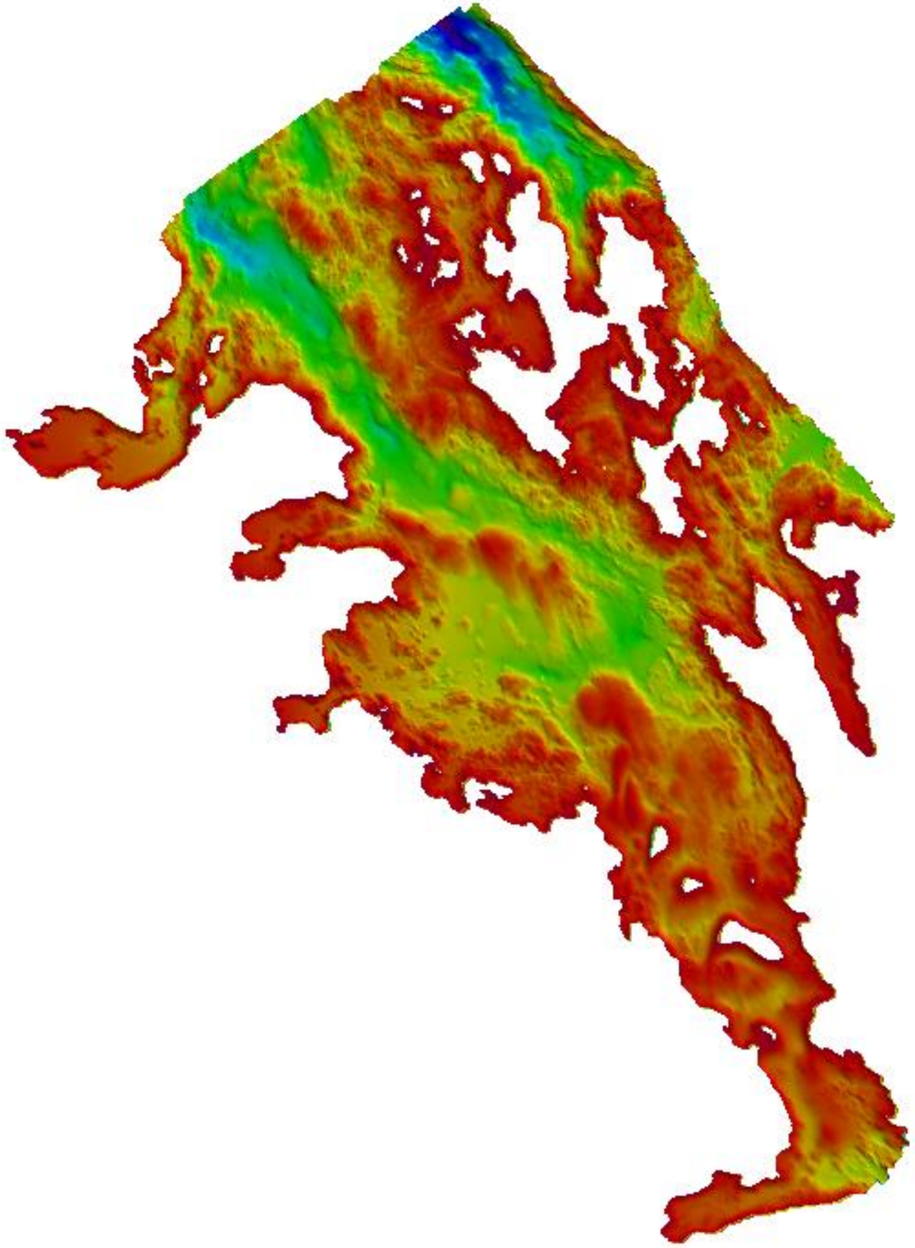
Object Detection

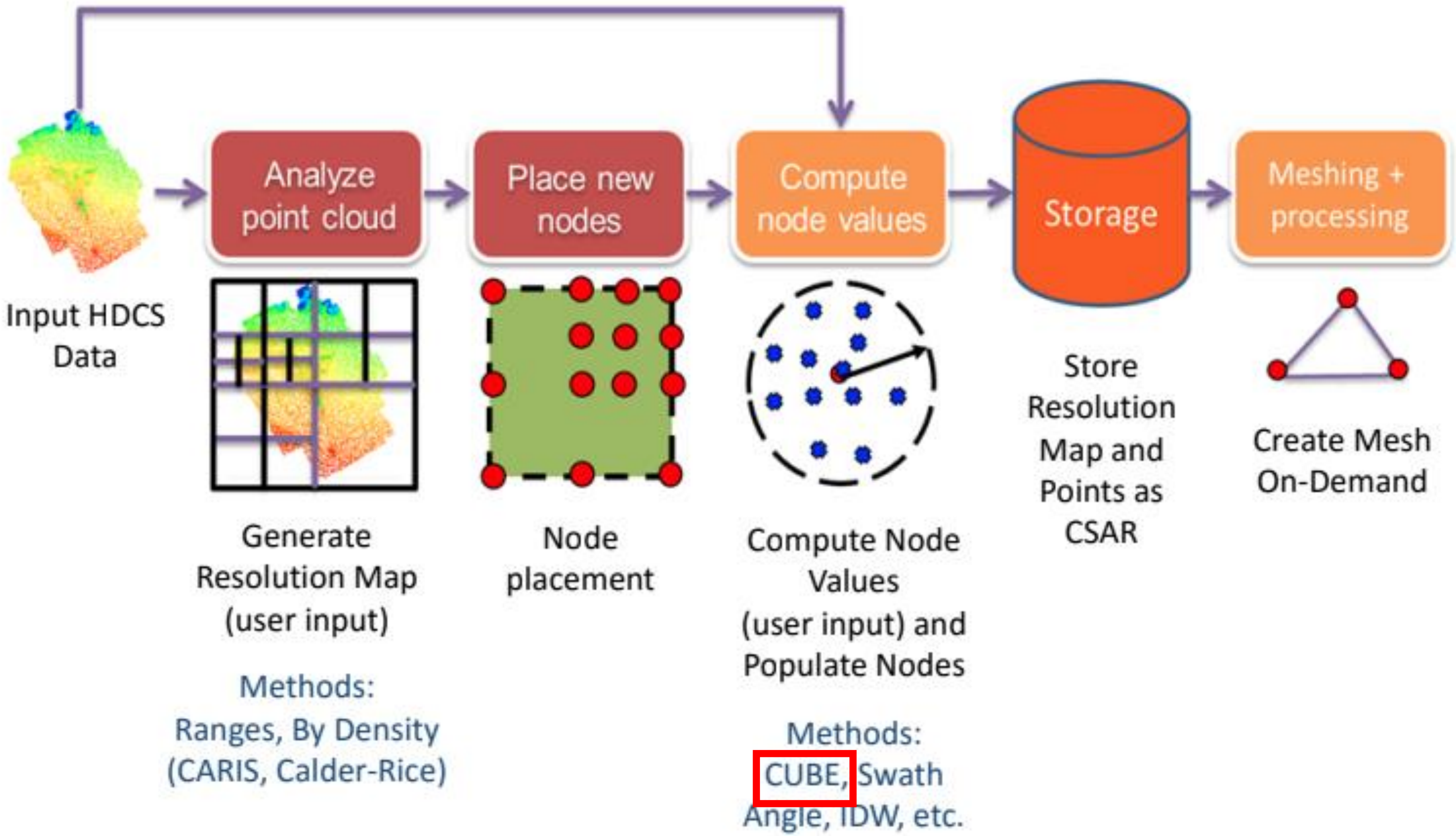
Single Resolution Surfaces	
Depth Range (m)	Resolution (m)
0-20	0.5
18-40	1
36-80	4
72-160	8
144-320	16

The grid resolution for water depths greater than 320 m r shall be 5% of the water depth, not to exceed 32 m resolution.

Why we wanted VR:

- Enables representation of bathymetric data at the required resolution within a single grid (Ranges).
- Can optionally algorithmically determine the highest resolution supported by data density (Density).
- Enables more streamlined and efficient data processing workflows.
- Yields better data products for, and thus provides greater value to, NOAA's customers and end users of hydrographic data.

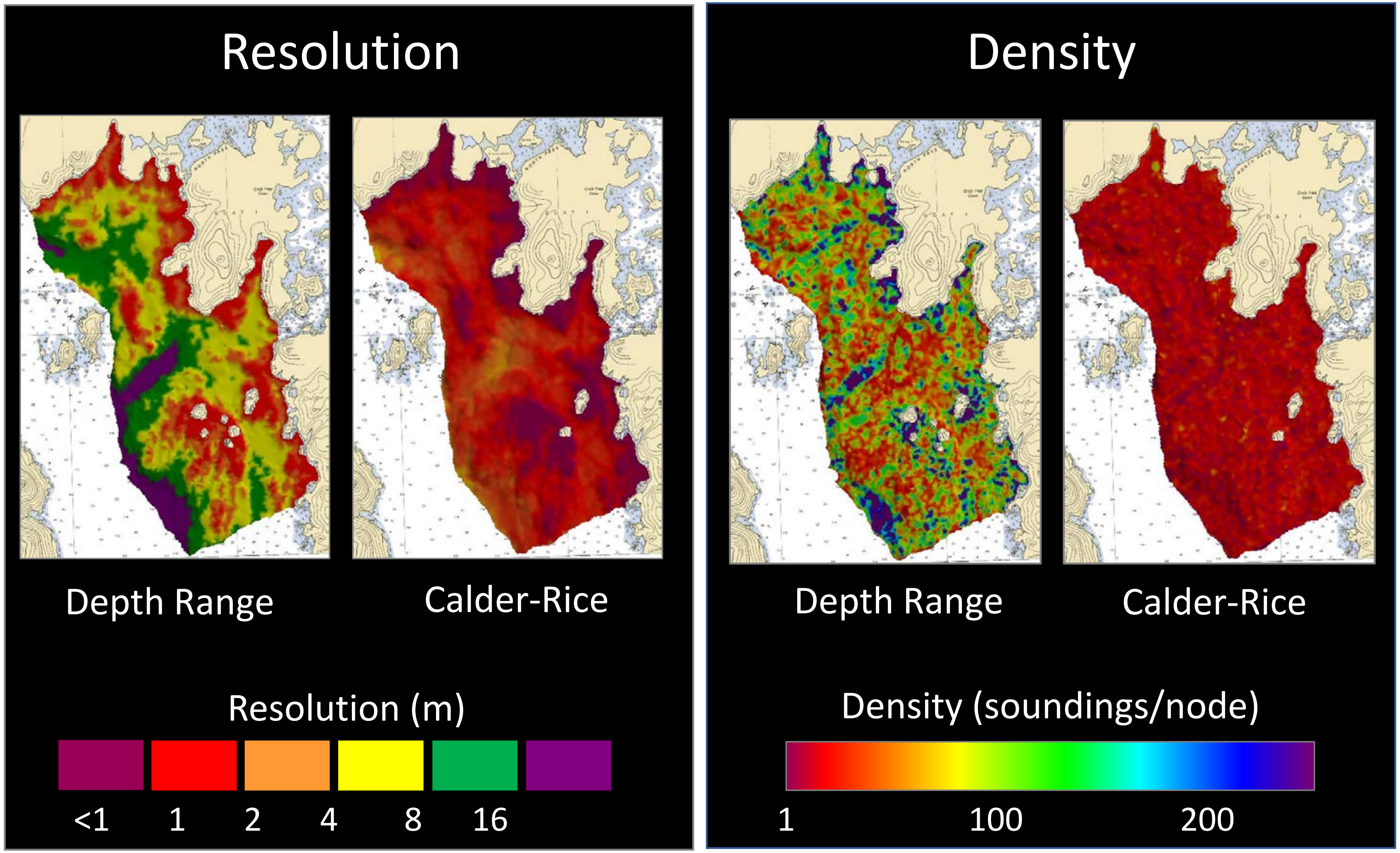




Source: Teledyne CARIS

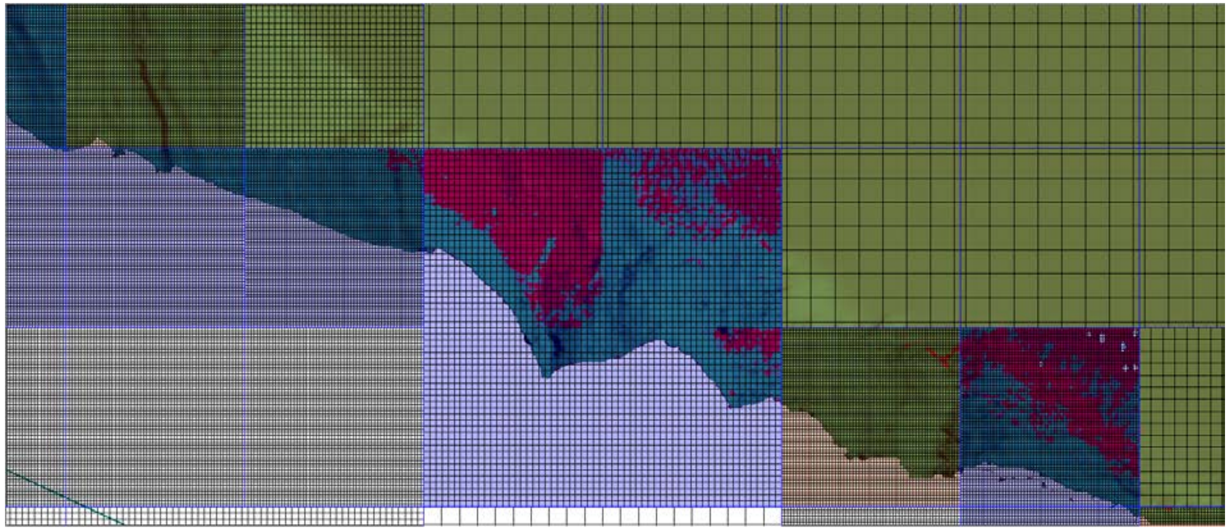
Which Method Is Best?

	By Depth (Ranges)	**By Density** (Calder-Rice)
Pros	• Conceptually similar to current method • Depth range table can be tailored to meet resolution requirements	• Resolution map driven by data density (there is no a priori estimate of supported resolution)
Cons	• Resolution map driven by depth instead of actual data density (likely to result in over-sampling)	• Sensitive to input parameters (e.g., density) • Potential for artifacts where density gradients exist along tile boundaries

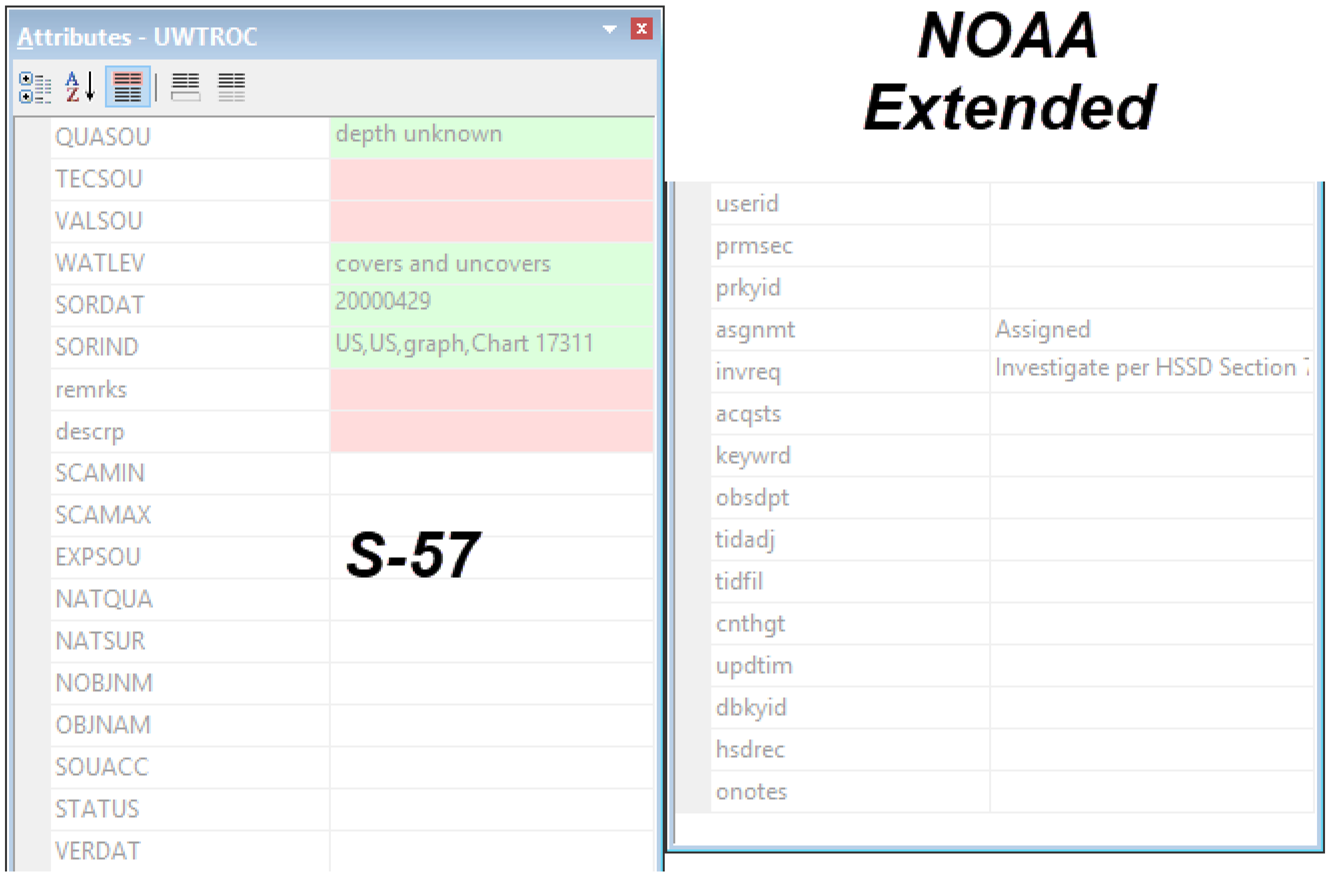

Resolution
Depth Range
Calder-Rice
Resolution (m)
<1
1
2
4
8
16
Density
Depth Range
Calder-Rice
Density (soundings/node)
1
100
200

PROBLEMS CAUSED BY VARIABLE RESOLUTION SURFACES

- High rendering times
- Higher surface computation times
- More cleaning of fliers is sometimes required in low density, deep depths



DATA ACQUISITION → FINAL REVIEW & SUBMISSION



Extended attribution facilitates the communication between office, field units, and cartographers.

QC TOOLS

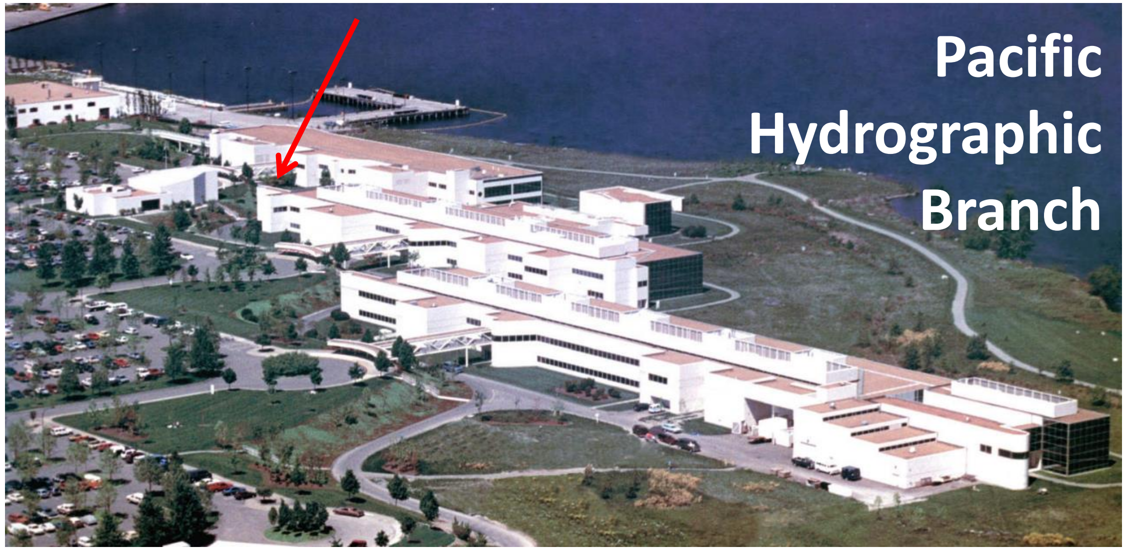
Data Acquisition → Final Review & Submission

All raw and processed data including but not limited to:

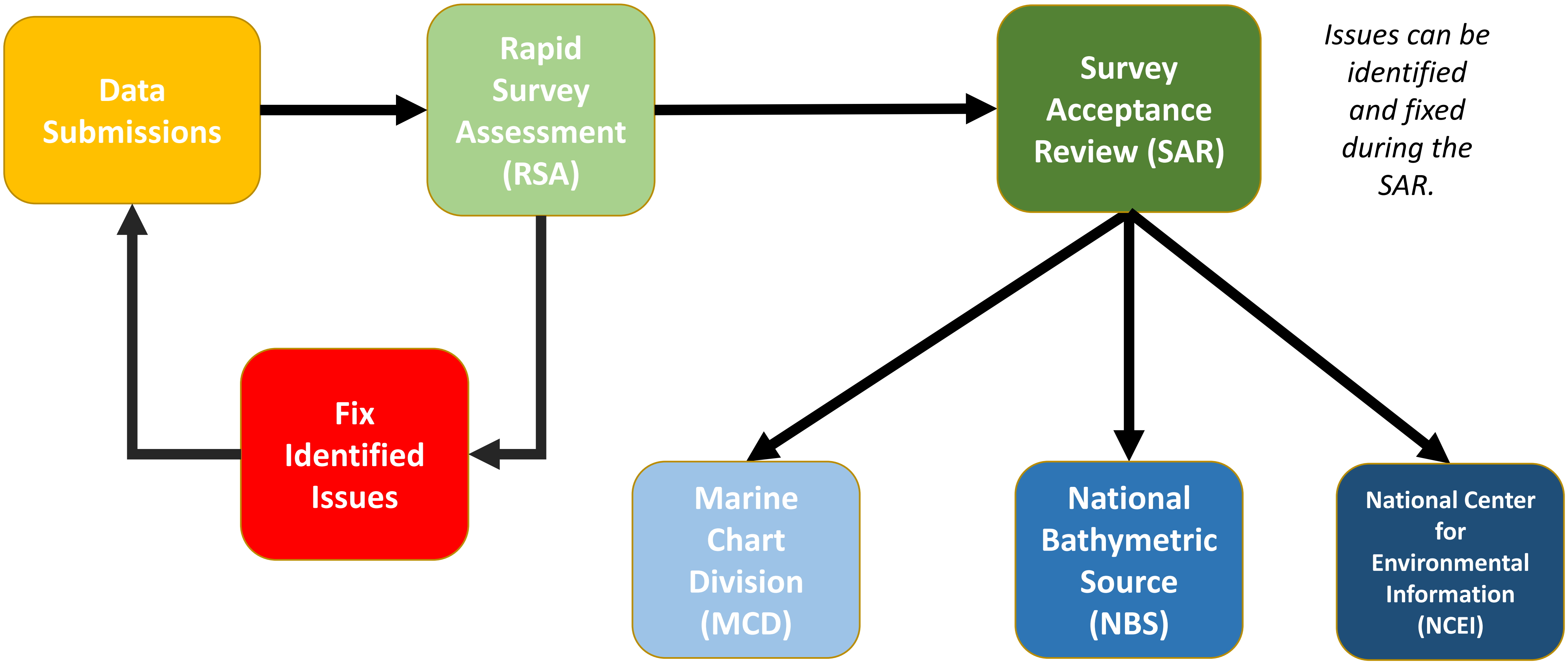
- Sonar/Lidar
- Positioning
- Tide
- Sound speed
- Features
- Reports

QC Tools: Submission Scan

HYDRO OFFICE PROCESSING



Hydro Office Processing



HYDRO OFFICE PROCESSING: RSA

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

OCS QMS
Controlled Document

Project Number:	OPR-0190-FA-15	Registry Number:	H12744
Field Unit:	Fairweather	State or Territory:	Alaska
General Locality:	West Prince of Wales Island		
Sub-Locality:	Meares Island to Halibut Nose		
Survey Start Date:	10/21/2015	Survey End Date:	11/11/2015
Survey Scale:	20,000	Survey Type:	Navigable Area
Survey Reviewer:	Mueller	Final Reviewer:	Herzog

1a - Data Management Review

1b - Rapid Survey Assessment (RSA) Review

2 - Housekeeping Review

2.1 Survey Tracker Metadata

2.1.1 Was the SAR Start Date entered in Survey Tracker? ☒ Yes ☐ No ☐ N/A ☐ No, see below

2.1.2 Did the survey Start and End Dates in Survey Tracker match the dates in the DR? ☐ Yes ☐ No ☐ N/A ☒ No, see below

Comments:

2.1.2 – Dates in Survey Tracker did not match the DR and were updated by the reviewer.

2.2 Field Notification

2.2.1 Was the field unit notified via e-mail that the SAR has commenced and enquired as to the best point-of-contact should questions arise? CC Branch Chief, Team Lead, and COR (if applicable) ☒ Yes ☐ No ☐ N/A ☐ No, see below

2.3 Identify RNC, ENC, and Ortho-Imagery Information

Raster Navigational Charts

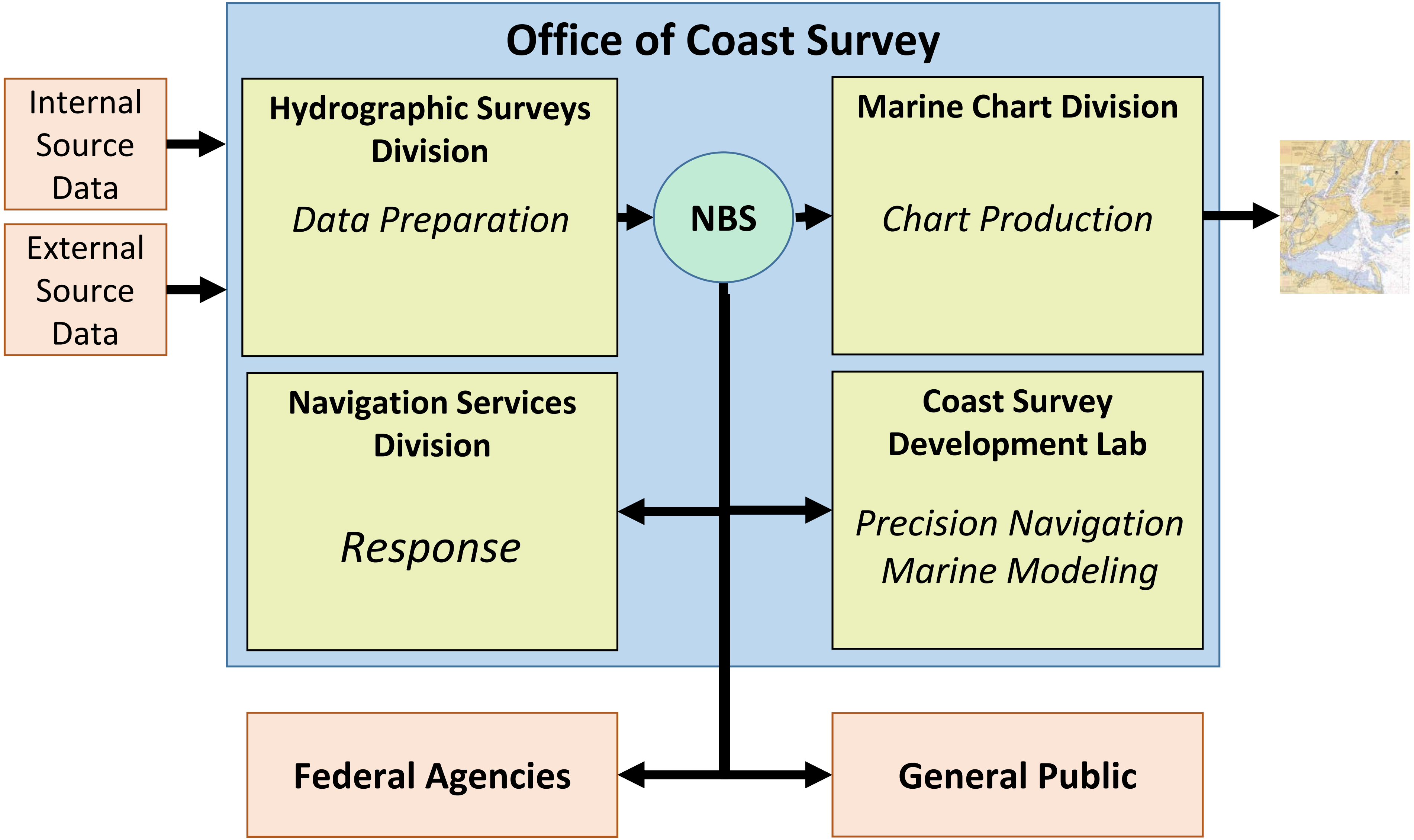
Chart Number	Edition Number	Date	Local Notice to Mariners	Scale	KAPP
17407	16	December, 2014	Aug 20, 2016	40,000	2726

HYDRO OFFICE PROCESSING: SAR

- Ensures survey's compliance with:
  - HSSD
  - Project Instructions/Statement of Work
- All data receives similar QA Review no matter the origin of the data
- Office compiles final cartographic recommendations, surfaces, and feature files that will be used for MCD for chart compilation

HYDRO OFFICE PROCESSING: DATA ARCHIVING

- Survey data transferred to the National Center of Environmental Information (NCEI) for archival and public dissemination
- Direct download:
  - Descriptive Report
  - Surfaces
  - Backscatter and SSS Mosaics
  - Survey GeoPDF
- All data (raw and processed) can be requested to download via NCEI.

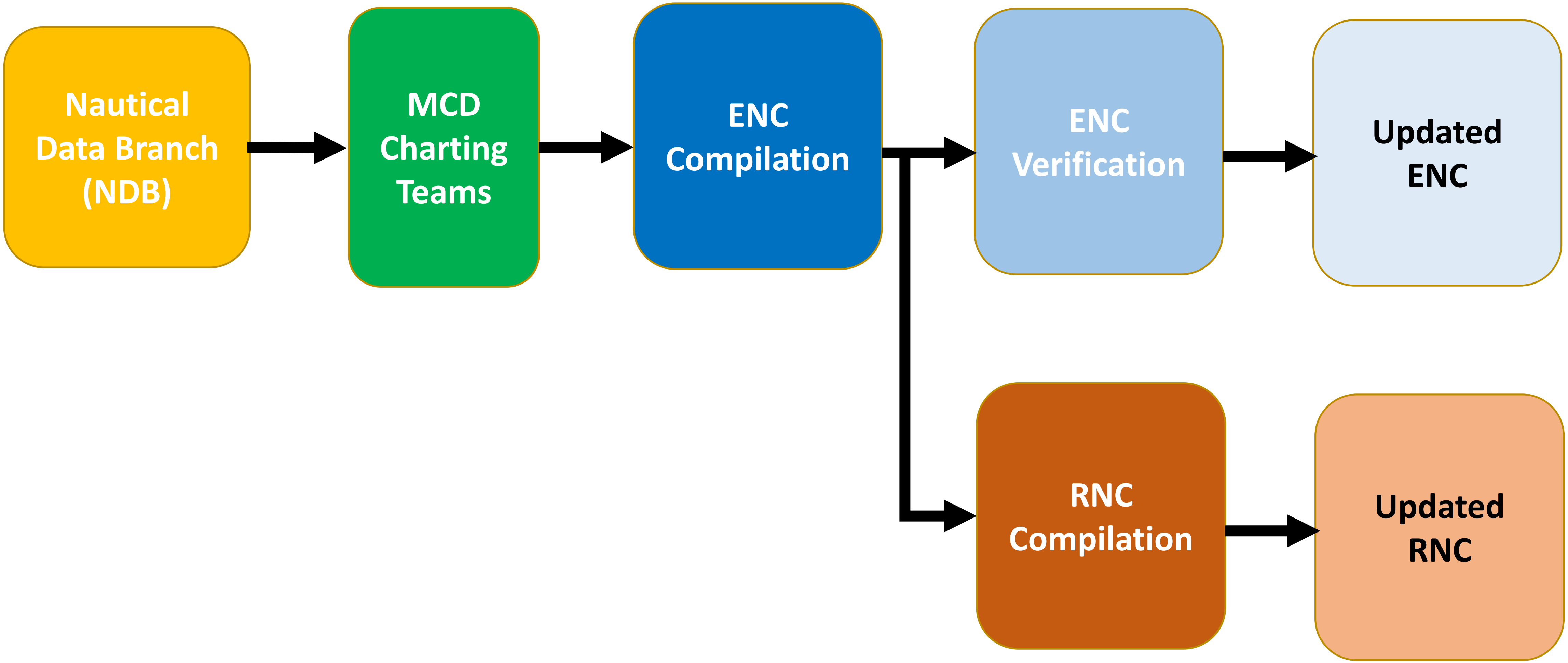

Office of Coast Survey
Internal Source Data
External Source Data
Hydrographic Surveys Division
Data Preparation
NBS
Marine Chart Division
Chart Production
Navigation Services Division
Response
Coast Survey Development Lab
Precision Navigation
Marine Modeling
Federal Agencies
General Public

Marine Chart Division

Marine Chart Division applies the data to charts:

- Hydrographic Survey Division's Bathymetry
- National Geodetic Survey
  - National shoreline
- US Coast Guard (USCG)
  - Aids to Navigation (ATONs)
- Army Corps of Engineers (USACE)
  - Channels, dams, locks, shoreline construction
- Other sources:
  - As-builts for marinas, ports, other shoreline
  - Topography
  - Landmarks, place names, tides and currents

MARINE CHART DIVISION



THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

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Pydro

T. Faulkes & G. Masetti

Canberra, June 18-20 2019

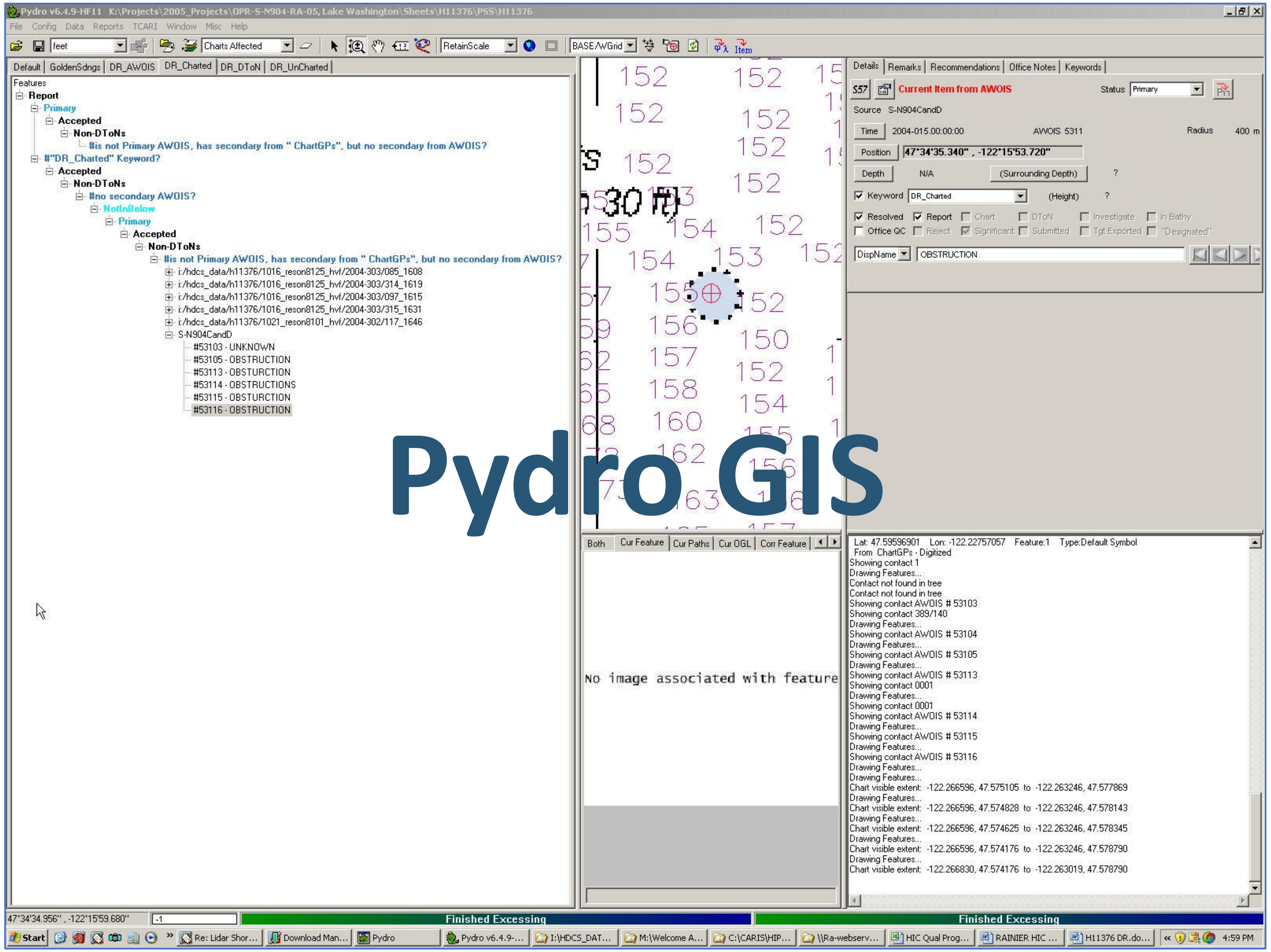
Pydro Universe

A NOAA **Py**thon Distribution

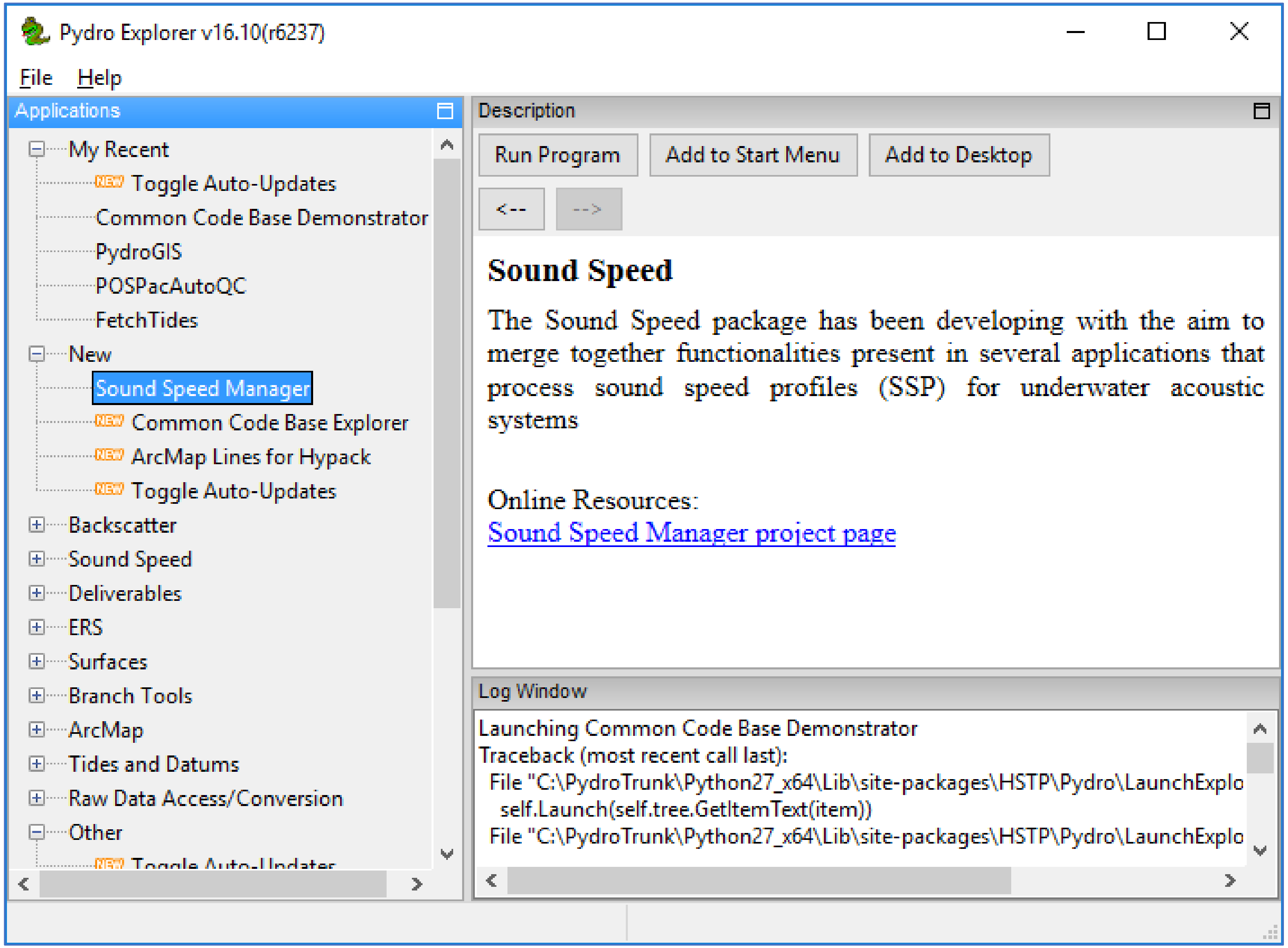
A Collection of Open-Source Hy**dro**graphic Tools

A Growing Community of People with Interests in Ocean Mapping

Pydro GIS



1994 Closed Source 2015


Pydro Explorer v16.10(r6237)
File Help
Applications
My Recent
Toggle Auto-Updates
Common Code Base Demonstrator
PydroGIS
POSPacAutoQC
FetchTides
New
Sound Speed Manager
Common Code Base Explorer
ArcMap Lines for Hypack
Toggle Auto-Updates
Backscatter
Sound Speed
Deliverables
ERS
Surfaces
Branch Tools
ArcMap
Tides and Datums
Raw Data Access/Conversion
Other
Description
Run Program
Add to Start Menu
Add to Desktop
Sound Speed
The Sound Speed package has been developing with the aim to merge together functionalities present in several applications that process sound speed profiles (SSP) for underwater acoustic systems
Online Resources:
Sound Speed Manager project page
Log Window
Launching Common Code Base Demonstrator
Traceback (most recent call last):
File "C:\PydroTrunk\Python27_x64\Lib\site-packages\HSTP\Pydro\LaunchExplo
self.Launch(self.tree.GetItemText(item))
File "C:\PydroTrunk\Python27_x64\Lib\site-packages\HSTP\Pydro\LaunchExplo

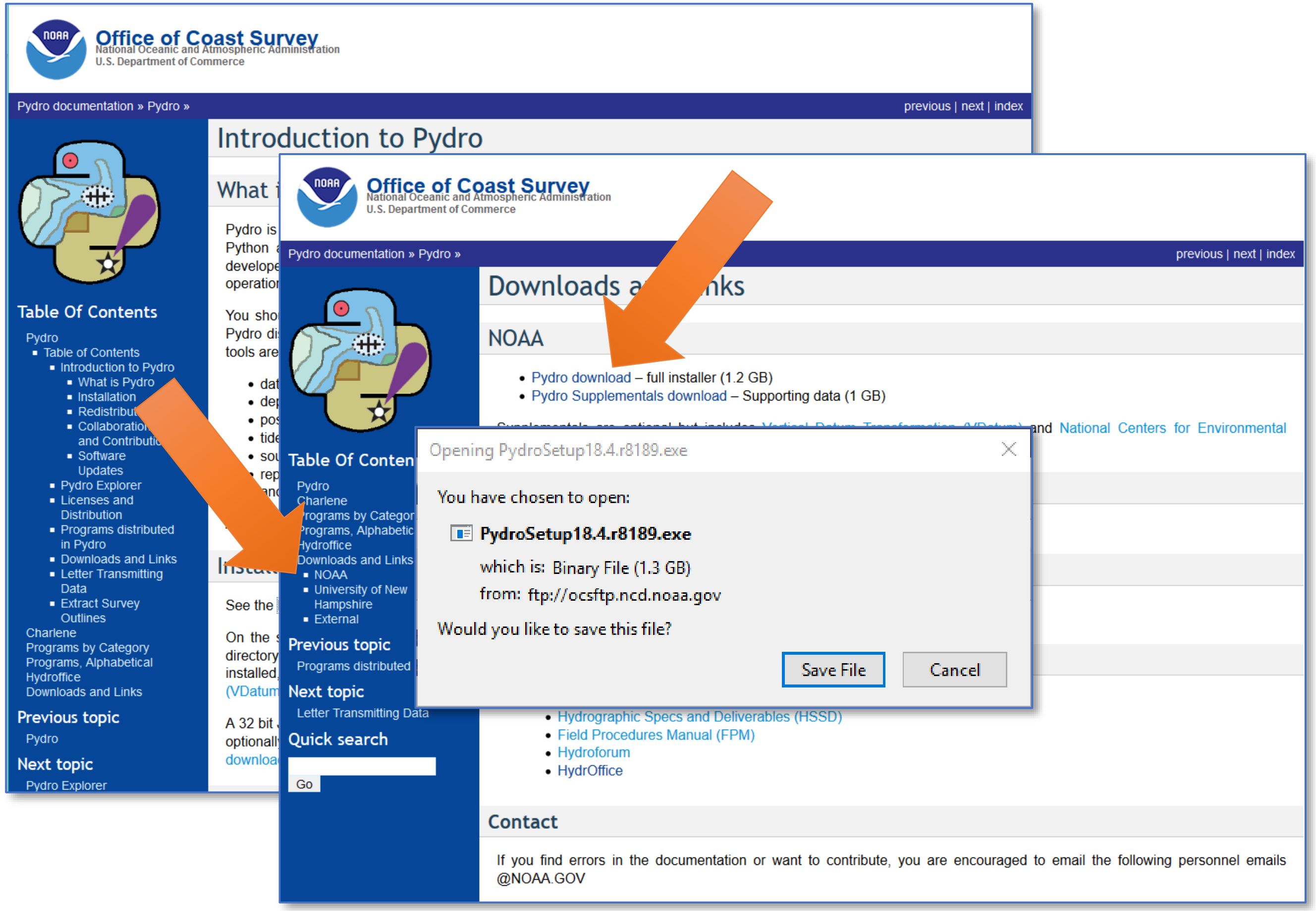

1994
Closed Source
2015
2016

2016 → Transitioning to Open

- Collaboration with the University of New Hampshire
- Release of NOAA built apps
- Open underlying code for use

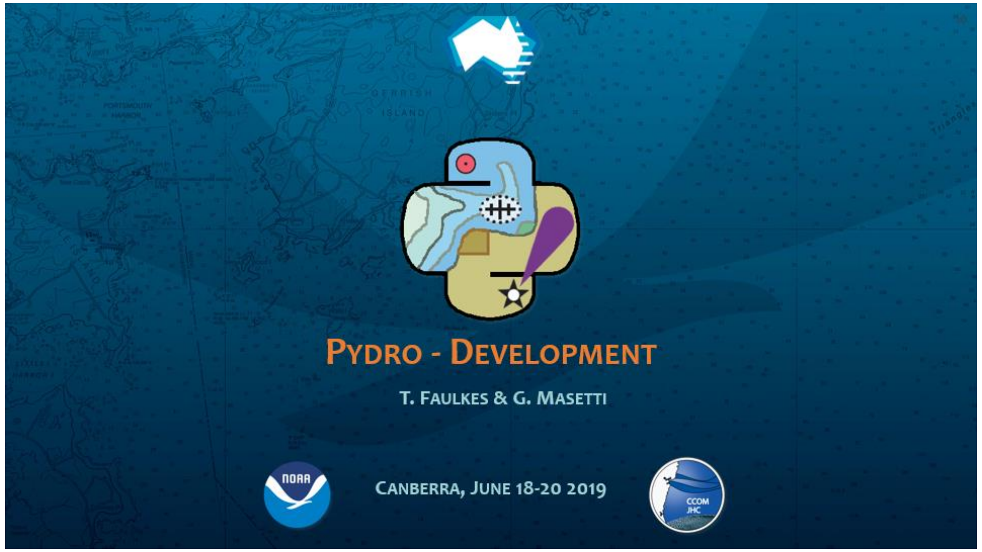
INSTALLATION

- https://svn.pydro.noaa.gov/




Pydro Explorer v18.4(r8977)
File Help
Applications
My Recent
New
Backscatter
Sound Speed
Deliverables
ERS
Surfaces
Branch Tools
ArcMap
Tides and Datums
Raw Data Access/Conversion
Other
BETA / EXPERIMENTAL
Filter Apps:
Search
Description
Run Program
Add to Start Menu
Add to Desktop
Debug
<--
-->
Pydro documentation » All Programs distributed in Pydro »
index
Pydro Explorer
The Explorer application is intended to give a central place to find the various tools from Pydro + friends distributed from a server by HSTB. The applications are developed in collaboration with HSTB, UNH, HSD-HQ, branches and field units.
When a menu item is clicked on it will display some information in the description window (which is internet explorer browser). The highlighted application can be launched from the description window or by double clicking on it. Also shortcut icons can be created for the current user in the start menu or the desktop.
Changelog:
1/4/2017 Added Common Code Base Demonstrator script to explorer.
11/18/2016 Sound Speed Manager RC available.
09/09/2016 Added Toggle Auto-Updates as menu item in Pydro Exporer (was only available under User Preferences in PydroGIS)
02/11/2016 Updated Arc Toolbox “PydroGIS.pyt” – lines clipped into two pieces will be different line numbers (and more updates)
01/30/2016 Large update for HydrOffice for BagExplorer,
Table Of Contents
Pydro
Charlene
Programs by Category
Programs, Alphabetical
AUV Depth
Apply TCARI
ArcMap
ArcMap Lines for Hypack
BAG Explorer
BDB Surface ASCII Export Stats
CA Tools
Caris Performance Benchmark
CastTime
Change ENC Product

Pydro - Development



- More info on Thursday:
  - Apps, libs, and dependencies
  - SVN server
  - Distribution & Licensing
  - Governance & Maintenance

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

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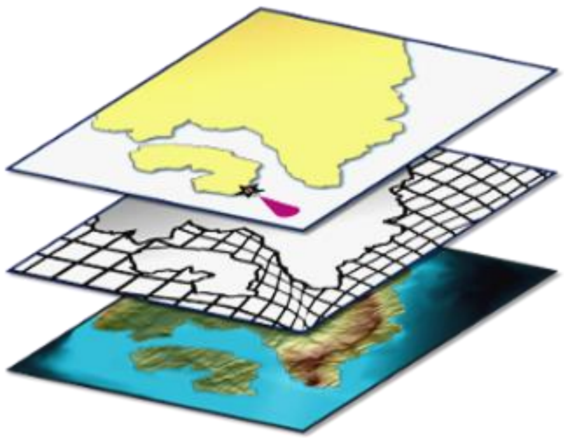
HydrOffice

G. Masetti & T. Faulkes

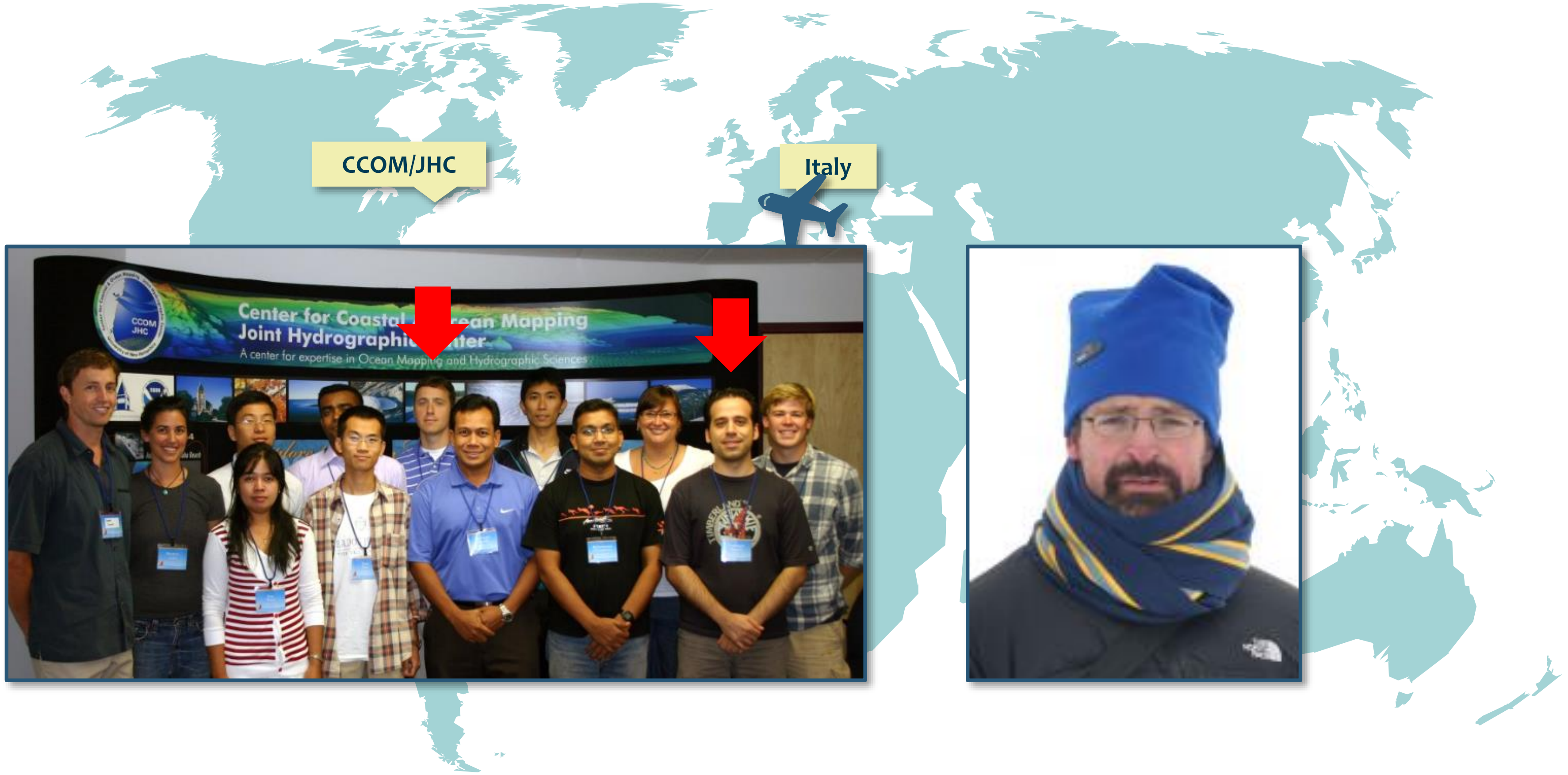
Canberra, June 18-20 2019

HydrOffice

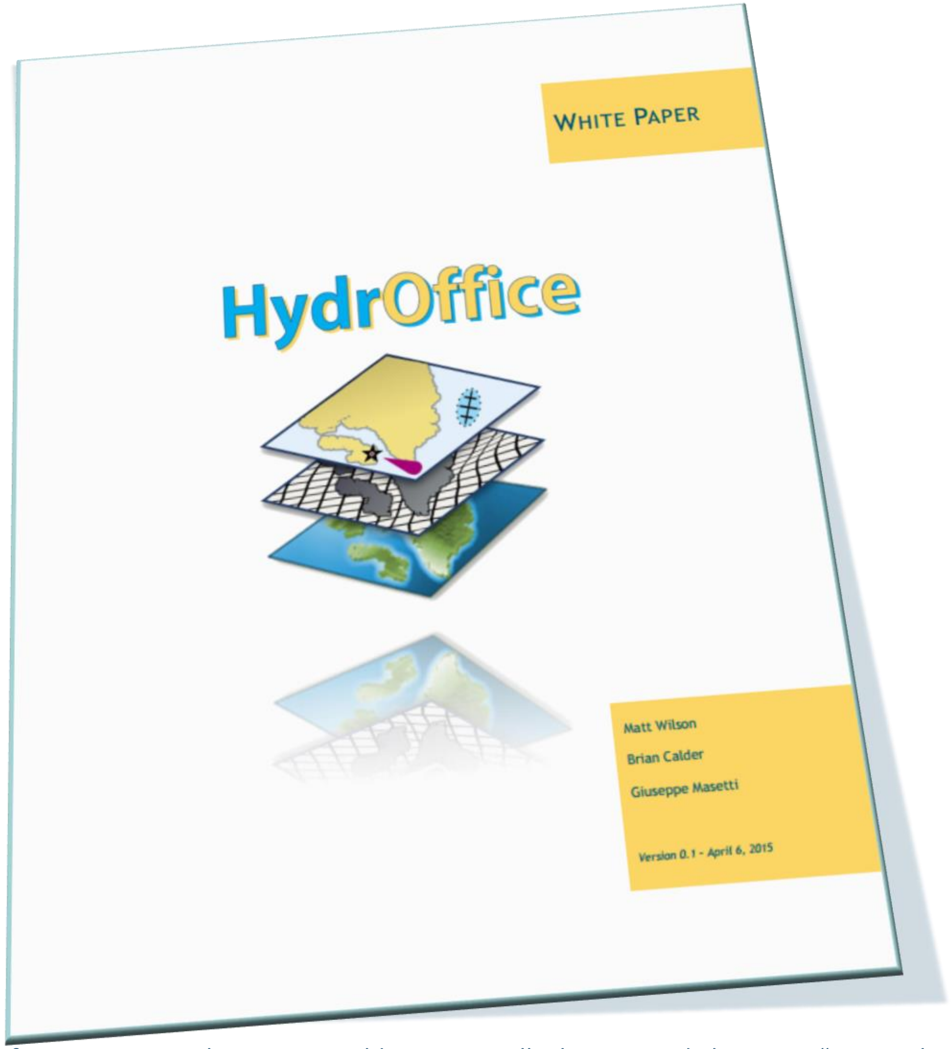


A research framework for ocean mapping to facilitate **research-to-operation** (R2O)


POLICY
GUIDELINES
PRACTICES
STANDARDS
RULES
REGULATIONS
COMPLIANCE
specs
tools
INSTRUCTION MANUAL
manuals



2013
Initial thoughts



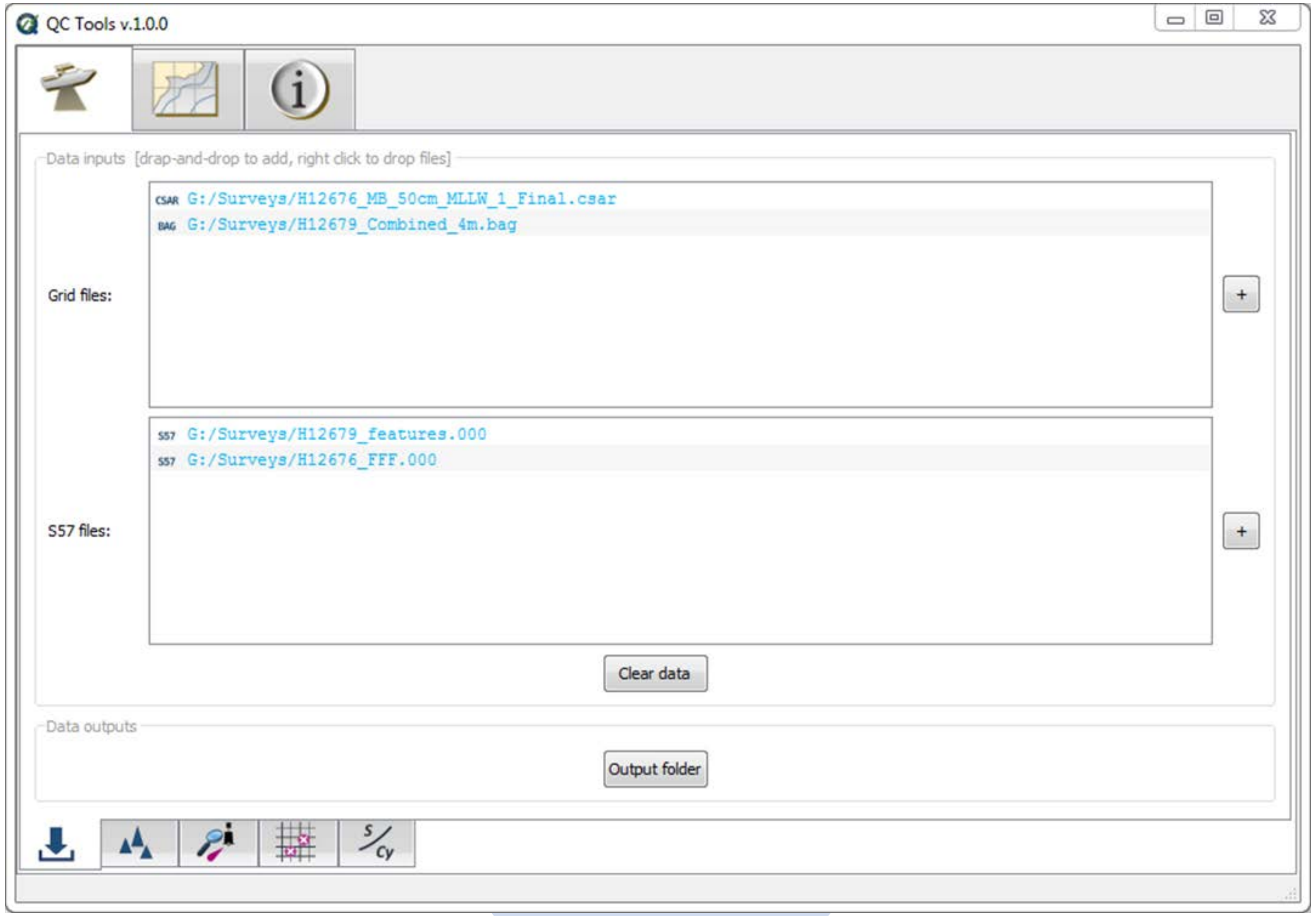
A framework of libraries and tools for Ocean Mapping

Quickly prototype and test innovative ideas

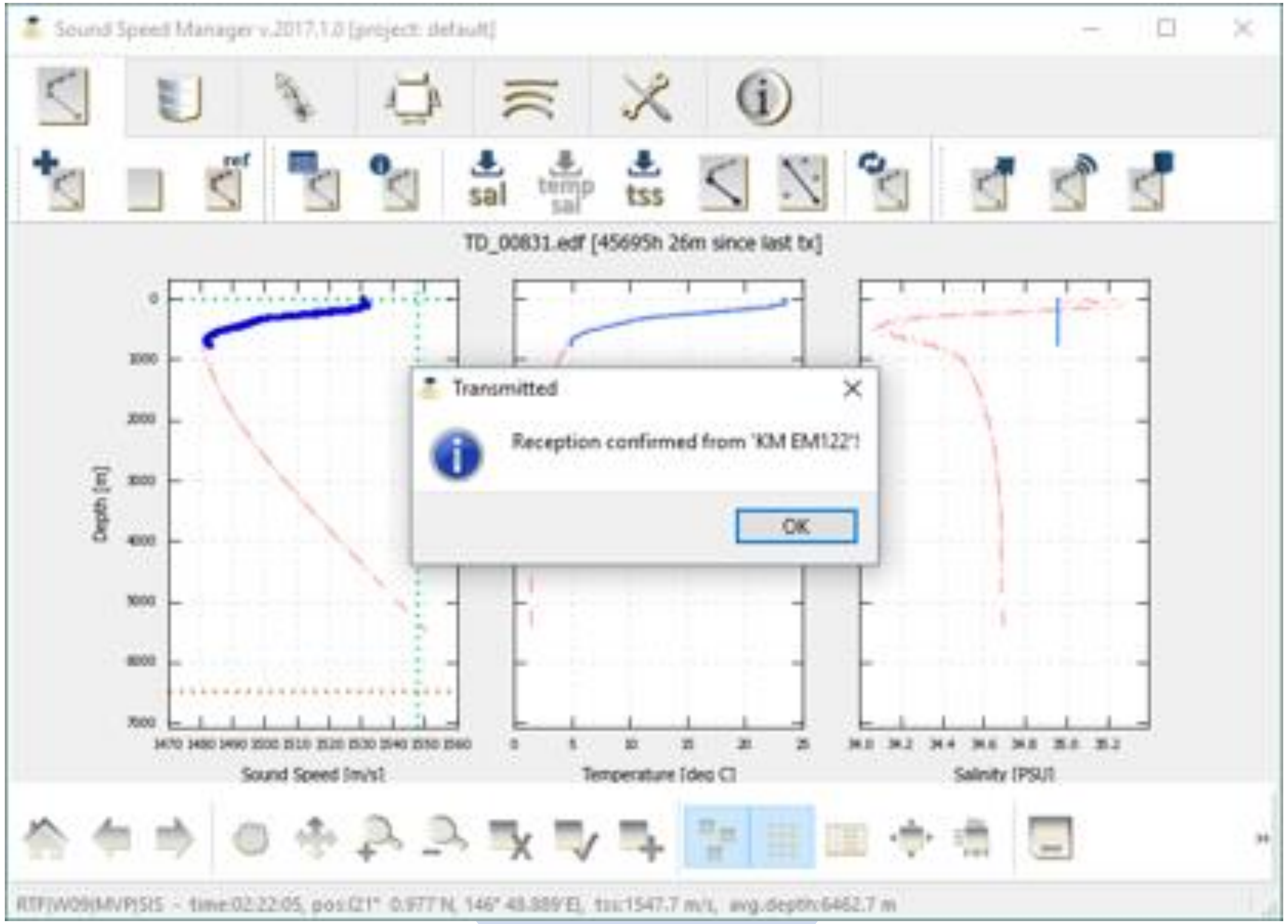
Ease the transition from research to operation

Ref.: G. Masetti, Wilson, M. J., Calder, B. R., Gallagher, B., and Zhang, C., “Research-driven Tools for Ocean Mappers”, Hydro Int., vol. 21, 5. GeoMares, 2017.

2015
White Paper



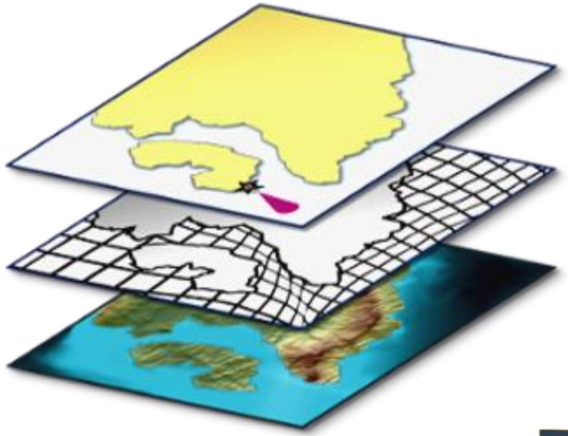
July 2016
Site Review



March 2017
SSM release

January 2018
Team Change

HydrOffice Apps

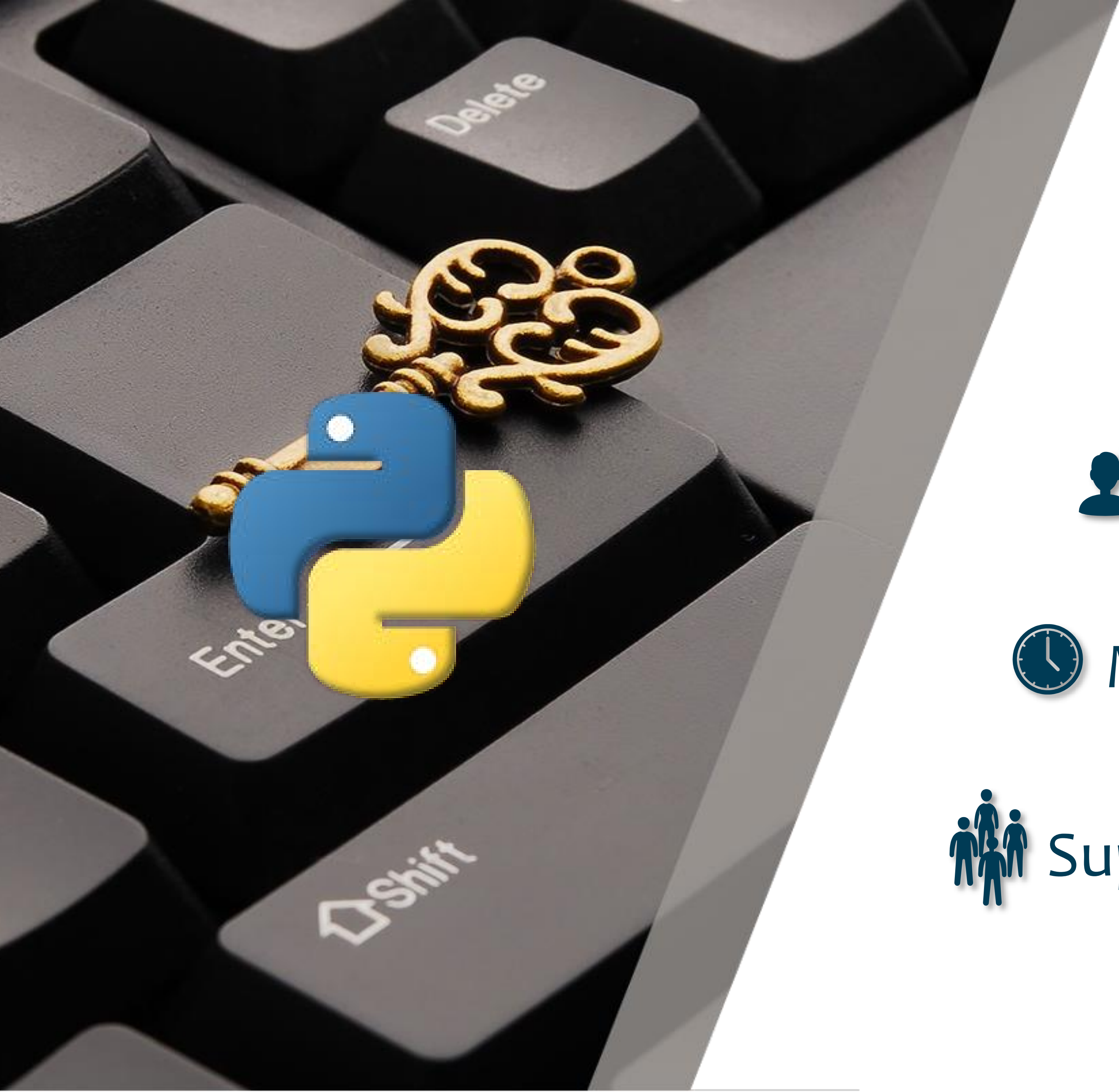


- QC Tools
- Sound Speed Manager
- BAG Explorer
- ENCx
- Huddl
- StormFix
- SmartMap
- Bress
- CA Tools
- OpenBST
- …

HydrOffice Apps & Scripts

Ocean Mapping Libs

Python Scientific Stack



Support open formats

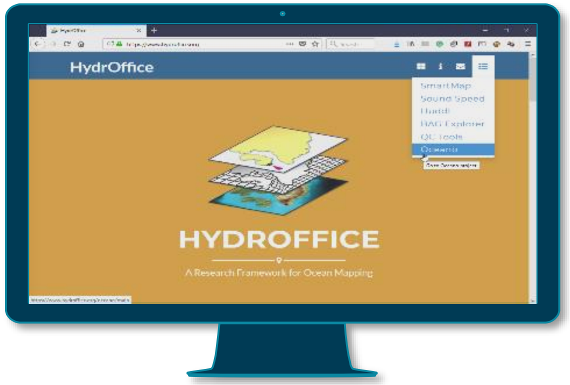
Listen the field feedback

Maintenance is a time sink

Support from hydro community

OCS-UNH CO-DEVELOPMENT

DISTRIBUTION



Pydro Universe

www.nauticalcharts.noaa.gov

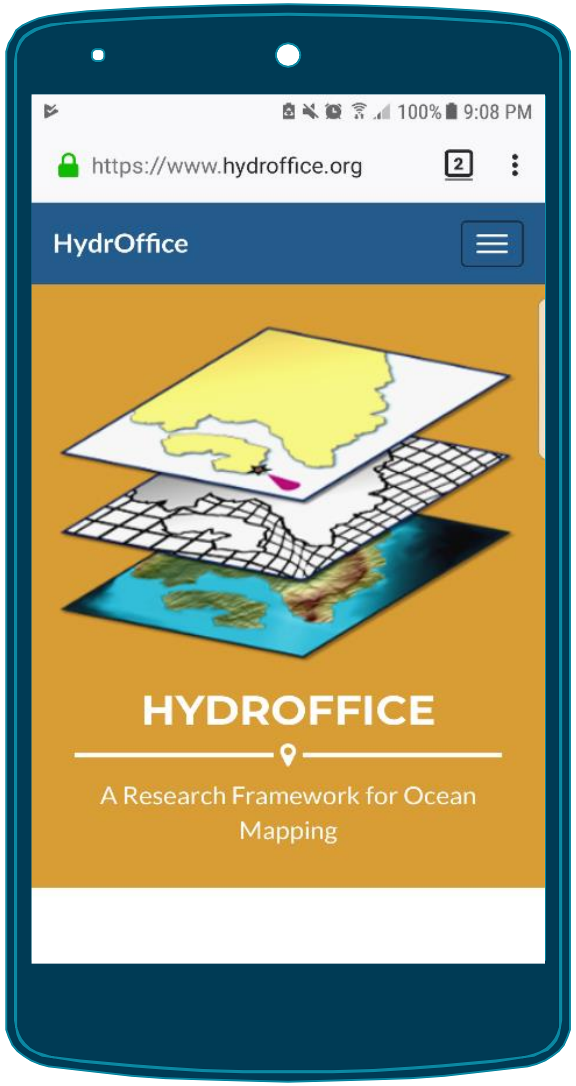
Stand-alone Apps

www.hydroffice.org

Python Packages

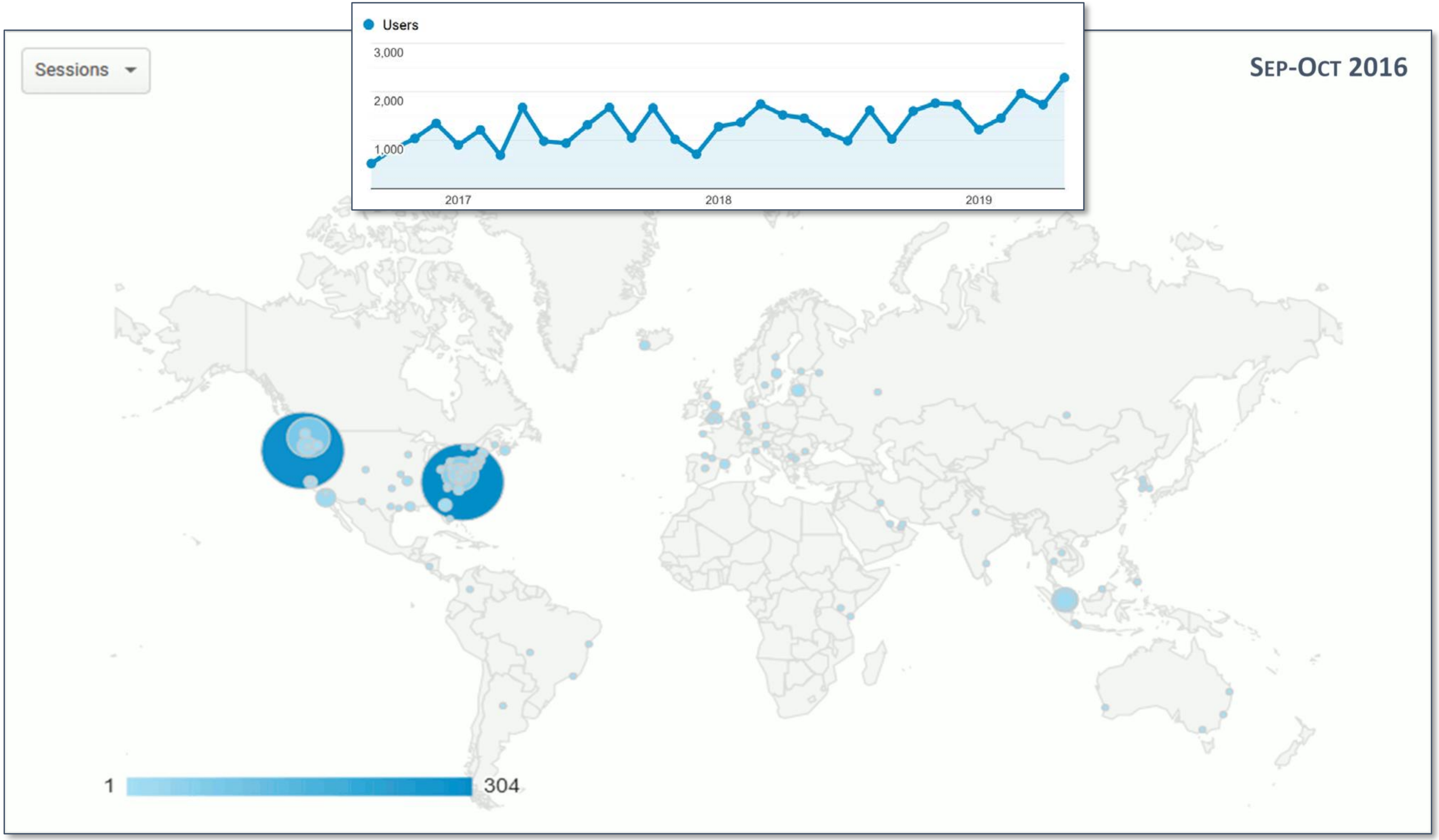
GitHub/PyPi/Conda

HYDROFFICE.ORG



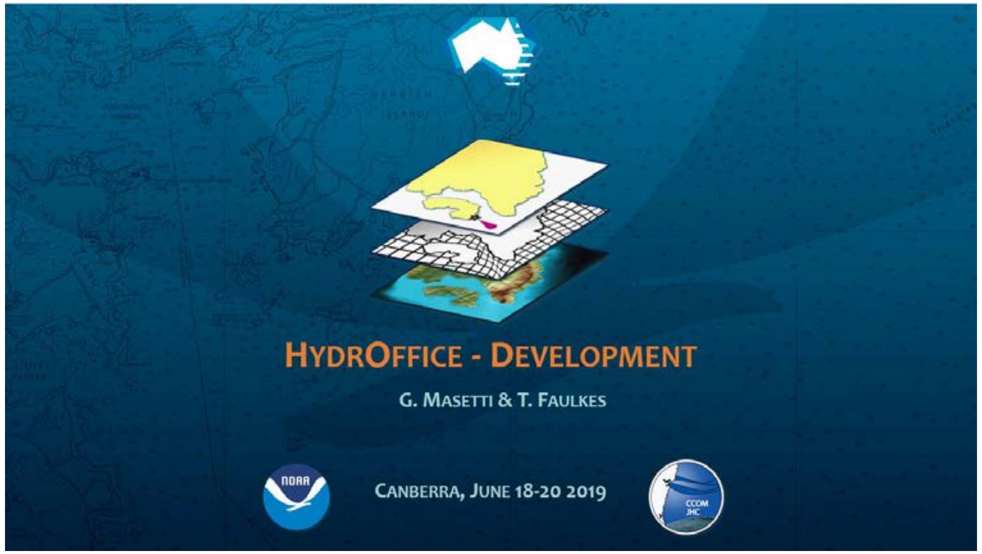
- Mobile-first, dynamic website
- Based on Django & JavaScript
- Per-tool Home Page
  - Info
  - Stand-alone downloads
  - Manuals
  - Embedded tutorials

HydrOffice.org



(*) Google Analytics, Number of Sessions, location filtered: Durham, unset.

HydrOffice - Development



- More info on Thursday:
  - Apps, libs, and dependencies
  - Packaging
  - Distribution & Licensing
  - Governance & Maintenance

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

V0

QC TOOLS

T. FAULKES & G. MASETTI

CANBERRA, JUNE 18-20 2019

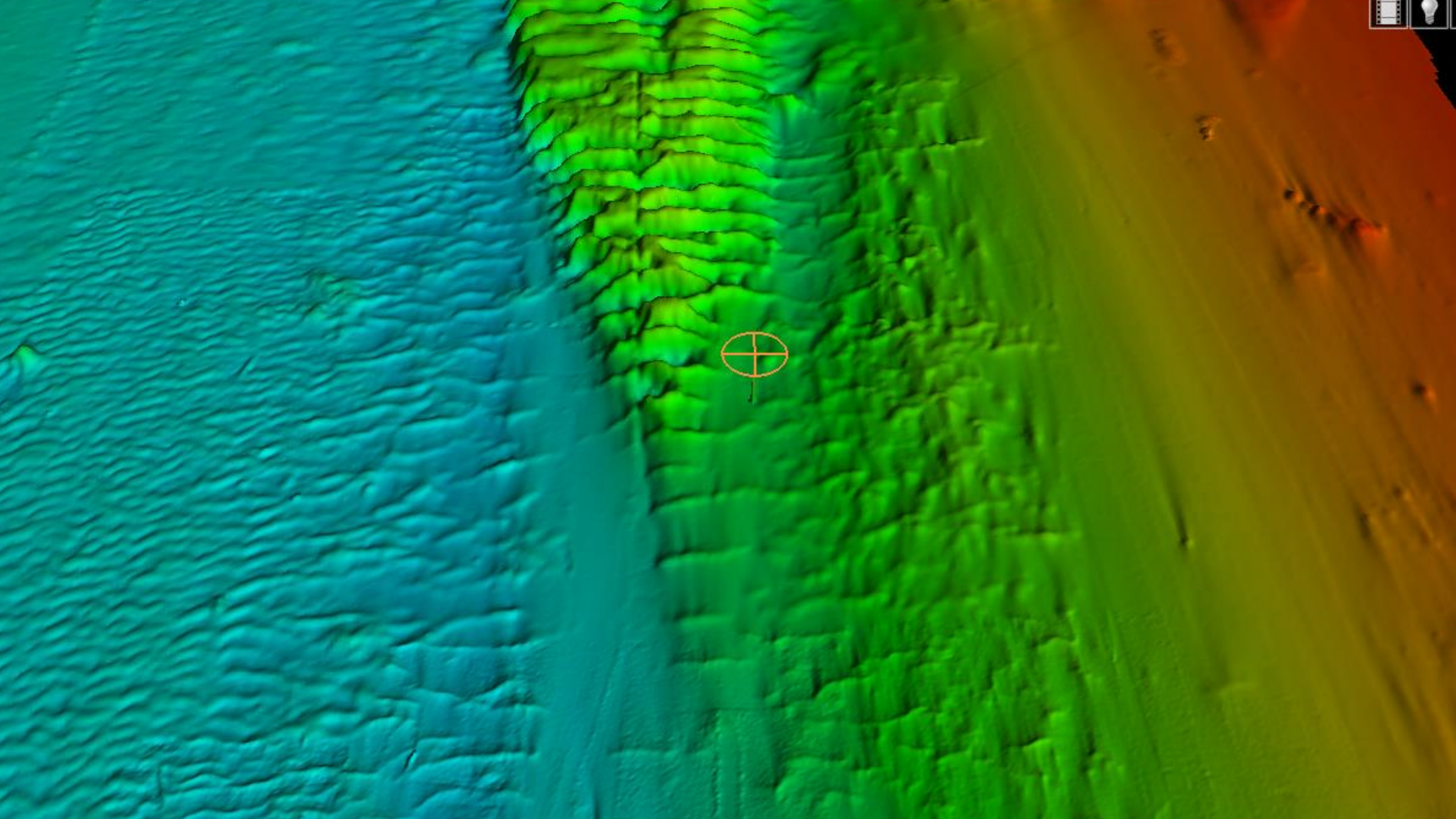
QC Tools

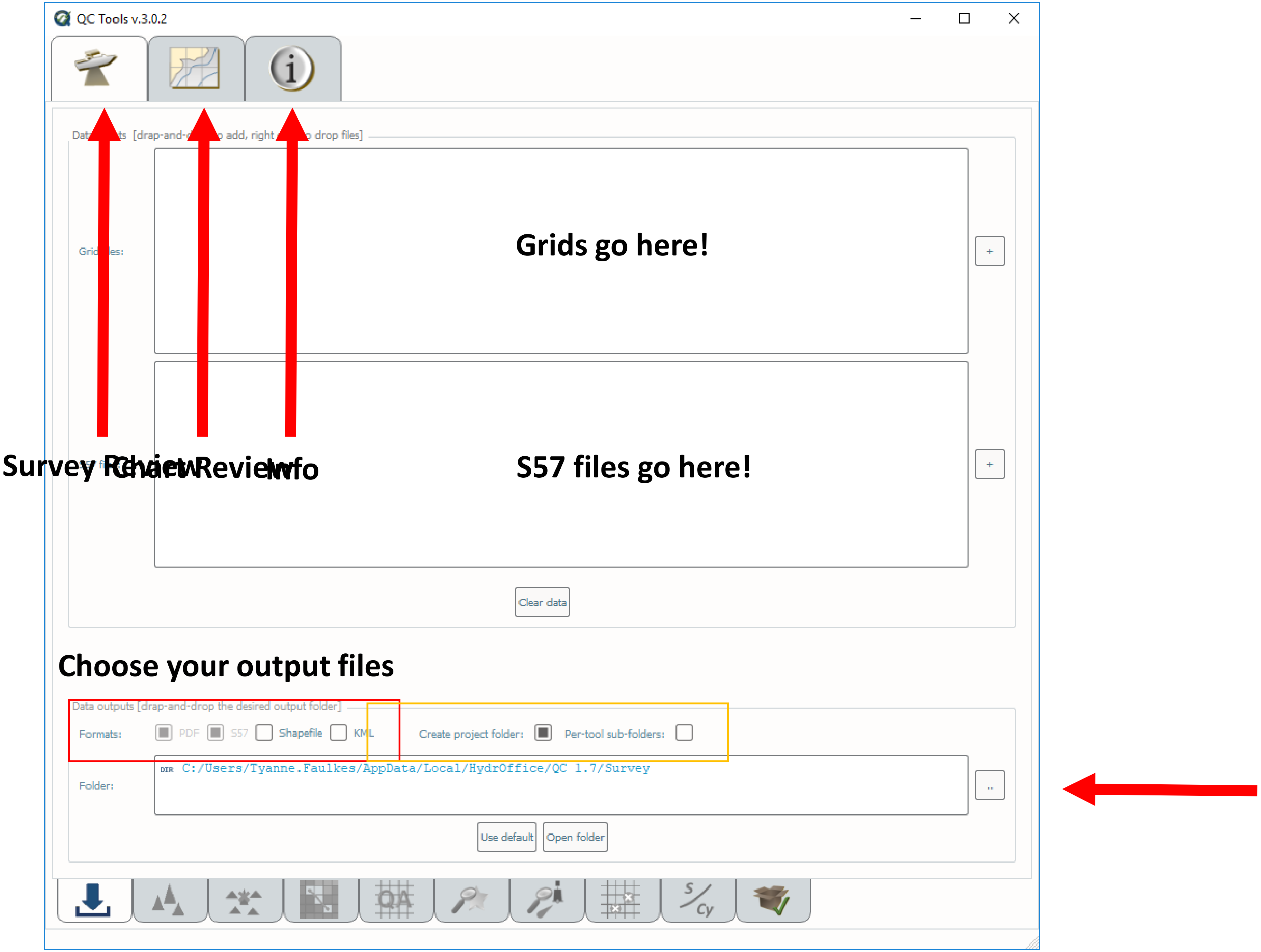
Performs automated **quality control checks** on surfaces and final feature files

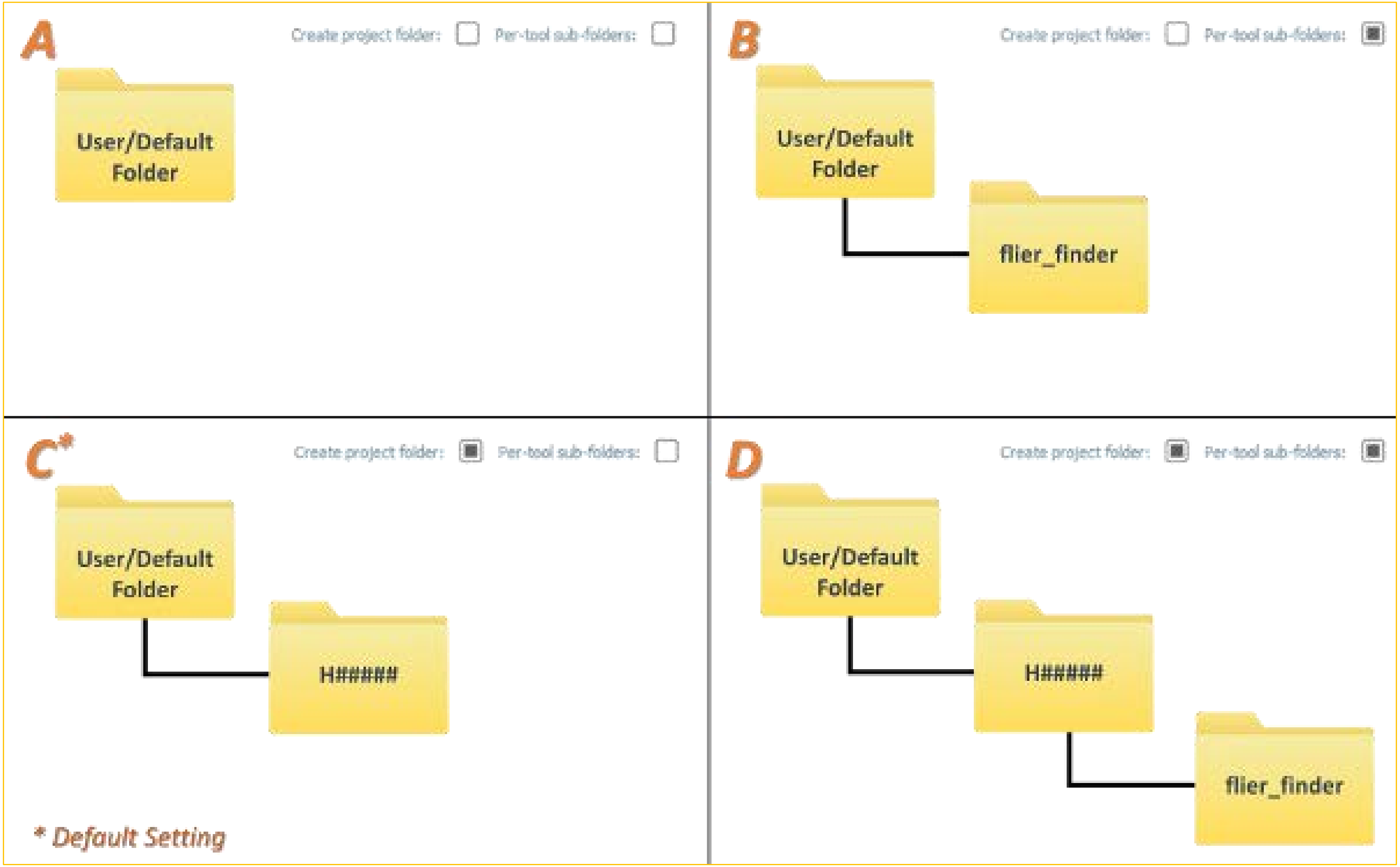
Workflow

GDAL Open Formats

- BAG
- S-57
- Shapefile
- KML



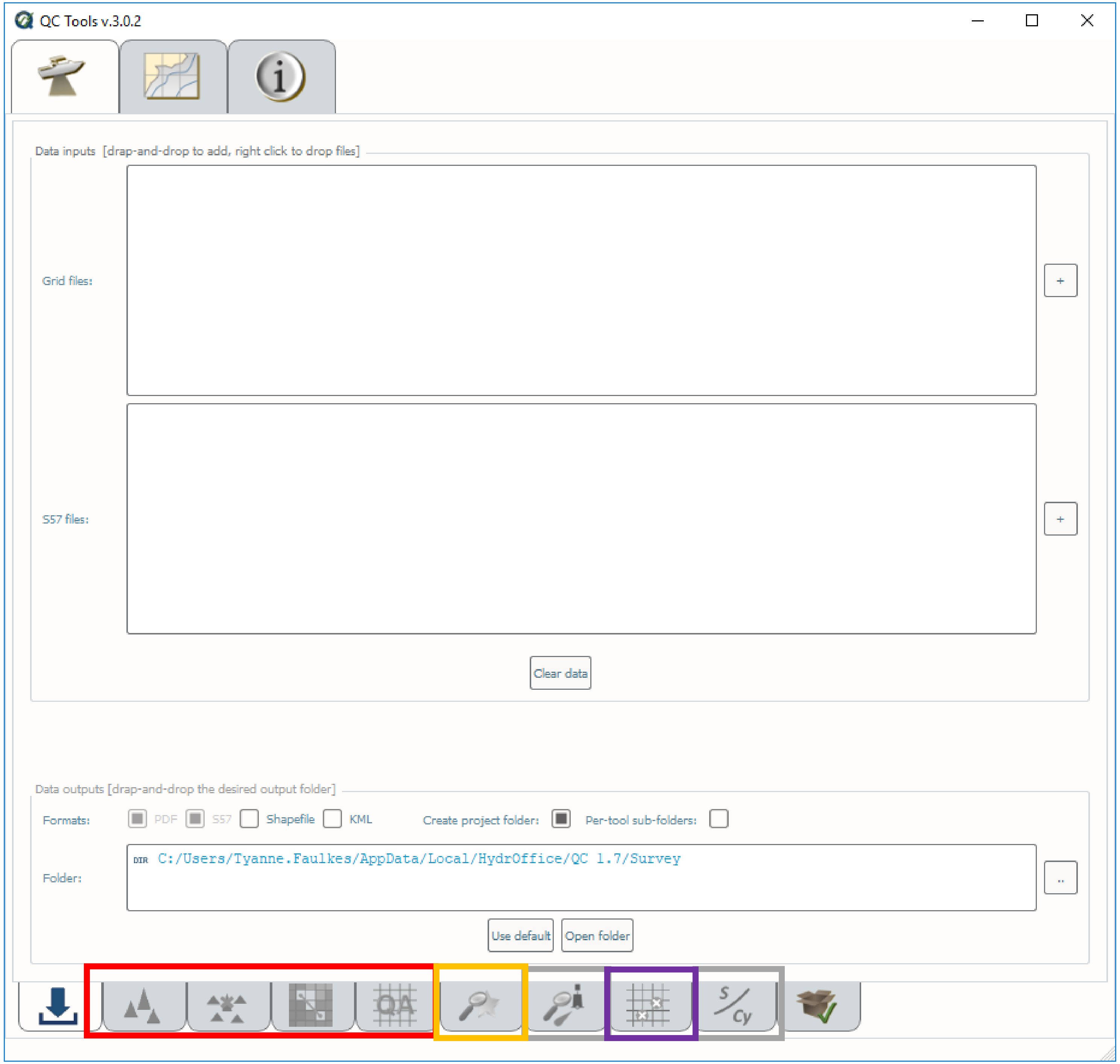

QC Tools v.3.0.2
Grids go here!
S57 files go here!
Survey Review
Chart Review
Info
Clear data
Choose your output files
Data outputs [drap-and-drop the desired output folder]
Formats:
PDF
S57
Shapefile
KML
Create project folder:
Per-tool sub-folders:
Folder:
C:/Users/Tyanne.Faulkes/AppData/Local/HydrOffice/QC 1.7/Survey
Use default
Open folder


A
Create project folder:
Per-tool sub-folders:
User/Default Folder
B
Create project folder:
Per-tool sub-folders:
User/Default Folder
flier_finder
C*
Create project folder:
Per-tool sub-folders:
User/Default Folder
H#####
D
Create project folder:
Per-tool sub-folders:
User/Default Folder
H#####
flier_finder
* Default Setting

SURVEY REVIEW

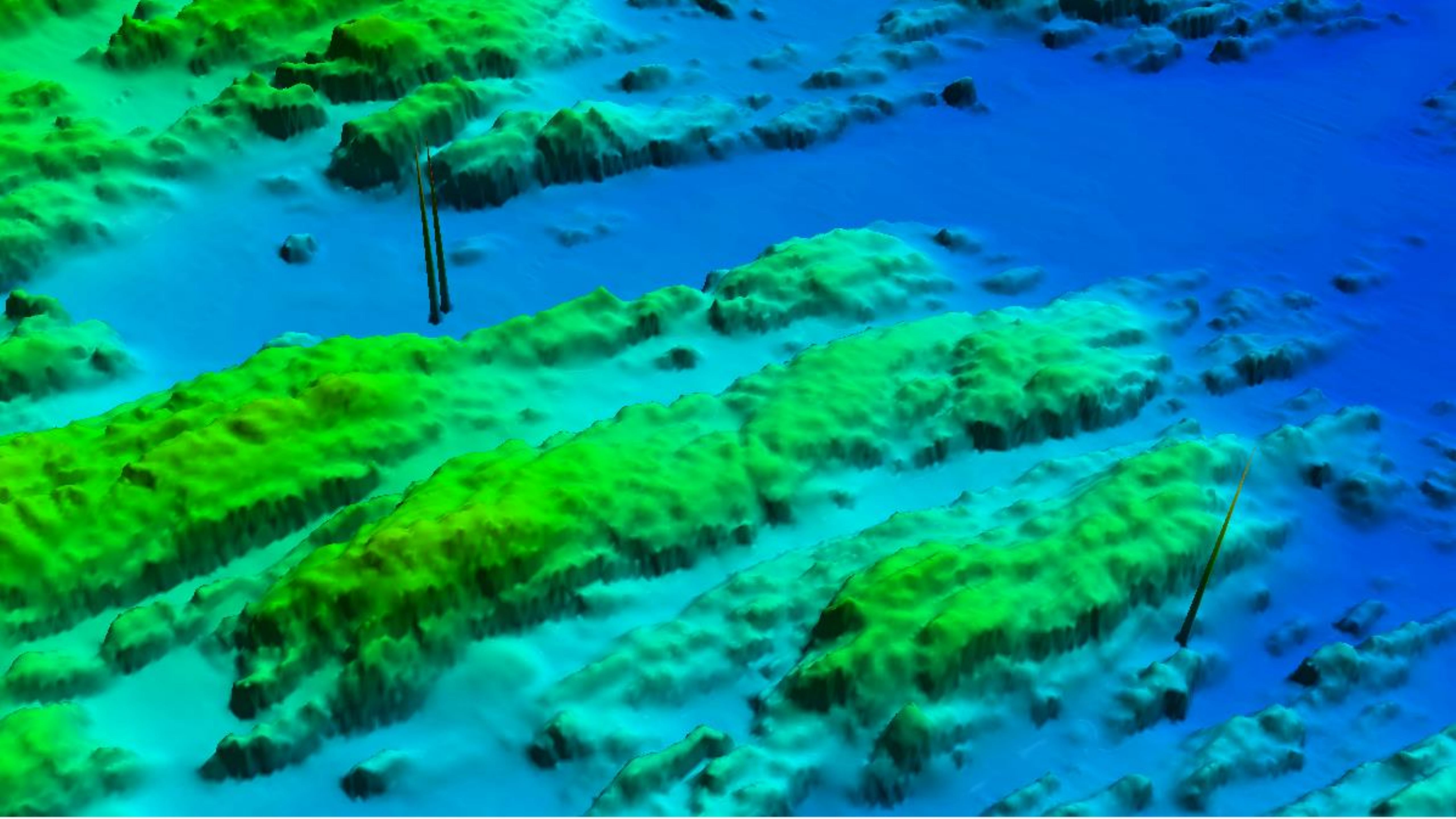
Survey Review

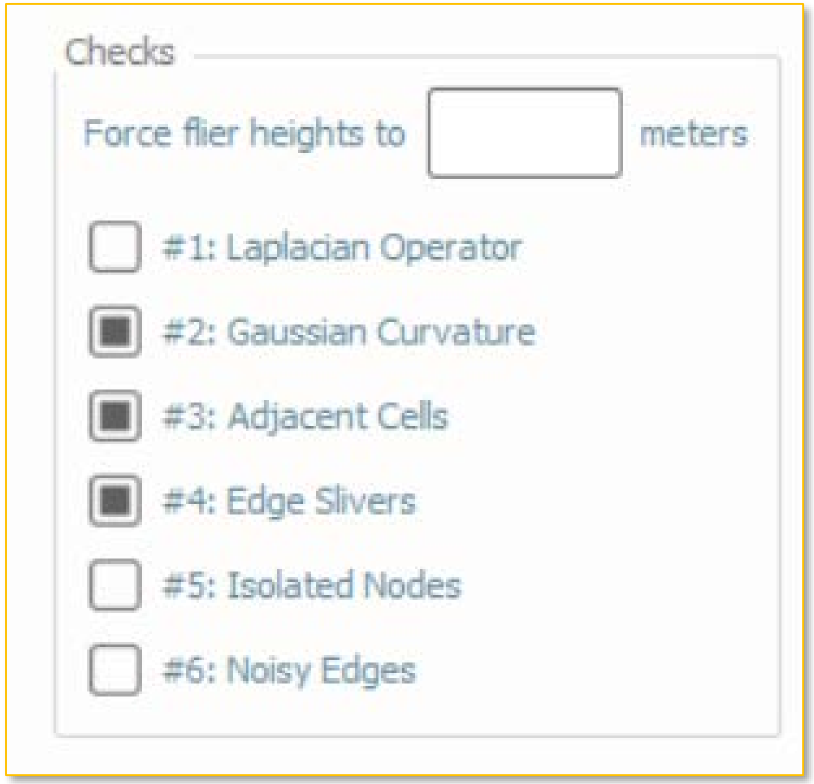
- **Detect Fliers**
- **Anomaly Detector**
- **Detect Holidays**
- **Grid QA**
- **Scan Designated**
- **Scan Features**
- **VALSOU Check**
- **SBDARE Export**
- **Submission Checks**


QC Tools v.3.0.2
Data inputs [drag-and-drop to add, right click to drop files]
Grid files:
S57 files:
Clear data
Data outputs [drap-and-drop the desired output folder]
Formats:
PDF
S57
Shapefile
KML
Create project folder:
Per-tool sub-folders:
Folder:
C:/Users/Tyanne.Faulkes/AppData/Local/HydrOffice/QC 1.7/Survey
Use default
Open folder

Detect Fliers and Anomaly Detector

Algorithms and how to use




Checks
Force flier heights to
meters
#1: Laplacian Operator
#2: Gaussian Curvature
#3: Adjacent Cells
#4: Edge Slivers
#5: Isolated Nodes
#6: Noisy Edges

Laplacian Operator

Depth Layer					Laplace			
9	9	9	9		0	1	0	3
9	8	9	6		1	4	10	9
9	9	3	9		0	7	24	9
9	9	9	9		0	0	6	0

If the estimated flier height = 2m, greater than 8 will be flagged

LAPLACIAN OPERATOR

Depth Layer					Laplace			
9	9	9	9		0	1	0	3
9	8	9	6		1	4	10	9
9	9	$\boxed{3}$	9		0	7	$\boxed{24}$	9
9	9	9	9		0	0	6	0

$$(9\text{-}3) + (9\text{-}3) + (9\text{-}3) + (9\text{-}3) = 24$$

$$24 > (2\text{m threshold} \times 4)$$

Laplacian Operator

Depth Layer					Laplace			
9	9	9	9		0	1	0	3
9	8	9	6		1	4	10	9
9	9	3	9		0	7	24	9
9	9	9	9		0	0	6	0

$$(9-9) + (9-6) + (9-3) + (9-8) = 10$$

$$10 > (2\text{m threshold} \times 4)$$

Laplacian Operator

Depth Layer					Laplace			
9	9	9	9		0	1	0	3
9	8	9	6		1	4	10	9
9	9	3	9		0	7	24	9
9	9	9	9		0	0	6	0

$$(8-9) + (8-9) + (8-9) + (8-9) = 4$$

$$4 < (2x4)$$

LAPLACIAN OPERATOR

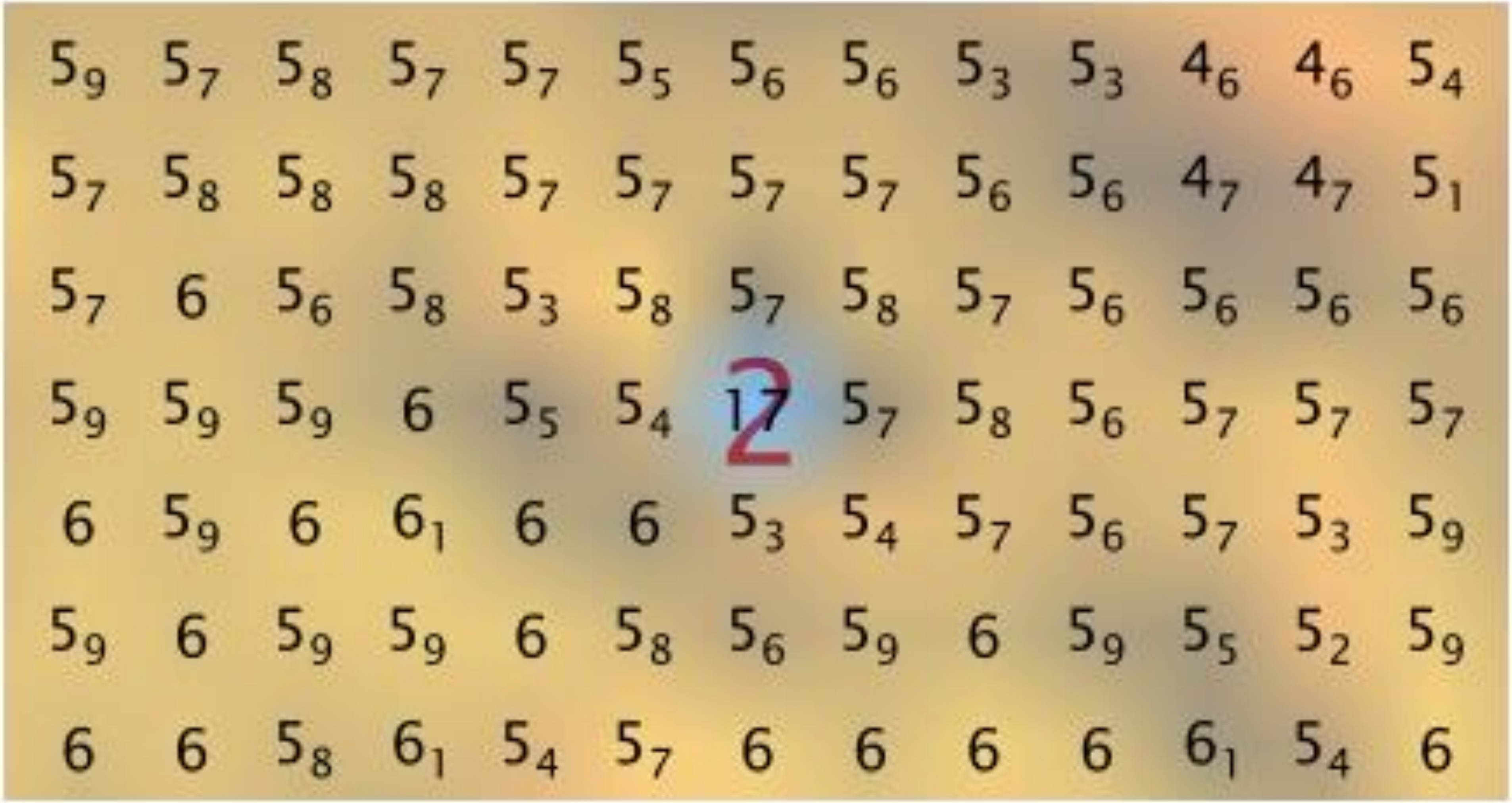
9_5	11_7	11_6	12_1	12_4	21_8	22_5	22_7	22_5	23_4	23_6	24	24
9	9_1	9_1	10_5	12_4	20_2	22_3	22_4	22_3	22_5	23_2	23_8	24_1
8_3	8_4	8_4	9	10_7	18_3	9_8	22	22_2	22_1	22_9	23_1	24
7_5	7_8	8_1	8_1	9_6	18_5	9_8	21_6	21_9	21_9	22_7	22_8	23_2
4_7	6_8	7_7	7_7	8_1	13_3	19_8	21	21_7	21_9	22_4	22_7	22_9
5_8	6_5	7	7_3	8	9_2	20_2	20_7	21_3	21_7	22	22_3	22_7
5_3	5_8	6_4	6_8	6_9	8_9	10_4	20_6	20_9	21_2	21_4	22_2	22_3
4_9	5_4	5_8	6_5	6_8	8_5	9_3	8_8	20_7	20_9	20_6	20_9	22_1
3_8	4_1	4_5	5_5	5_4	5_6	7_9	9_6	11_2	20_1	20_4	20_6	21_2

Gaussian Curvature

Depth Layer					Gaussian Curvature			
9	9	9	9		-1	0	-1	-.09
9	8	9	6		0	-2.3	0	-.14
9	9	$\boxed{3}$	9		-2.5	0	$\boxed{20}$	0
9	9	9	9		0	-9	0	-36

$$K = \frac{\left(g_{xx} \times g_{yy} - g_{xy} \times g_{yx}\right)}{\left(1 + g_x^2 + g_y^2\right)^2}$$

Gaussian Curvature



Adjacent Cells

Depth Layer					Adjacent Cells(3m)			
9	9	9	9		0	0	.2	.33
9	8	9	6		0	.13	.25	1
9	9	3	9		0	0	1	.4
9	9	9	9		0	.2	.2	.33

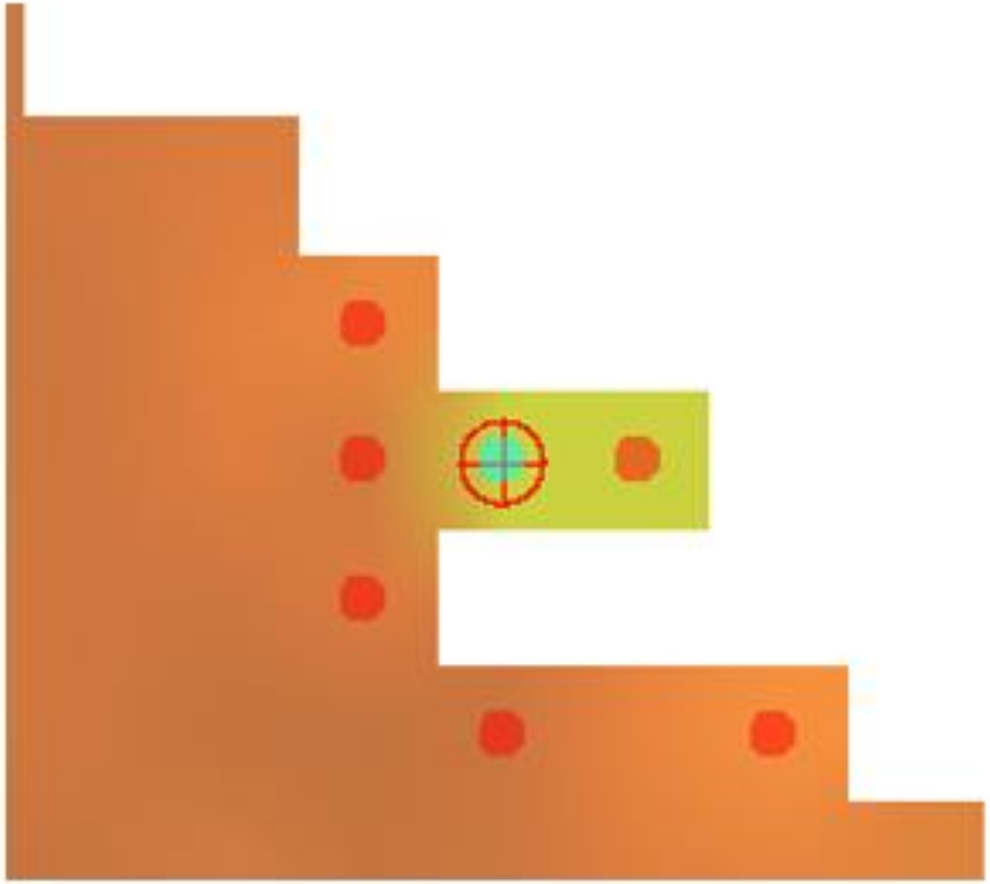
Flier height = 3m

ADJACENT CELLS

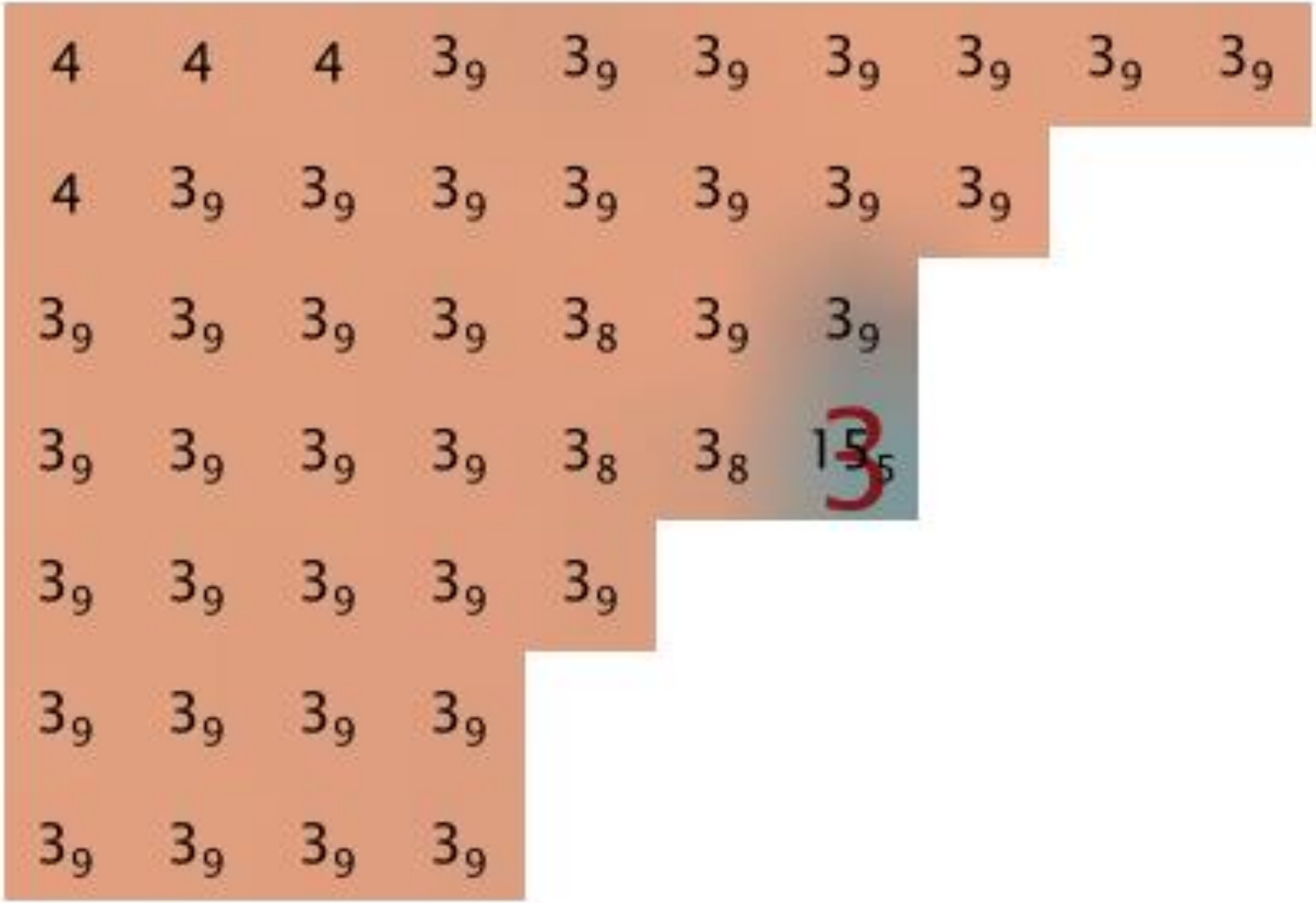
Depth Layer					Adjacent Cells(3m)			
9	9	9	9		0	0	.2	.33
9	8	9	6		0	.13	.25	1
9	9	3	9		0	0	1	.4
9	9	9	9		0	.2	.2	.33

Flier height = 3m

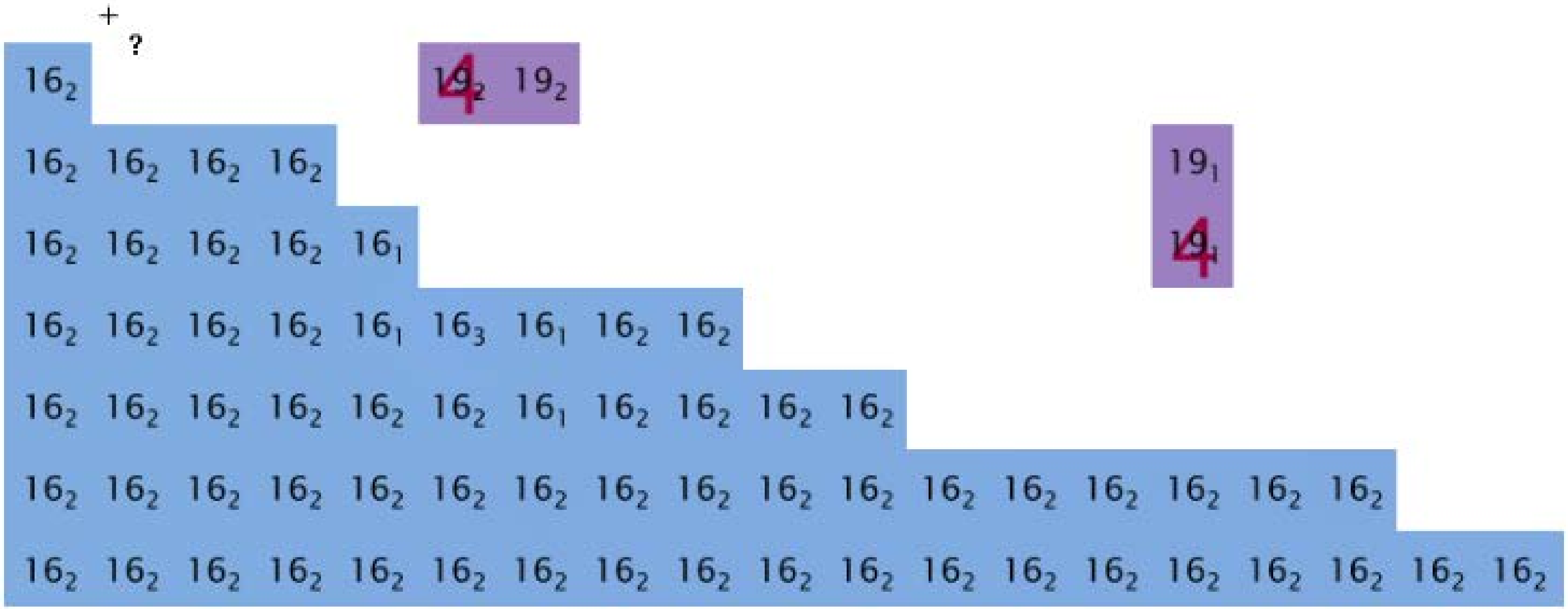
Adjacent Cells



ADJACENT CELLS

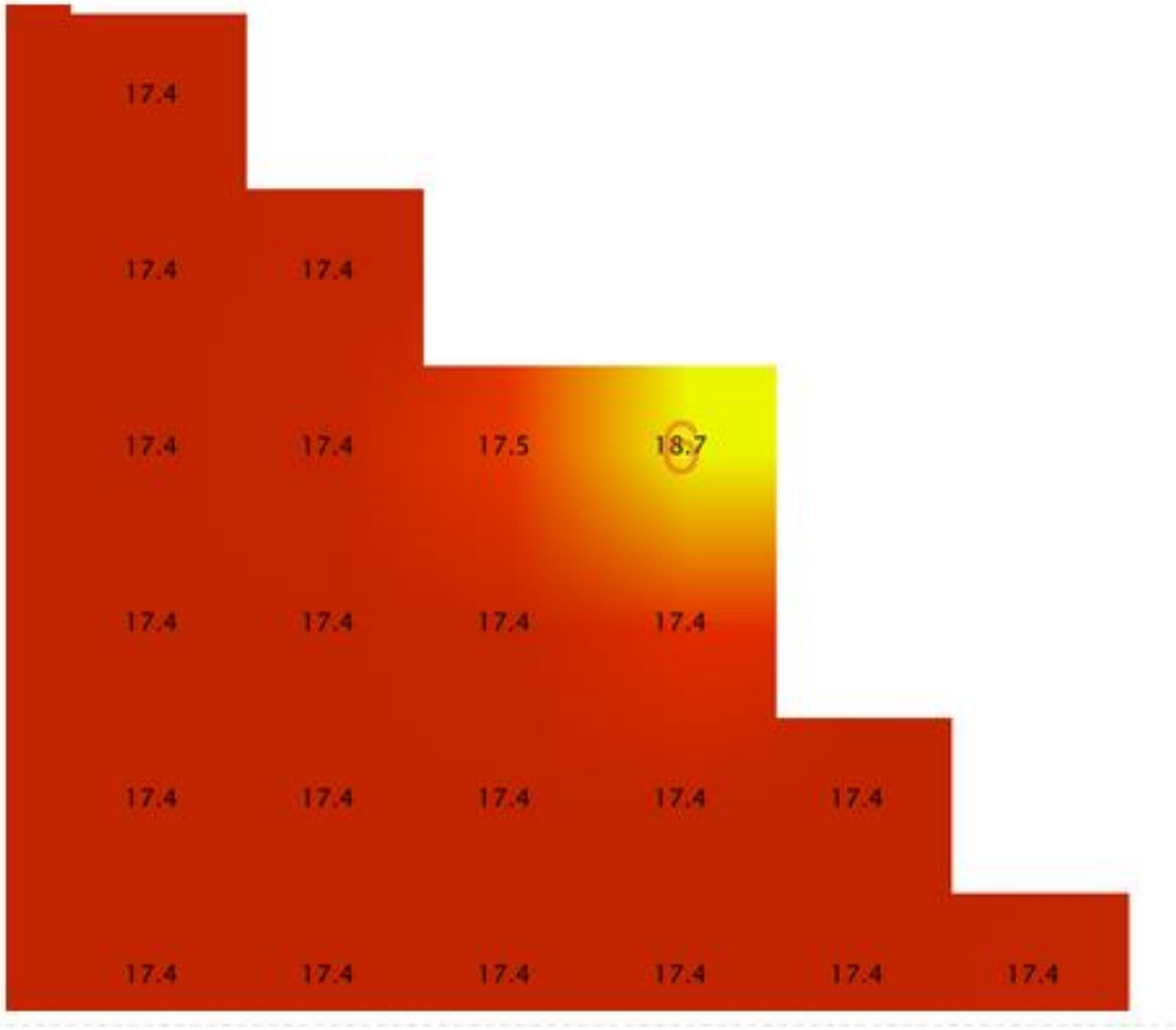


Edge Slivers



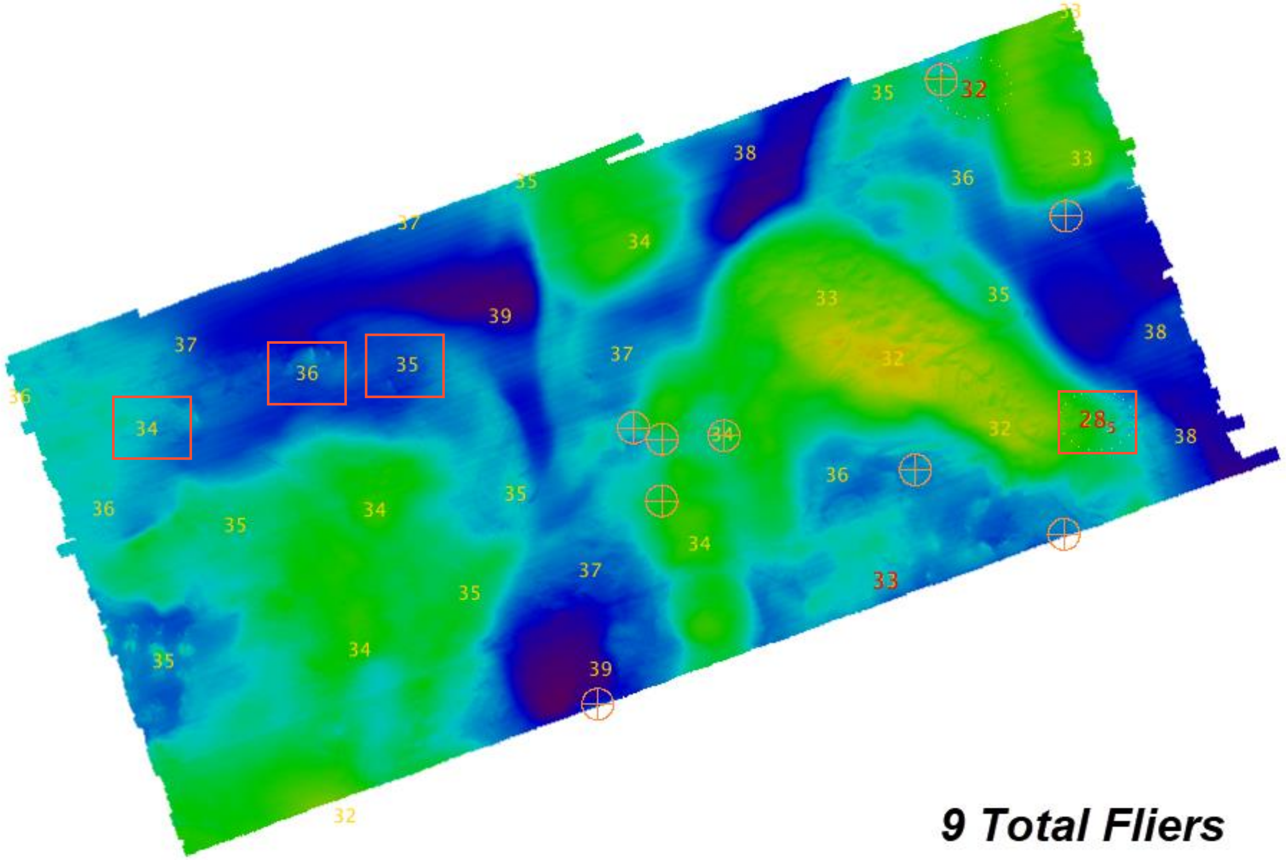
Isolated Nodes

NOISY EDGES



17.4
17.4
17.4
17.4
17.4
17.5
18.7
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4
17.4

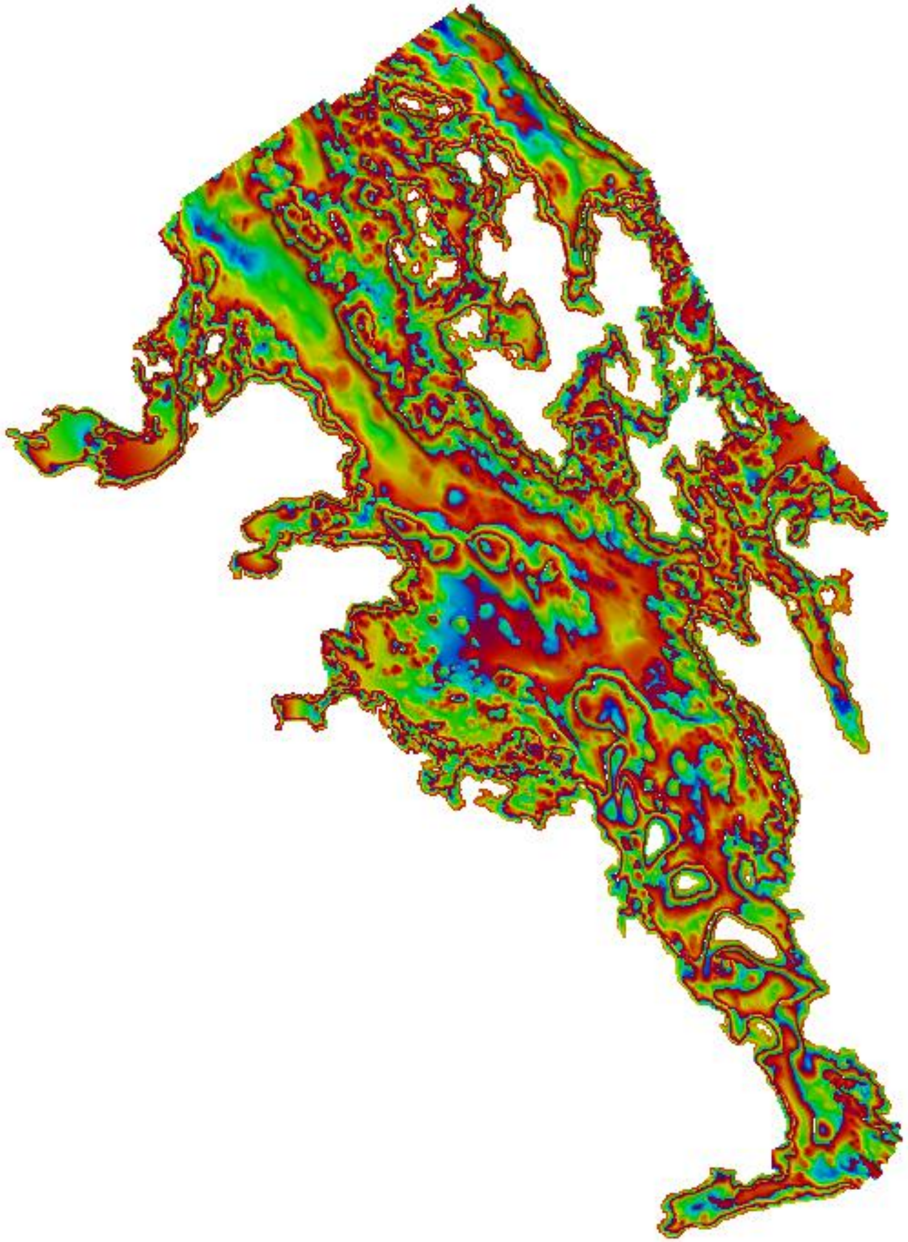
FILTERS



35
32
38
33
36
35
37
34
33
39
35
37
37
36
35
32
38
36
32
28
38
34
34
36
36
35
34
35
34
35
37
34
33
35
34
39
32
9 Total Fliers

Flier Heights

Flier Finder vs Anomaly Detector

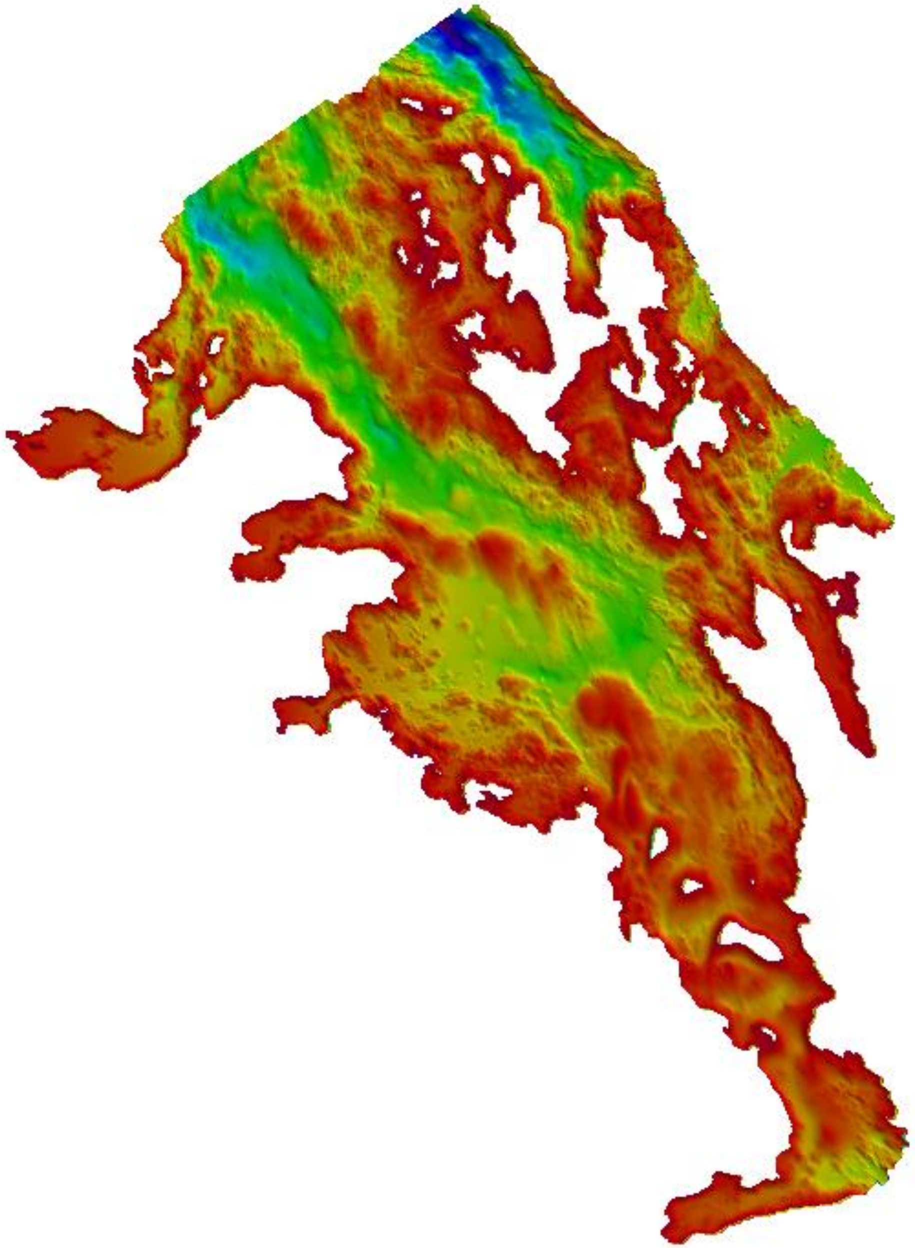


Determining Flier Height: Flier Finder

Depth Interval	Base height
if < 20	1.0
if < 40	2.0
if < 80	4.0
if < 160	6.0
if >= 160	8.0

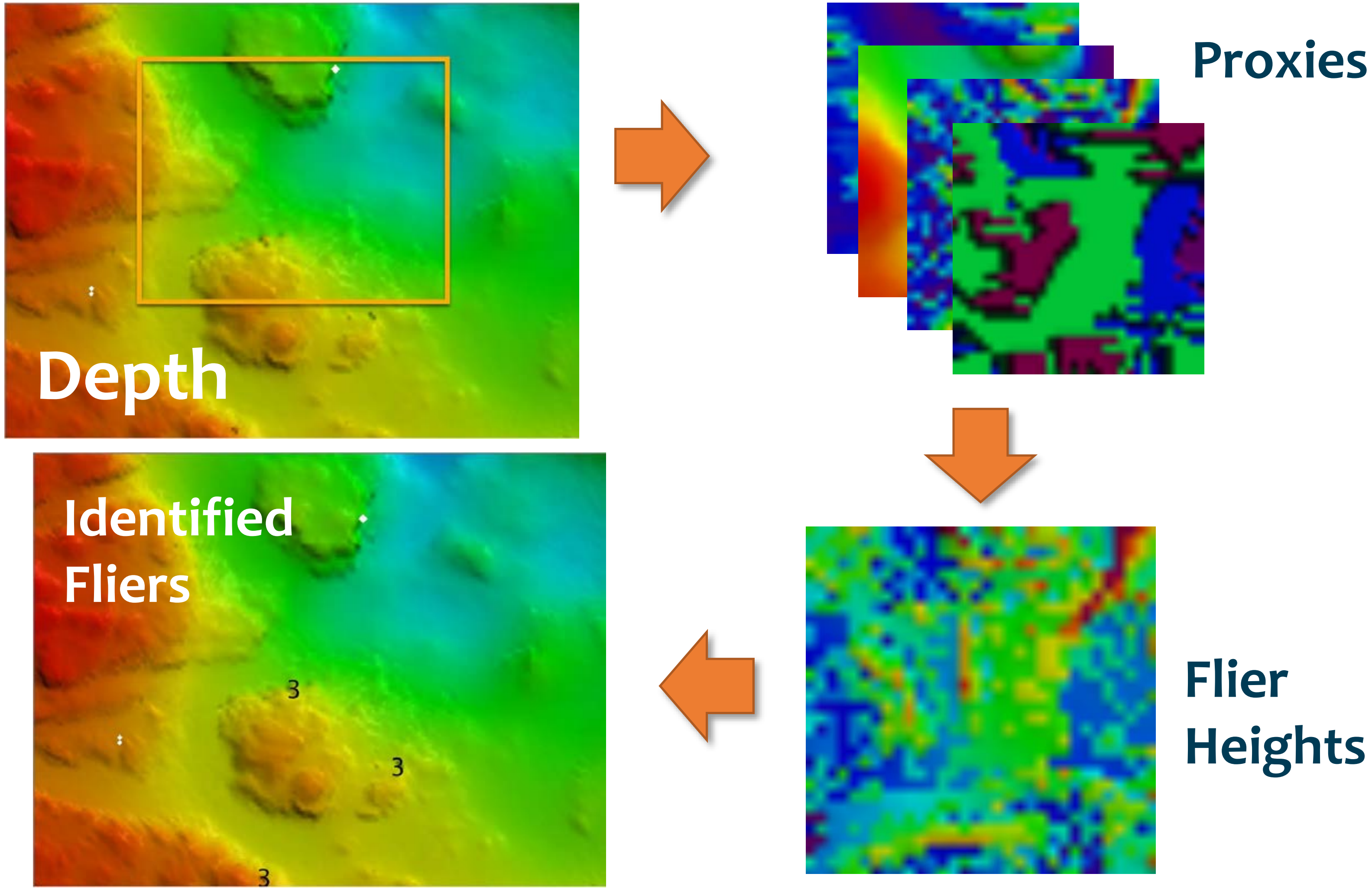
Base heights are increased due to :

- Depth variability (NMAD)
- Roughness (Gaussian Curvature)



Determining Flier Height: Anomaly Detector

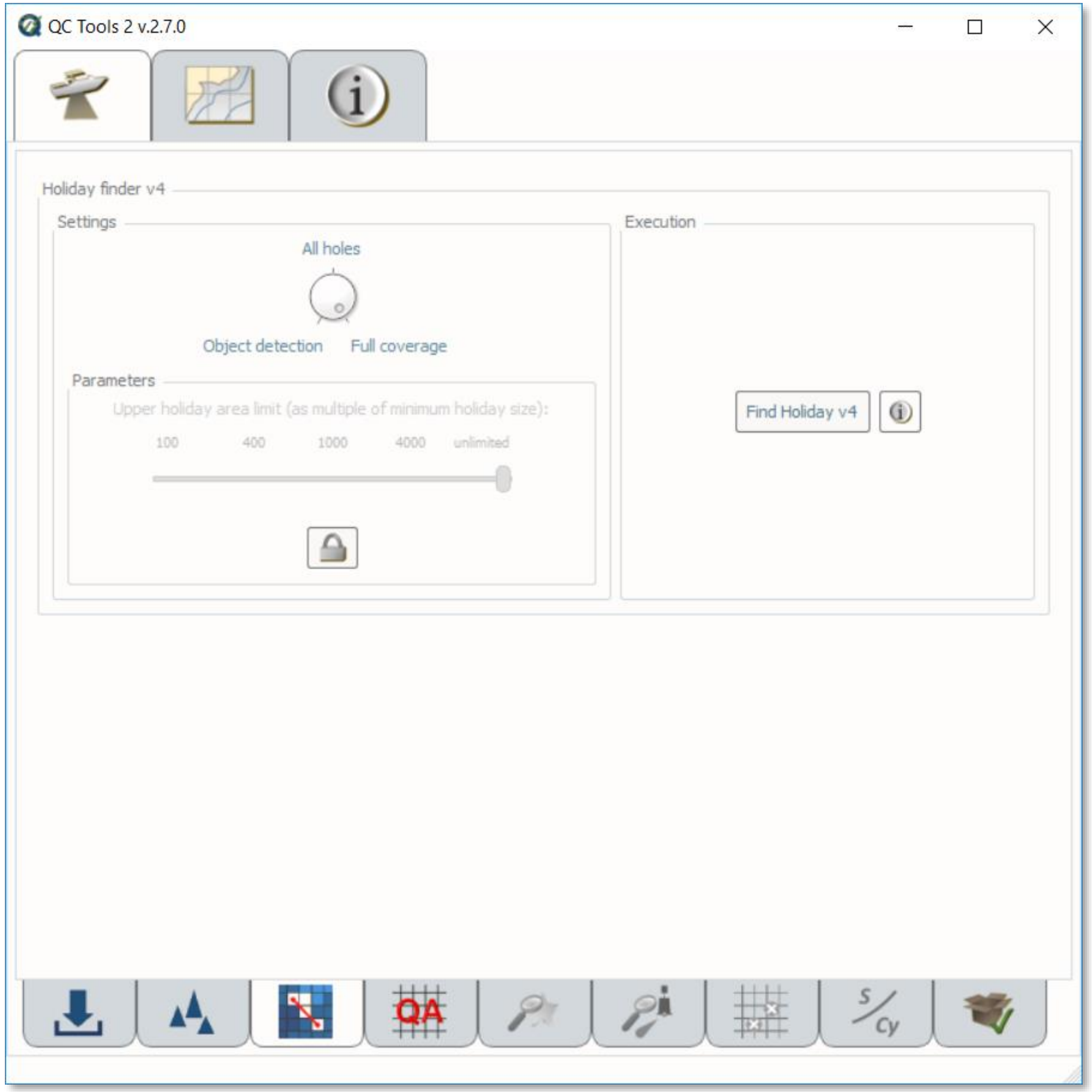
- Local proxies!
- Base height starts as a percentage of median depth
- Flier height increases with a percentage of depth depending on the localized depth variability and roughness.


Depth
Proxies
Flier
Heights
Identified
Fliers
3
3
3

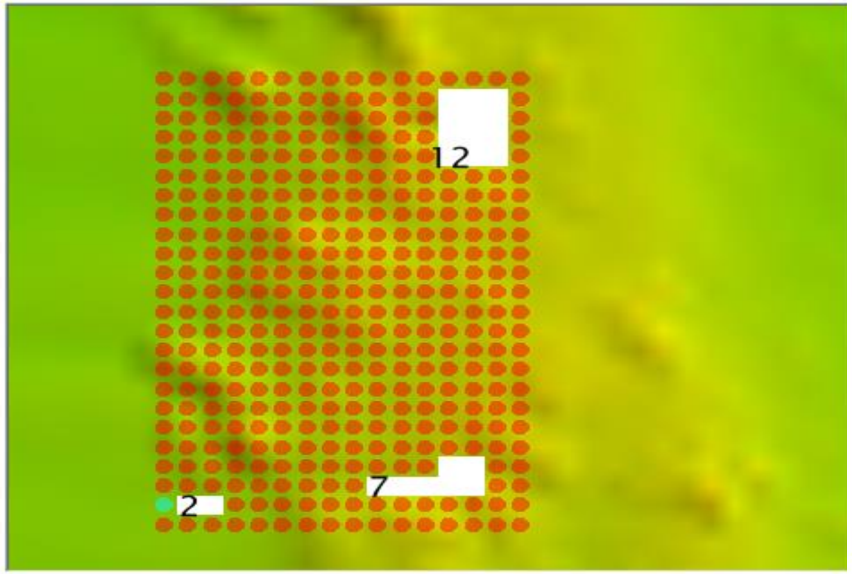
Holiday Finder

Algorithms and how to use

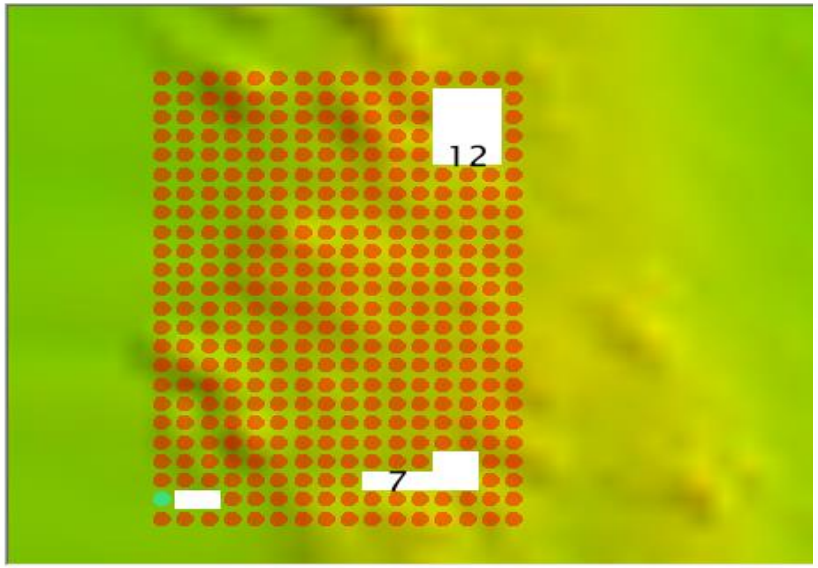
Holiday Finder



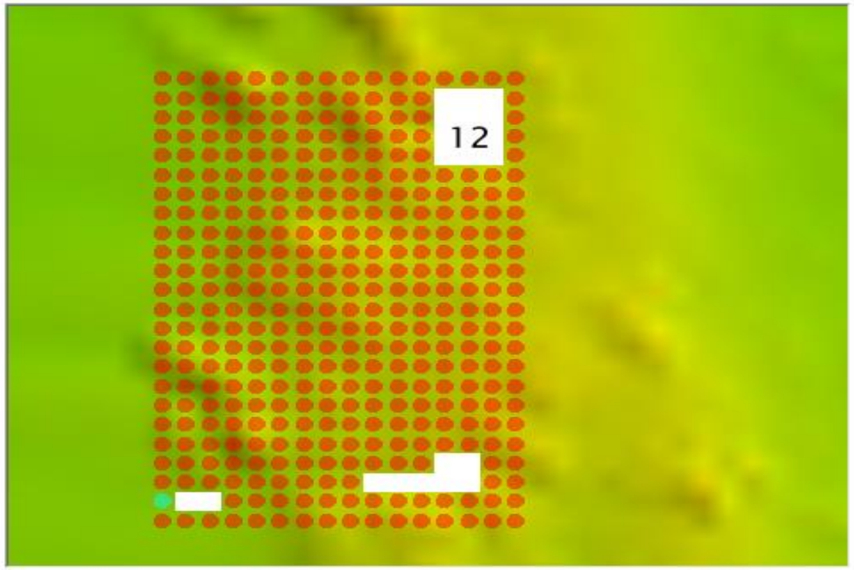
HOLIDAY FINDER



All Holes

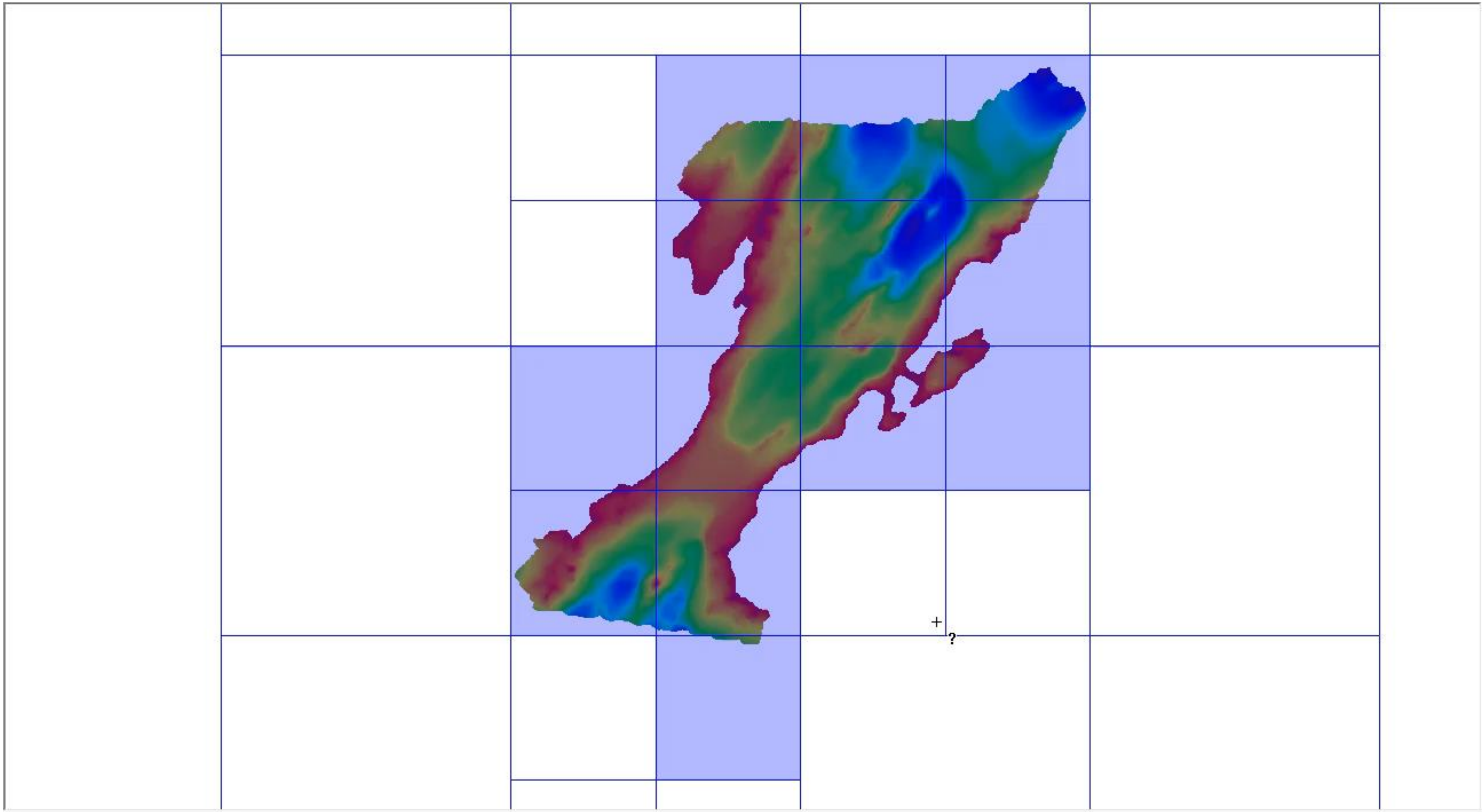


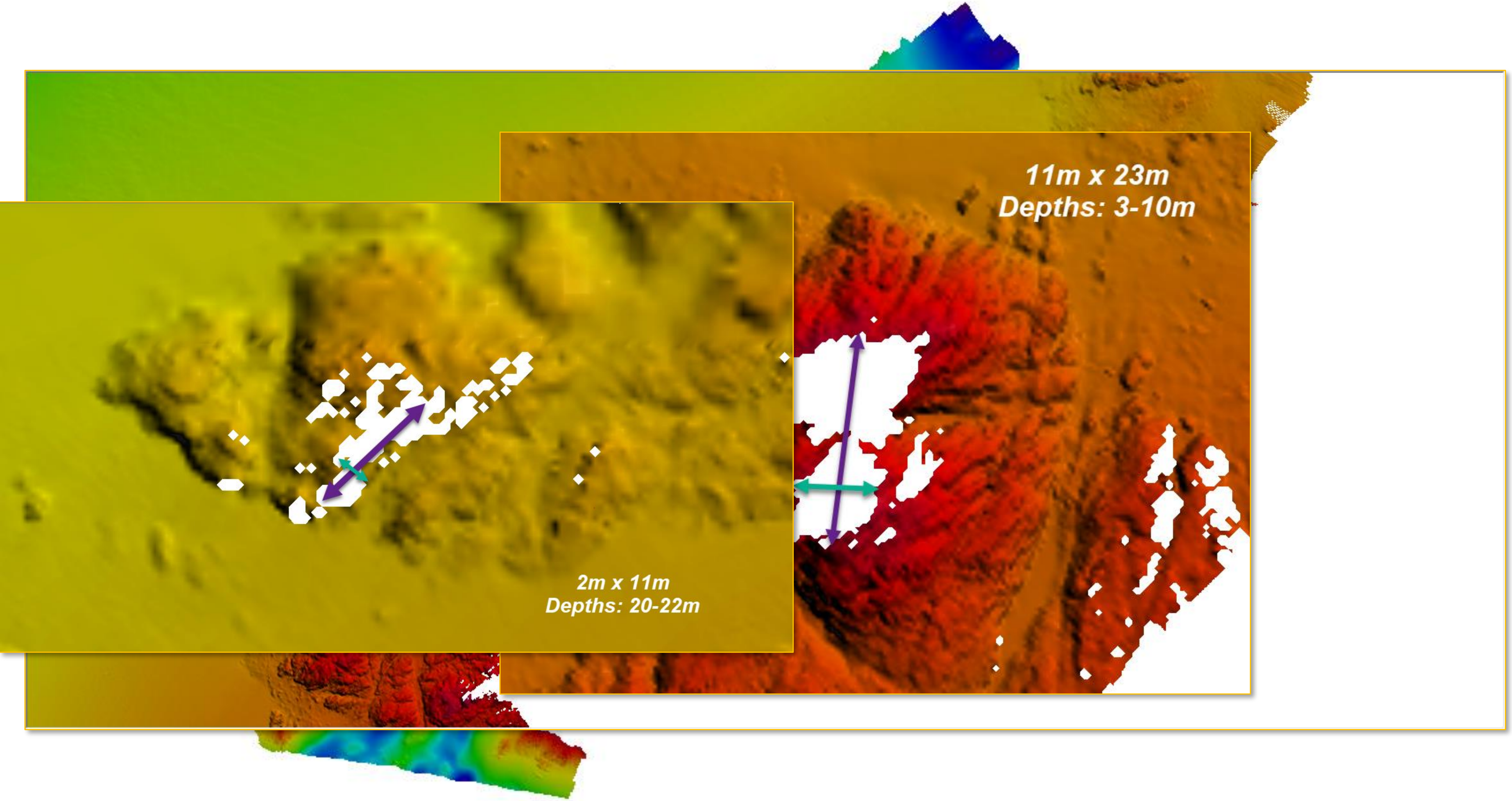
Object Detection*: >3 collinear nodes



Full Coverage*: >3x3 nodes

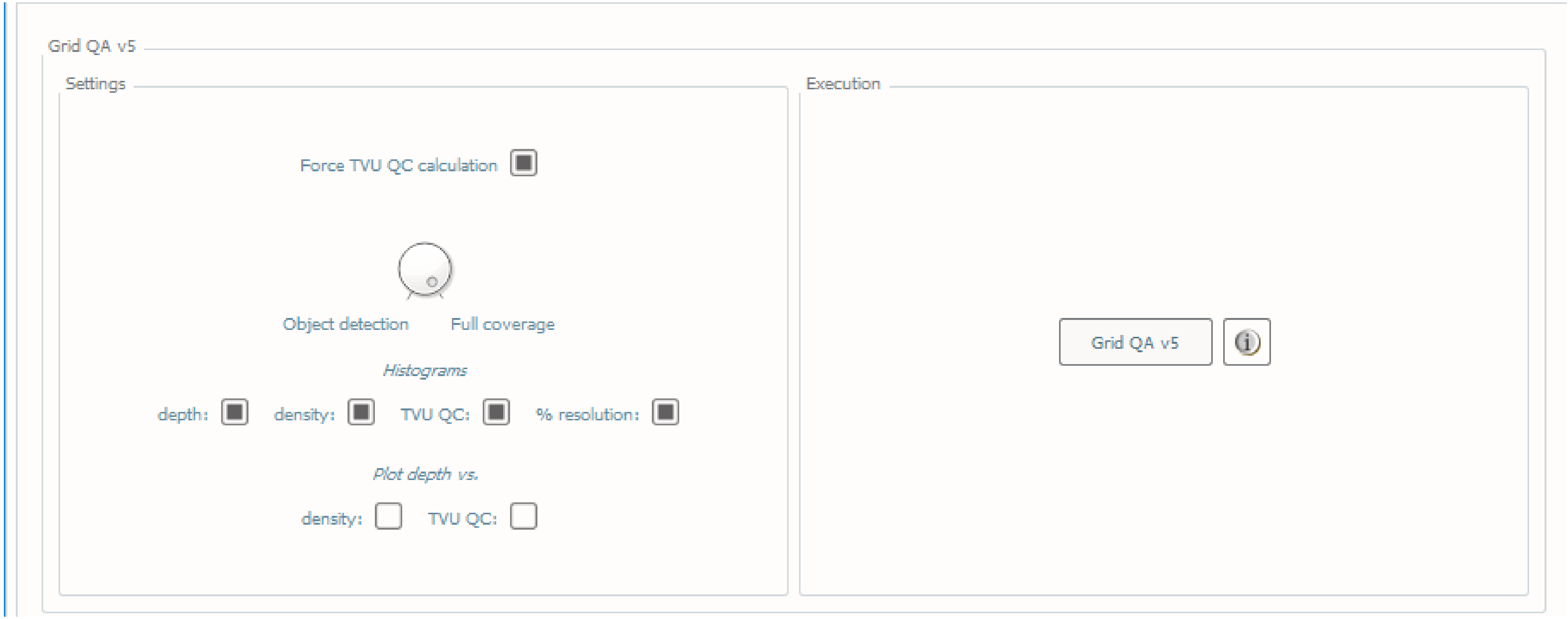
** From the 2019 HSSD*




11m x 23m
Depths: 3-10m
2m x 11m
Depths: 20-22m

Grid QA

Grid QA


Grid QA v5
Settings
Execution
Force TVU QC calculation
Object detection
Full coverage
Histograms
depth:
density:
TVU QC:
% resolution:
Plot depth vs.
density:
TVU QC:
Grid QA v5

Object Detection	Complete Coverage
Option A: 100% bathymetric bottom coverage with multibeam sonars with object detection multibeam developments of contacts and features*	Option A: 100% bathymetric bottom coverage with multibeam sonars with complete coverage multibeam developments of contacts and features*
Option B: 200% side scan sonar coverage with concurrent multibeam bathymetry collection with object detection development of contacts and features. Bathymetric splits, where appropriate, are required.	Option B: 100% side scan sonar coverage with concurrent multibeam bathymetry collection with complete coverage requirements of contacts and features. Bathymetric splits, where appropriate, are required. Note that all 100% side scan sonar is insufficient to disprove a feature.

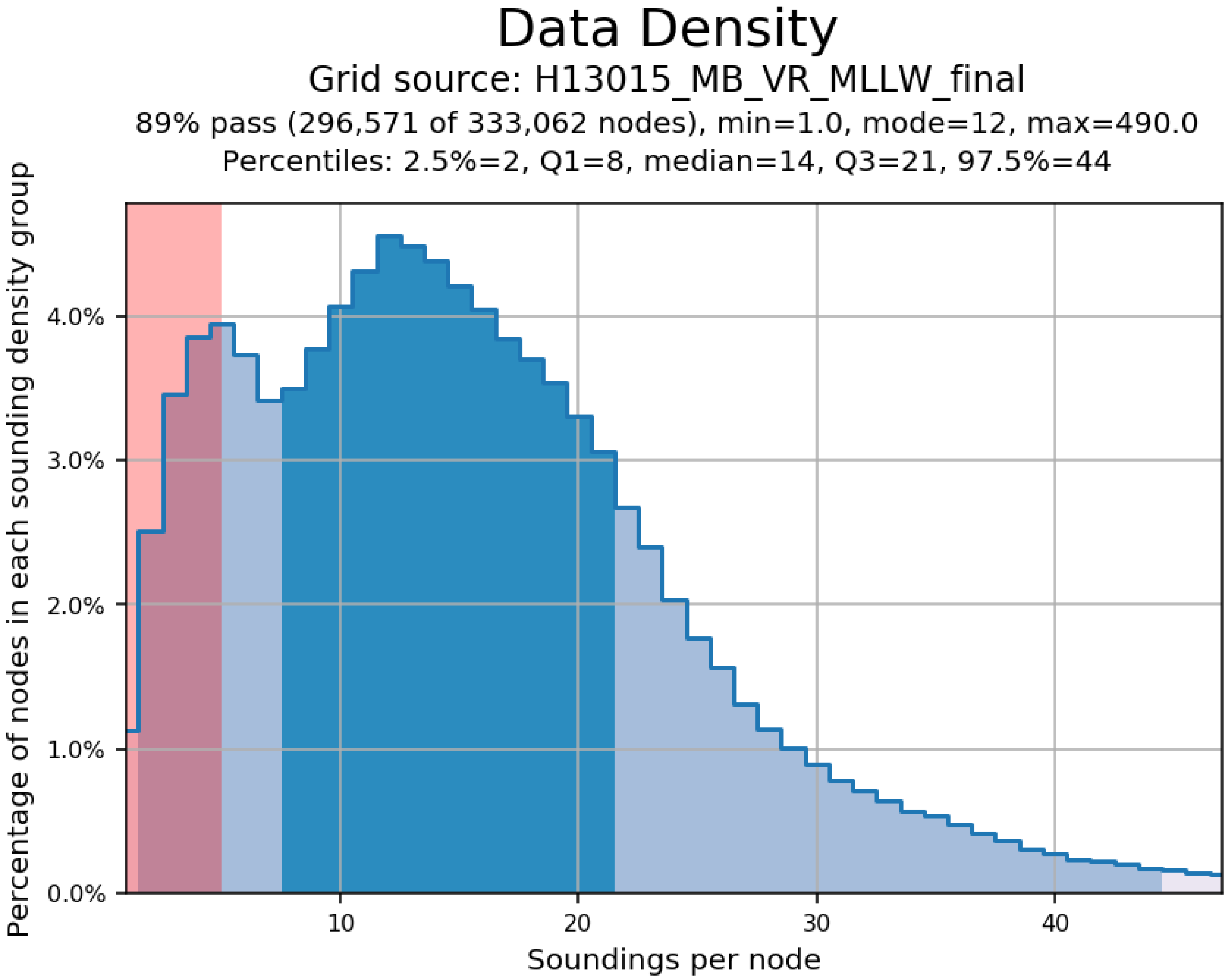
Object Detection vs. Complete Coverage

Single Resolution Surfaces	
Depth Range (m)	Resolution (m)
0-20	0.5
18-40	1
36-80	4
72-160	8
144-320	16

Single Resolution Surfaces	
Depth Range (m)	Resolution (m)
0-20	1
18-40	2
36-80	4
72-160	8
144-320	16

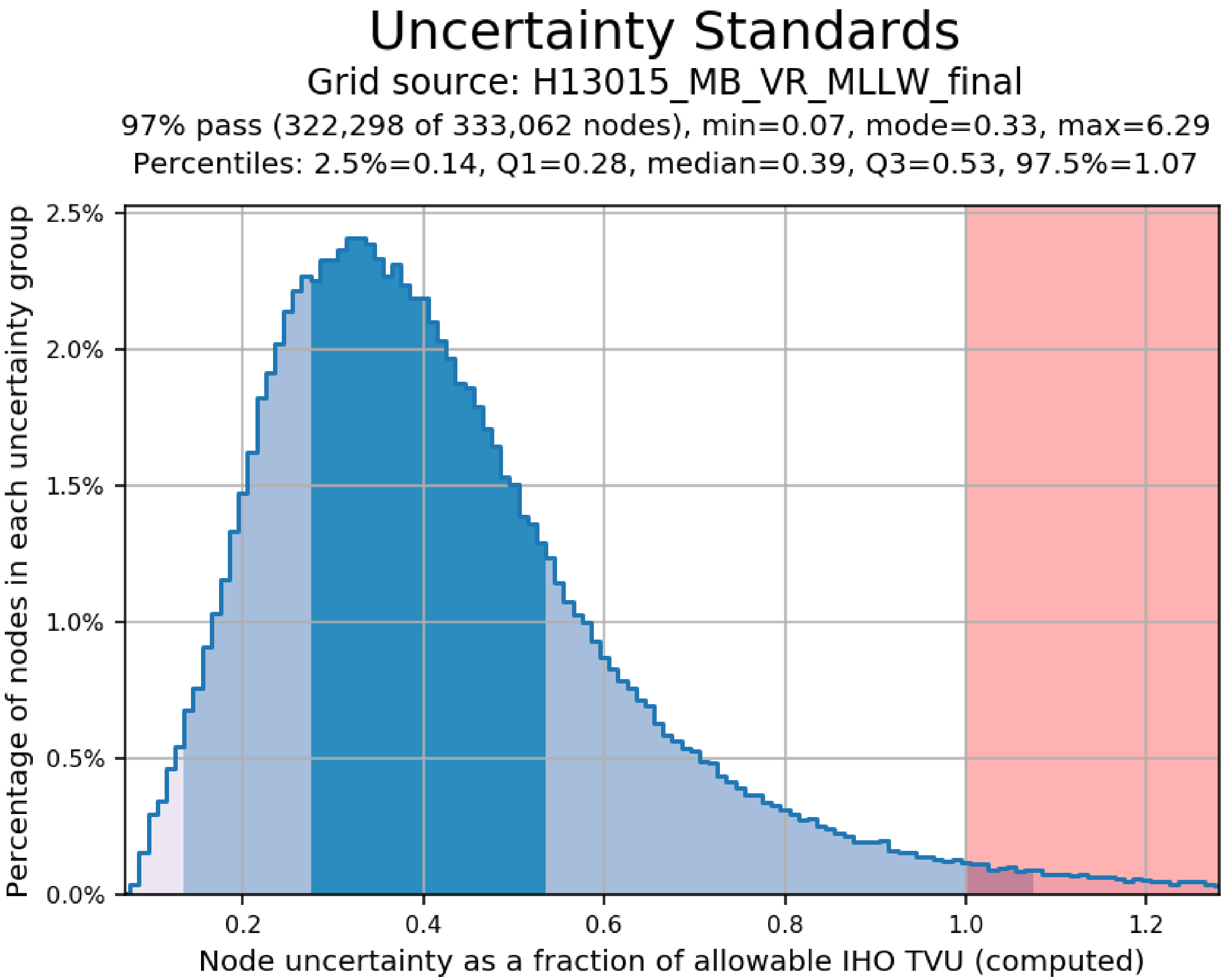
Variable Resolution Surfaces	
Depth Range (m)	Resolution (m)
0-20	0.5
20-40	1
40-80	4
80-160	8
160-320	16

Variable Resolution Surfaces	
Depth Range (m)	Resolution (m)
0-20	1
20-40	2
40-80	4
80-160	8
160-320	16



Specification:

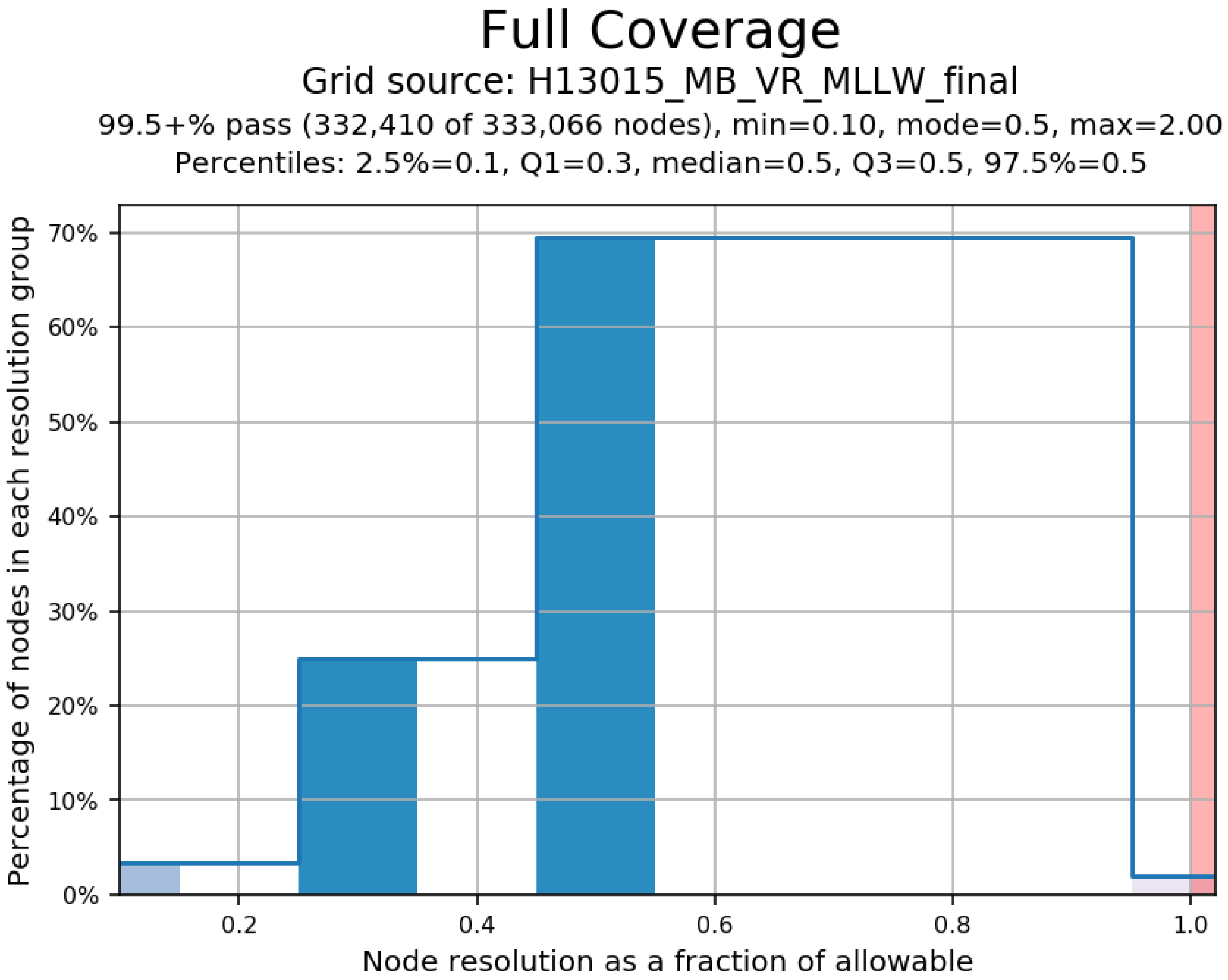
At least 95% of all nodes on the surface shall be populated, with at least 5 soundings.



Specification:
At least 95% of geographically distributed grid nodes shall meet TVU specification.

$$TVU\ QC = \frac{Uncertainty}{\sqrt{A^2 + (B * Depth)^2}}$$

where depths less than 100m: A = 0.5, B= 0.013 (IHO Order 1)
depths greater than 100m:
A = 1.0, B = 0.023 (IHO Order 2)



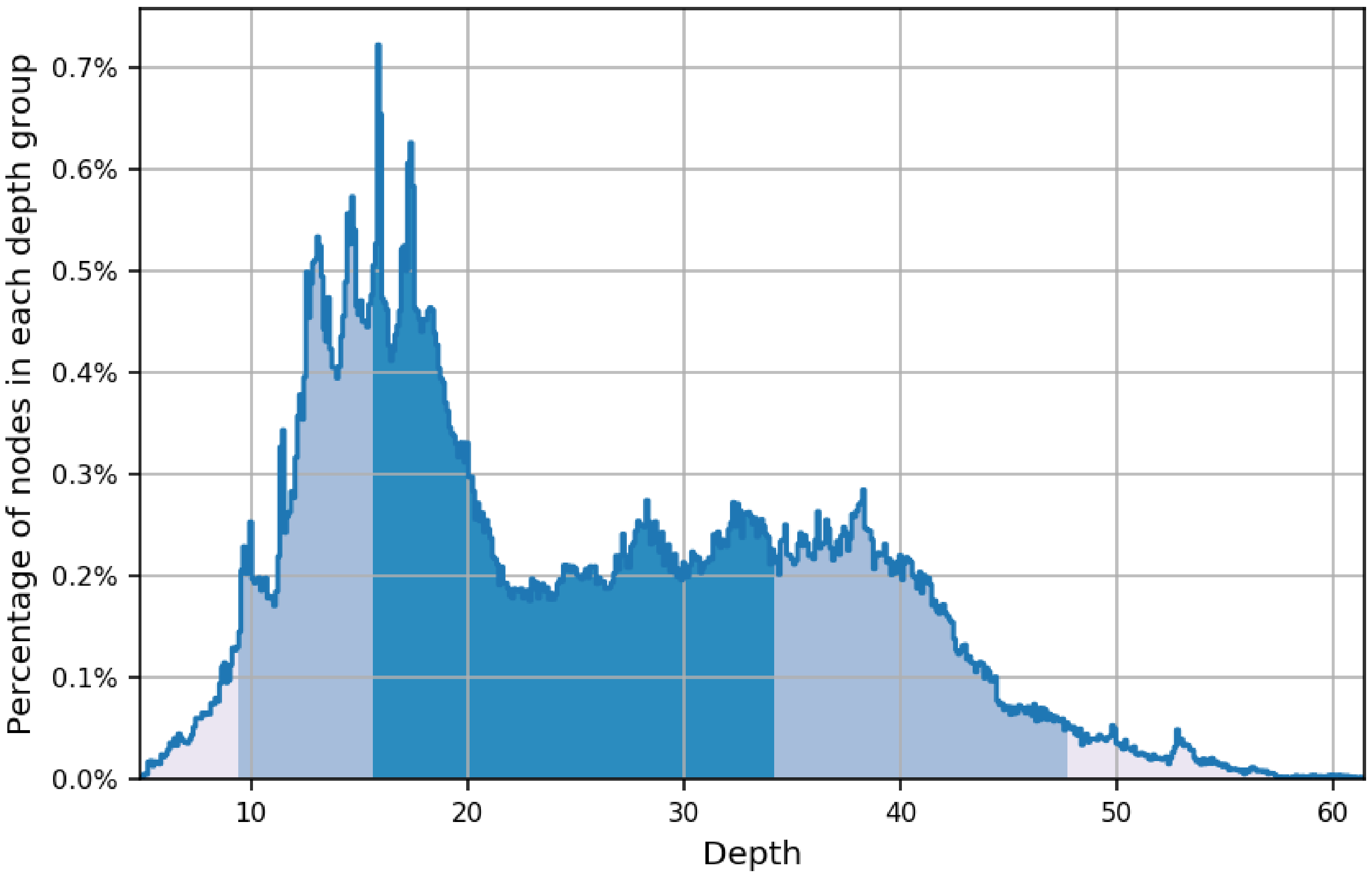
Specification:
For variable resolution surfaces, 95% of all surface nodes shall have a resolution equal to or smaller than the coarsest allowable resolution for the node depth.

Depth Distribution

Grid source: H13015_MB_VR_MLLW_final

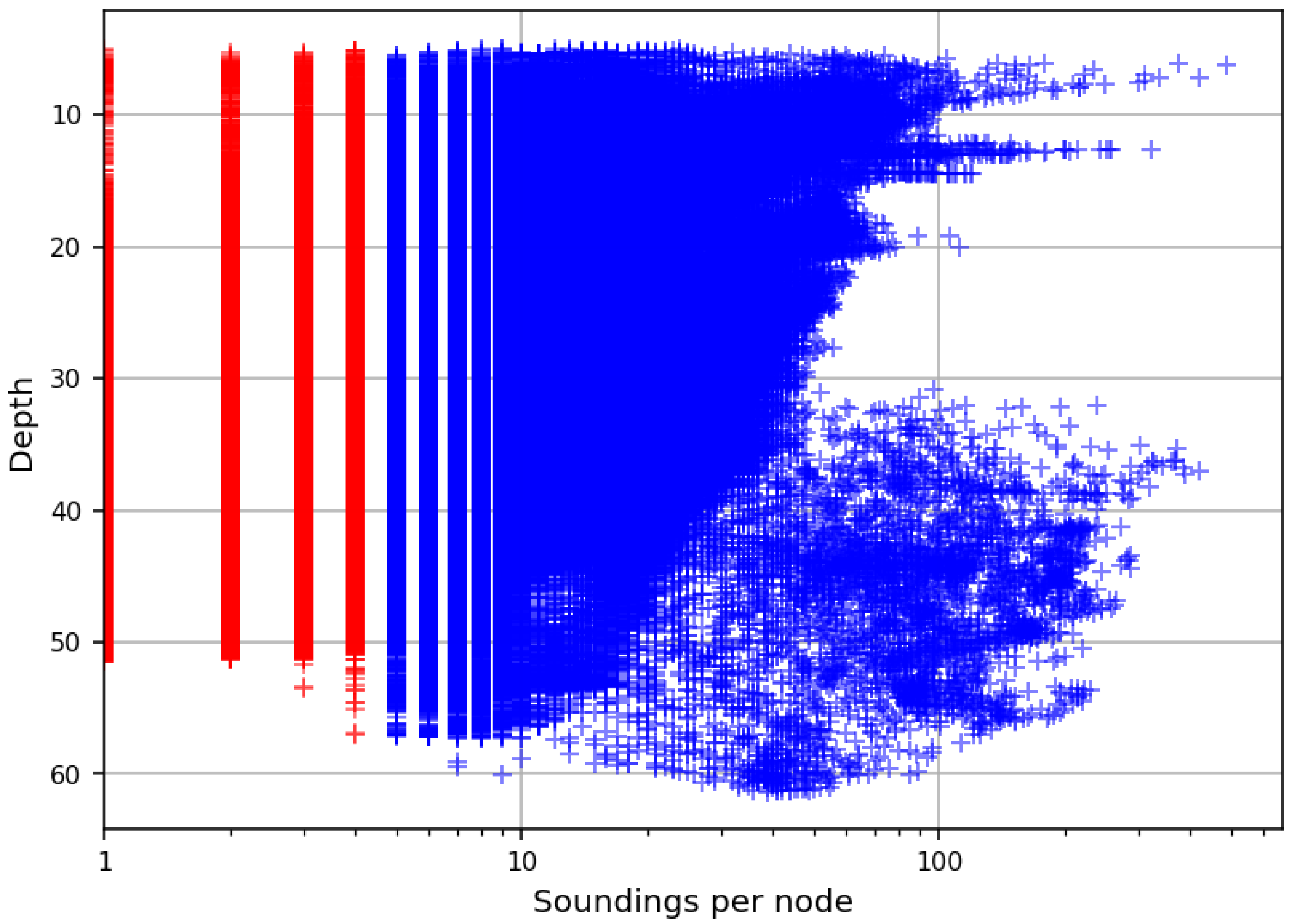
Total nodes: 333,066, min=4.95, mode=15.9, max=61.37

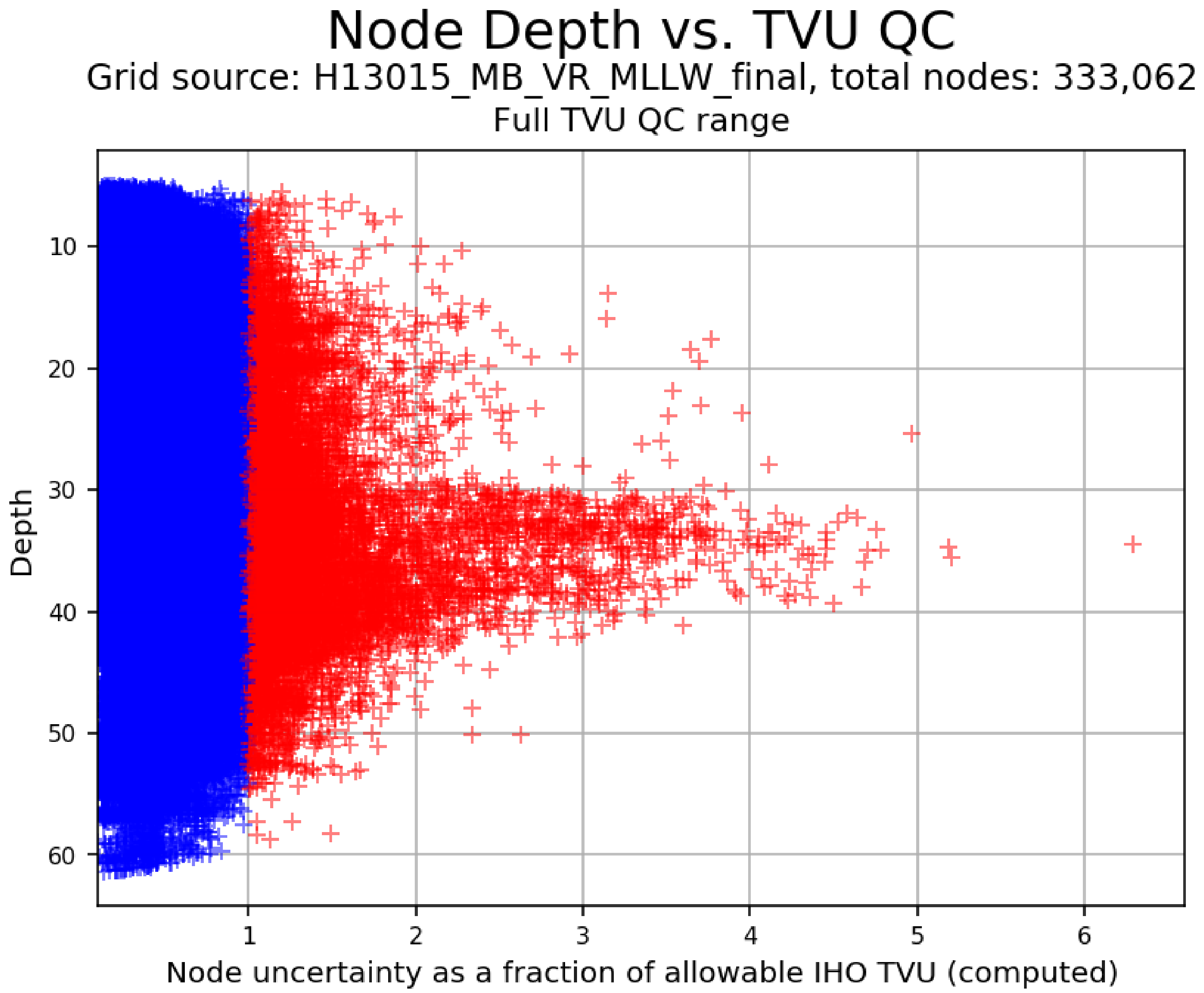
Percentiles: 2.5%=9.5, Q1=15.7, median=22.7, Q3=34.1, 97.5%=47.7



Node Depth vs. Sounding Density

Grid source: H13015_MB_VR_MLLW_final, total nodes: 333,062




Node Depth vs. TVU QC
Grid source: H13015_MB_VR_MLLW_final, total nodes: 333,062
Full TVU QC range
Depth
Node uncertainty as a fraction of allowable IHO TVU (computed)
10
20
30
40
50
60
1
2
3
4
5
6

Scan Designated

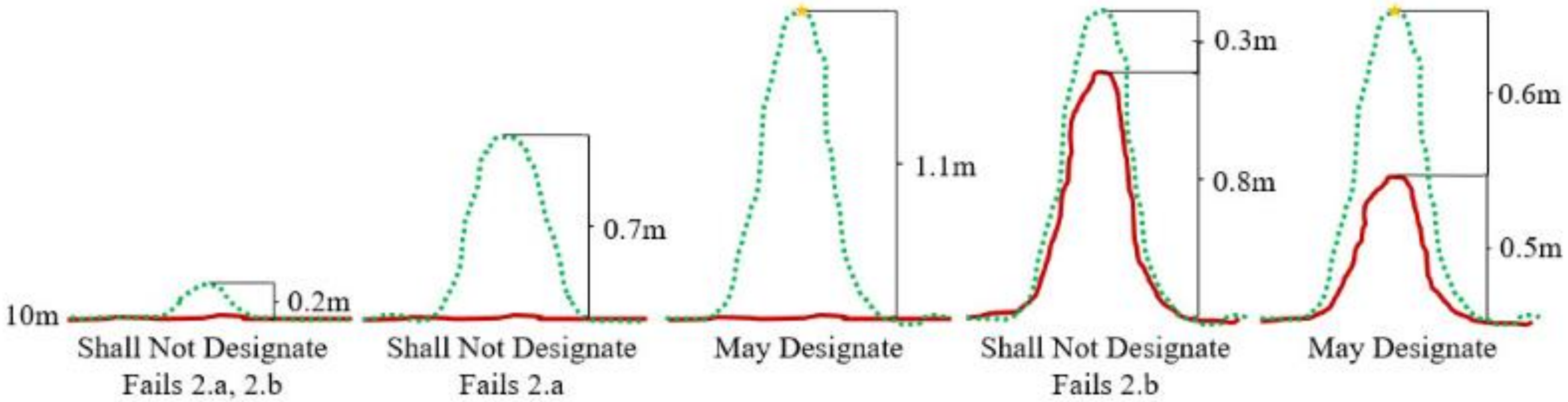
Algorithms and how to use

SCAN DESIGNATED

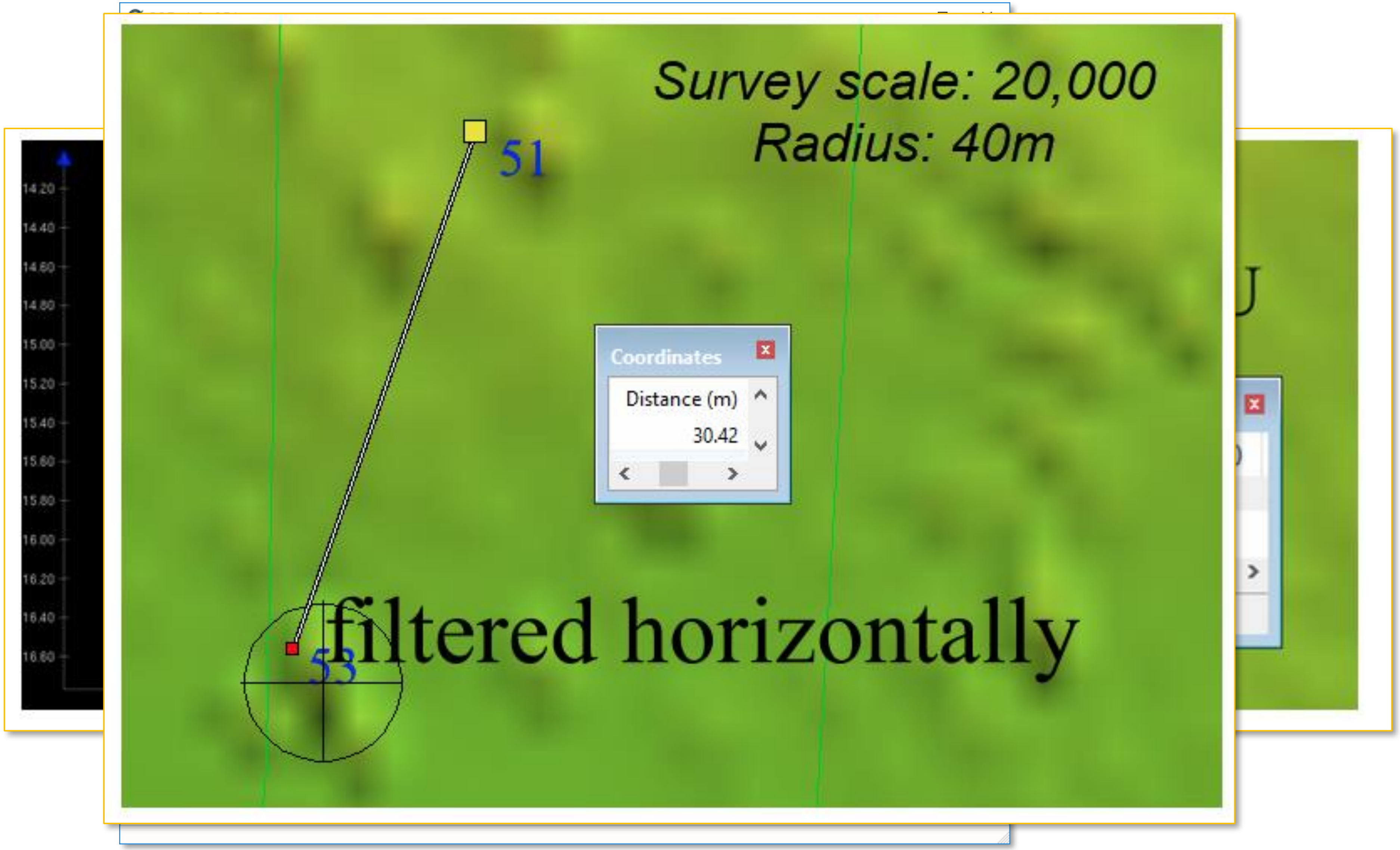
From the 2019 HSSD:

- All submerged features must have designated soundings.
- Distance between two designated soundings must be greater than 2mm at survey scale.
- Top of natural topography must be greater than 1m proud off the seafloor, and
- The difference between gridded surface and potential designated sounding is greater than the allowable TVU at that depth.

SCAN DESIGNATED



Scan Designated



Feature Scan

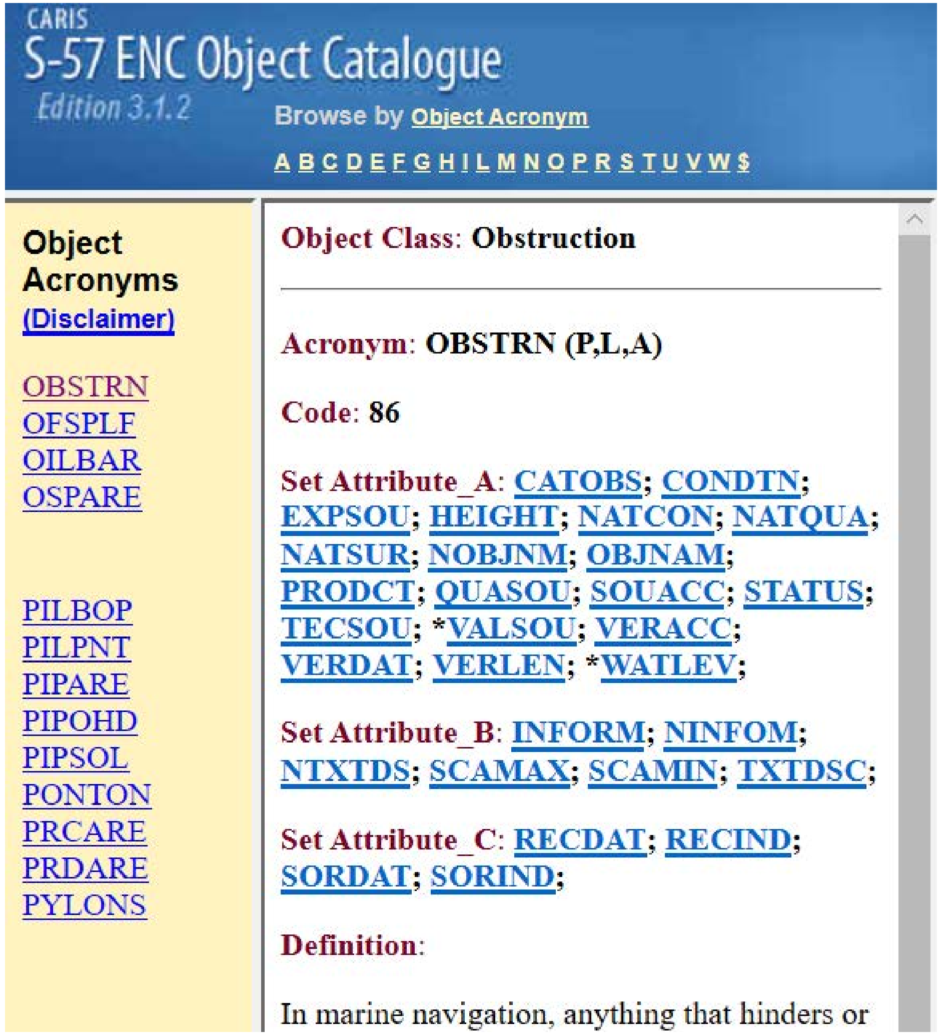
Algorithms and how to use

What are Features?

A feature can be any anthropogenic or natural object that may merit individual cartographic representation (e.g., rocks, wrecks, obstructions, bottom types).

The minimum size of a feature that is required to be found and represented in the submitted surface is different for water depths in object detection (i.e., features ≥ 1 m x 1 m x 1 m) and complete coverage (i.e., features ≥ 2 m x 2 m x 1 m) requirements, see Sections 5.2.2.2 and 5.2.2.3, respectively.

S-57 Files: A Communication Device



CARIS
S-57 ENC Object Catalogue
Edition 3.1.2
Browse by Object Acronym
A B C D E F G H I L M N O P R S T U V W $

Object Acronyms
(Disclaimer)

OBSTRN
OFSPLF
OILBAR
OSPARE

PILBOP
PILPNT
PIPARE
PIPOHD
PIPSOL
PONTON
PRCARE
PRDARE
PYLONS

Object Class: Obstruction

Acronym: OBSTRN (P,L,A)

Code: 86

Set Attribute_A: CATOBS; CONDTN; EXPSOU; HEIGHT; NATCON; NATQUA; NATSUR; NOBJNM; OBJNAM; PRODCT; QUASOU; SOUACC; STATUS; TECSOU; *VALSOU; VERACC; VERDAT; VERLEN; *WATLEV;

Set Attribute_B: INFORM; NINFOM; NTXTDS; SCAMAX; SCAMIN; TXTDSC;

Set Attribute_C: RECDAT; RECIND; SORDAT; SORIND;

Definition:

In marine navigation, anything that hinders or

Acronym	Name	Description	ISO8221 ID	Type
acqsts	Acquisition status	Status of acquisition	2007	(E)numeration
asgnmt	Assignment status	Indicates whether a feature is (un)assigned	2001	(E)numeration
cnthgt	Contact height	Contact height	2008	(F)oat
dbkyid	Database key ID	Unique ID for use in relational database	1041	Free text (S)tring
descrp	Description	Field recommended charting action	2000	(E)numeration
images	Images	List of semicolon-delimited file name(s); do not include path(s)	2003	Free text (S)tring
invreq	Investigation Requirements	Specific instructions for investigation requirements	2009	Free text (S)tring
keywrd	Keyword	List of semicolon-delimited user keyword(s)	2006	Free text (S)tring
onotes	Office notes	Office notes	2004	Free text (S)tring
prmsec	Primary / secondary correlation status	Indicates whether a feature is the primary contact or a secondary view	2002	(E)numeration
prkyid	Primary key ID	For Secondary feature(s); the Primary feature dbkyid	2010	Free text (S)tring
recomd	Recommendations	Charting recommendations	1119	Free text (S)tring
remrks	Remarks	Remarks	1118	Free text (S)tring
sftype	Special feature type	Indicates special features	2005	(E)numeration

Assignment of Features

- Field is provided a Composite Source File (CSF) .
- CSF is compiled from ENCs, preliminary ENCs, and geographic cells (from the Remote Sensing Division)—provides the field with the largest scale and most up-to-date shoreline data.
- CSFs contained assigned features which are indicated in NOAA extended attribute “asgnmt”. Project managers will fill out “invreq” to provide more information on how to address an assigned feature.
- All features off shore of the Navigational Limit Line (NALL) whill be assigned.
- The Project Manager may deem items inshore of the NALL navigationally significant and will individually assign those items as well.

Attribution of Features

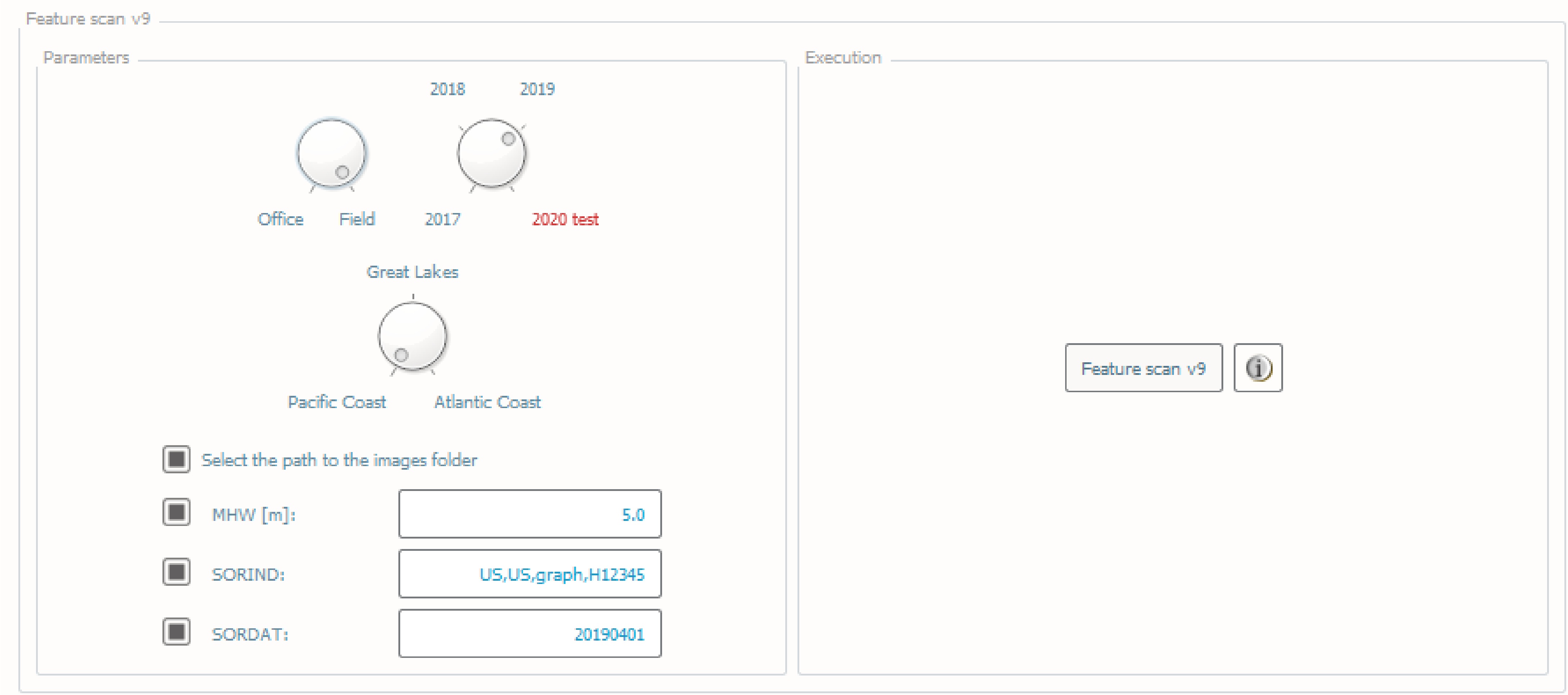
Attribute	Description		
descrp	Description	Portrays the field charting action.	
		New	New features or new position
		Update	Modification to attribution, geometry, and/or feature object class. Exception: change of geometry for line and area features
		Delete	Disprovals or erroneous features
		Retain	Addressed items that are represented properly on the chart. Included a remark for informational purposes as necessary
		Not Addressed	'Assigned' items in the CSF which were not addressed. Include remark describing why the feature was not addressed

Attribute	Description	
All Feature Objects	All surveyed objects will have the following attributes populated.	
SORIND	Source Indication	Information about the source of the object
• *Country Code - US* • *US Authority code - US for OSC* • *Source - graph* • *ID code - registry number* • *E.g., US,US,graph,H12345*		
SORDAT	Source Date	The last day of survey acquisition formatted as YYYYMMDD
Instances which require altering SORDAT and SORIND: • New feature • Modification to the geographic position of a feature • Modification to the geometry (shape) of a feature • Modification to the geographic primitive of a feature (e.g., point becomes line) • Modification to a feature's S-57 object class • Modification or addition to a feature's attribution		
Note: • *There shall not be any spaces after comma separated values in SORIND*		

remrks	Remarks	Provides additional information about features that is not captured elsewhere in the digital data (e.g., S-57 attribution)
Note: • *See Section 7.3.1 for descrp/remrks of assigned features located between the surveyed NALL and 0.8 mm buffer.* • *Do NOT include exact geographic positions (Latitude and Longitude), least depths, etc.*		
recomd	**Recommendations**	Charting Recommendations – As needed, include information to ensure proper charting of a feature.
Note: • *Only required for new features and charted feature disprovals.* • *Do NOT include exact geographic positions (Lat.- Long.), least depths, etc.*		

Object	Attribute	
	Acronym	Description
Features:	For all sounding-based features, see instructions for populating TECSOU and QUASOU attributes under DEPTHS, above	
WRECKS (wreck)	CATWRK	(Category of wreck)
	WATLEV	(Water level effect)
	VALSOU	(Value of sounding)
	TECSOU	(Technique of sounding measurement)
	QUASOU	(Quality of sounding measurement)
Note: *Reference Appendix E for WATLEV attribution.*		

Feature Scan



FEATURE SCAN

Survey Feature Scan v9 - Tests against HSSD 2019

1. Redundant features

OK

2. New or Updated features (excluding carto notes) missing mandatory attribute SORIND

found missing UWTROC at (-64.9523656, 18.3909002)
found missing UWTROC at (-64.9539763, 18.3906978)
found missing WRECKS at (-64.9521581, 18.3897607)
found missing WRECKS at (-64.9539637, 18.3895828)
found missing OBSTRN at (-64.9520032, 18.3883551)
found missing OBSTRN at (-64.9490879, 18.3887833)
found missing OBSTRN at (-64.9506155, 18.3886083)

3. New or Updated features (excluding carto notes) with invalid SORIND

found UWTROC at (-64.9508649, 18.3909953) with invalid SORIND
found WRECKS at (-64.9503793, 18.3898586) with invalid SORIND
found LNDELV at (-64.9533848, 18.3826326) with invalid SORIND

4. New or Updated features (excluding carto notes) missing mandatory attribute SORDAT

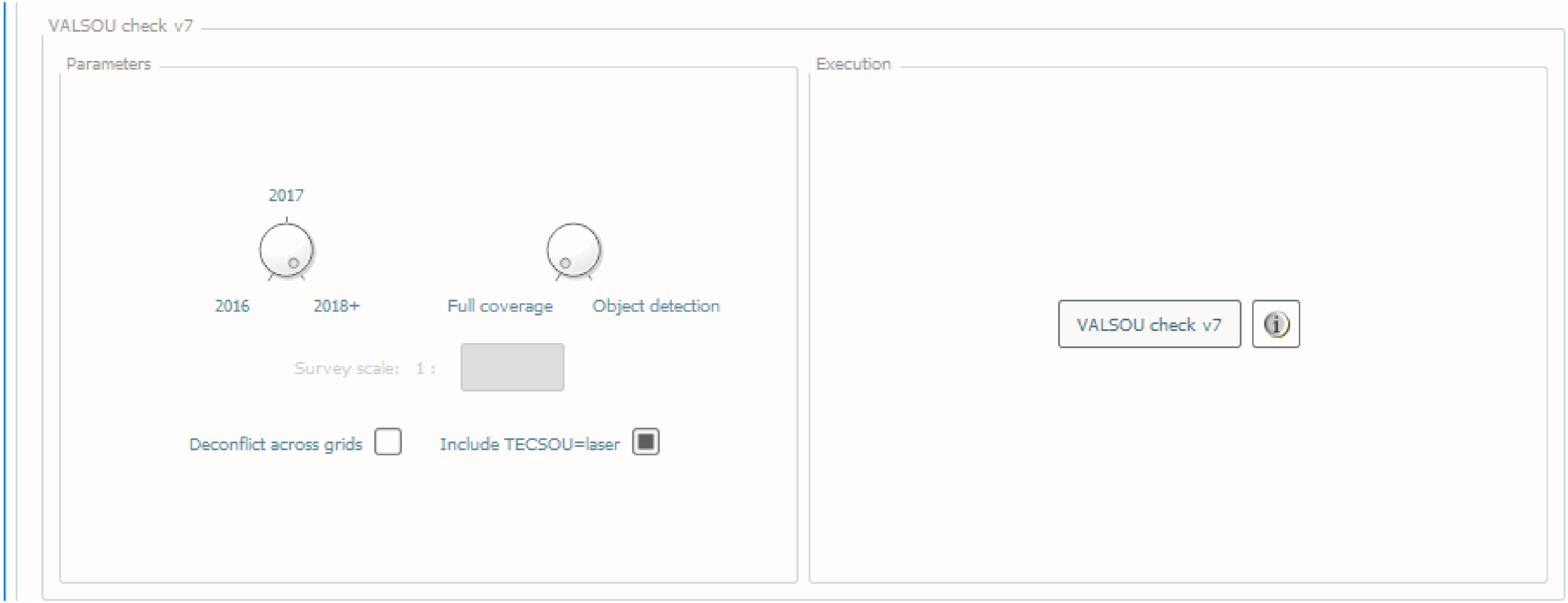
found missing UWTROC at (-64.9523656, 18.3909002)
found missing UWTROC at (-64.9539763, 18.3906978)
found missing WRECKS at (-64.9521581, 18.3897607)
found missing WRECKS at (-64.9539637, 18.3895828)
found missing OBSTRN at (-64.9520032, 18.3883551)
found missing OBSTRN at (-64.9490879, 18.3887833)
found missing OBSTRN at (-64.9506155, 18.3886083)

Demo

VALSOU Check

Algorithms and how to use

VALSOU Check



VALSOU Check

Add part about specification here

SBDARE Export

Algorithms and how to use

SBDARE Export

- Created to satisfy requirements outlined in Appendix G: Bottom Samples and Coastal and Marine Ecological Classification Standard (CMECS) Translation for Submittal to National Center for Environmental Informatio (NCEI) in HTD 2018-4: Bottom Sample Drop Camera Imagery
- Script exports ASCII file, shapefile, and 4 bottom type images populated with EXIF metadata (if available).

Sediment Size Classification

Type	Term	Grain Size (mm)
Clay		< 0.002
Silt		0.002-0.0625
Sand	fine	0.0625-0.25
	medium	0.25 -0.5
	coarse	0.5 - 2.0
Gravel		2.0-4.0
Pebbles		4.0-64.0
Cobble		64.0-256.0
Boulder		> 256.0
Stone		4.0-256.0+

COLOUR

ID	Meaning
1	white
2	black
3	red
4	green
5	blue
6	yellow
7	grey
8	brown
9	amber
10	violet
11	Orange
12	Magenta
13	Pink

ID	Meaning	NATQUA Description
1	fine	Falls within the smallest size continuum for a particular NATSUR term.
2	medium	Falls within the moderate size continuum for a particular NATSUR term.
3	coarse	Falls within the largest size continuum for a particular NATSUR term.
4	broken	Fractured or in pieces.
5	sticky	Having an adhesive or glue like property.
6	soft	Not hard or firm.
7	stiff	Not pliant; thick, resistant to flow.
8	volcanic	Composed of or containing material ejected from a volcano.
9	calcareous	Composed of or containing calcium or calcium carbonate.
10	hard	Firm; usually refers to an area of the sea floor not covered by unconsolidated sediment.

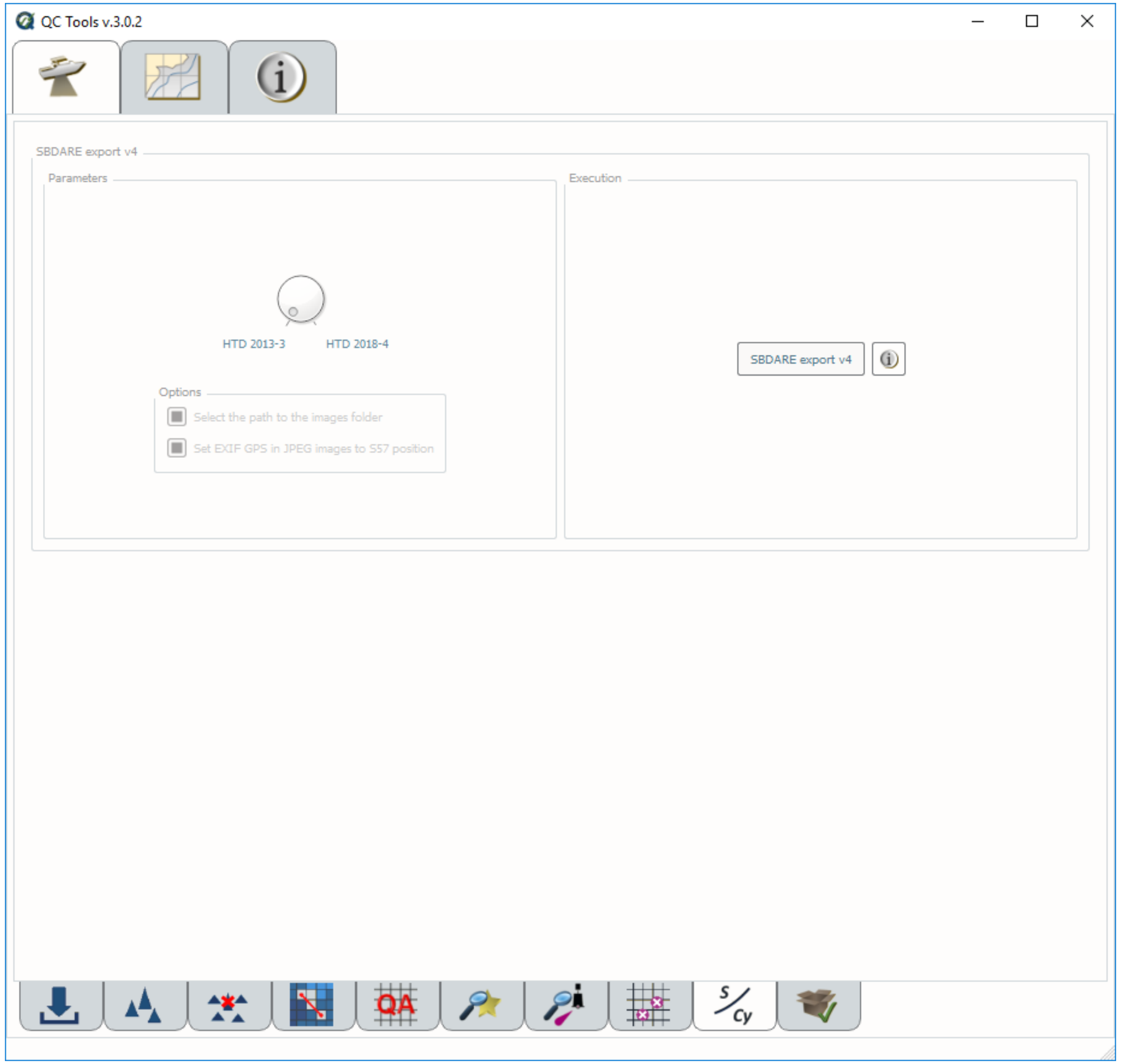
ID	Meaning	NATSUR Description
1	mud	Soft, wet earth.
2	clay	Particles of less than 0.002mm; stiff, sticky earth that becomes hard when baked.
3	silt	Particles of 0.002-0.0625mm; when dried on hand will rub off easily.
4	sand	Particles of 0.0625-2.0mm; tiny grains of crushed or worn rock.
5	stone	A general term for rock fragments ranging in size from pebbles and gravel to boulders or a large rock mass.
6	gravel	Particles of 2.0-4.0mm; small stones with coarse sand.
7	pebbles	Particles of 4.0-64.0mm; small stones made smooth and round by being rolled in water.
8	cobbles	Particles of 64.0-256.0mm; stones worn round and smooth by water and used for paving.
9	rock	Any formation of natural origin that constitutes an integral part of the lithosphere. The natural occurring material that forms firm, hard, and solid masses.
11	lava	The fluid or semi-fluid matter flowing from a volcano. The substance that results from the cooling of the molten rock.
14	coral	Hard calcareous skeletons of many tribes of marine polyps.
17	shells	Exoskeletons of various water dwelling animals.
18	boulder	A rounded rock with diameter of 256mm (25.6cm) or larger.

NATQUA / NATSUR	1 Fine	2 Medium	3 Coarse	4 Broken	5 Sticky	6 Soft	7 Stiff	8 Volcanic	9 Calcareous	10 Hard
1 Mud					x	x	x	x	x	x
2 Clay					x	x	x			x
3 Silt					x	x	x			x
4 Sand	x	x	x			x		x	x	x
5 Stone								x	x	
6 Gravel								x	x	
7 Pebbles								x	x	
8 Cobbles								x	x	
9 Rock								x	x	
11 Lava								x		
14 Coral				x						
17 Shells				x					x	
18 Boulder								x	x	

Coastal and Marine Ecological Classification Standard (CMECS)

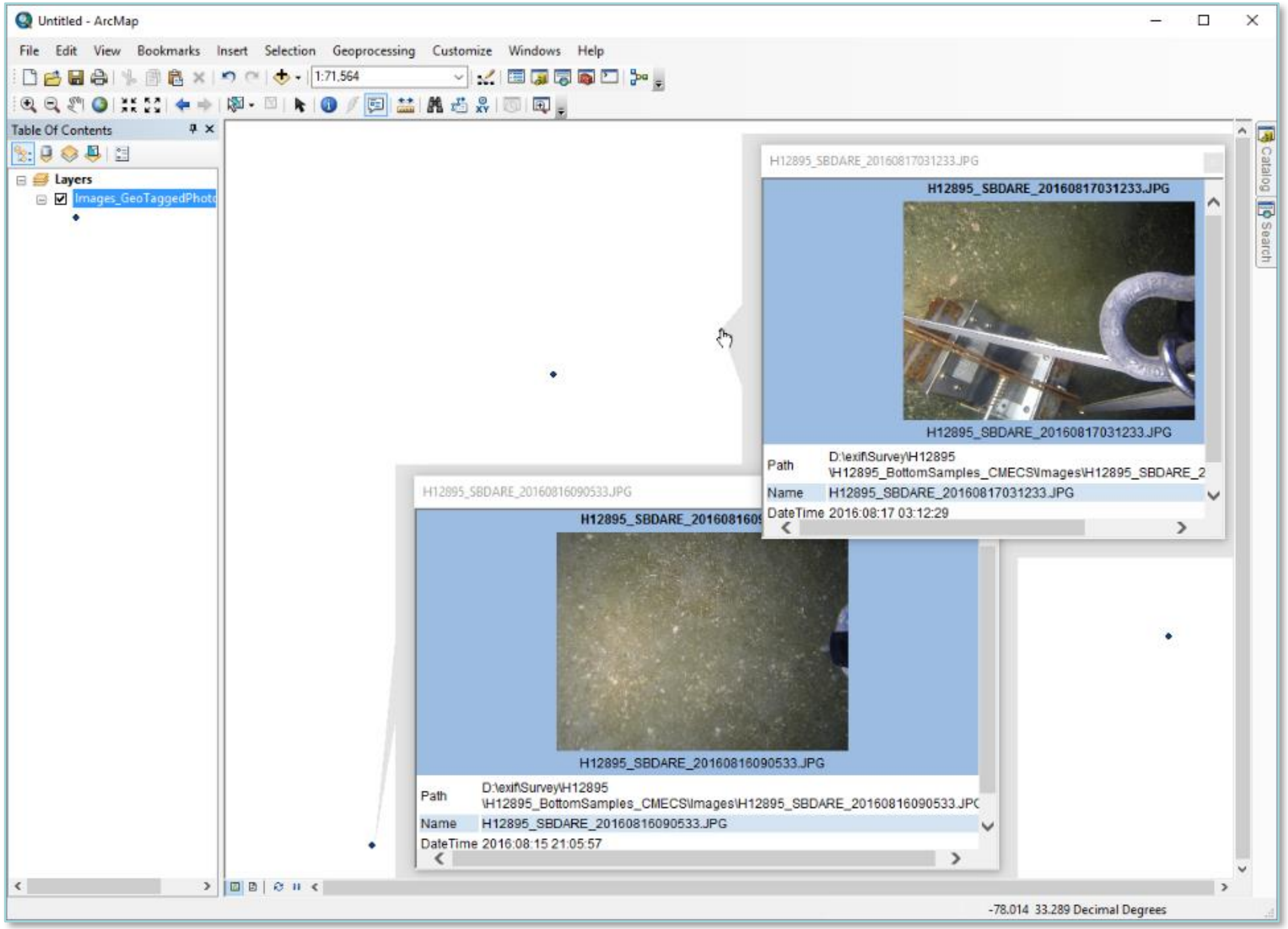
NATSUR	NATQUA	S-57 Term	CMECS Equivalent	CMECS Code
1	0	Mud	Mud	S1.2.2.5
2	0	Clay	Clay	S1.2.2.5.3
3	0	Silt	Silt	S1.2.2.5.1
4	0	Sand	Sand	S1.2.2.2
5	0	Stone	Gravel	S1.2.1.1
6	0	Gravel	Granule	S1.2.1.1.4
7	0	Pebbles	Pebble	S1.2.1.1.3
8	0	Cobbles	Cobble	S1.2.1.1.2
9	0	Rock	Rock	S1.1
11	0	Lava	Rock	S1.1
14	0	Coral	Coral	S2.2
17	0	Shells	Shell	S2.5
18	0	Boulder	Boulder	S1.2.1.1.1
4	1	Fine Sand	Fine Sand	S1.2.2.2.4
4	2	Medium Sand	Medium Sand	S1.2.2.2.3
4	3	Coarse Sand	Coarse Sand	S1.2.2.2.2
4	6	Soft Sand	Soft Sand	S1.2.2.2(I03)
4	8	Volcanic Sand	Volcaniclastic Sand	S1.2.2.2(SD13)
4	9	Calcareous Sand	Carbonate Sand	S1.2.2.2(SD01)
4	10	Hard Sand	Hard Sand	S1.2.2.2(I01)
14	4	Broken Coral	Coral Hash	S2.2.3
17	4	Broken Shells	Shell Hash	S2.5.3
17	9	Calcareous Shells	Carbonate Shells	S2.5(SD01)
18	8	Volcanic Boulder	Volcaniclastic Boulder	S1.2.1.1.1(SD13)
18	9	Calcareous Boulder	Carbonate Boulder	S1.2.1.1.1(SD01)
11	8	Volcanic Lava	Volcaniclastic Rock	S1.1(SD13)
9	8	Volcanic Rock	Volcaniclastic Rock	S1.1(SD13)
9	9	Calcareous Rock	Carbonate Rock	S1.1(SD01)
8	8	Volcanic Cobbles	Volcaniclastic Cobble	S1.2.1.1.2(SD13)
8	9	Calcareous Cobbles	Carbonate Cobble	S1.2.1.1.2(SD01)
7	8	Volcanic Pebbles	Volcaniclastic Pebble	S1.2.1.1.3(SD13)
7	9	Calcareous Pebbles	Carbonate Pebble	S1.2.1.1.3(SD01)
6	8	Volcanic Gravel	Volcaniclastic Granule	S1.2.1.1.4(SD13)
6	9	Calcareous Gravel	Carbonate Granule	S1.2.1.1.4(SD01)
5	8	Volcanic Stone	Volcaniclastic Gravel	S1.2.1.1(SD13)
5	9	Calcareous Stone	Carbonate Gravel	S1.2.1.1(SD01)
3	5	Sticky Silt	Silt	S1.2.2.5.1
3	6	Soft Silt	Soft Silt	S1.2.2.5.1(I03)
3	7	Stiff Silt	Silt	S1.2.2.5.1
3	10	Hard Silt	Hard Silt	S1.2.2.5.1(I01)
2	5	Sticky Clay	Clay	S1.2.2.5.3
2	6	Soft Clay	Soft Clay	S1.2.2.5.3(I03)
2	7	Stiff Clay	Clay	S1.2.2.5.3
2	10	Hard Clay	Hard Clay	S1.2.2.5.3(I01)
1	5	Sticky Mud	Mud	S1.2.2.5
1	6	Soft Mud	Soft Mud	S1.2.2.5(I03)
1	7	Stiff Mud	Mud	S1.2.2.5
1	8	Volcanic Mud	Volcaniclastic Mud	S1.2.2.5(SD13)
1	9	Calcareous Mud	Carbonate Mud	S1.2.2.5(SD01)
1	10	Hard Mud	Hard Mud	S1.2.2.5(I01)

SBDARE Export



SBDARE Export

- Filters the final feature file selection down to SBDARE features, and then only points.
- Creates an ASCII file that is semi-colon separated that collects the attribution for Latitude, Longitude, Observed time, Colour, NATQUA, Remarks, Source date, Source Indication, and images from the final feature file and two CMECS Co-Occurring Element Names and Codes which are defined in the HTD.
- Shapefile is created with all the same attribution but has four individual fields for images.



Untitled - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:71,564
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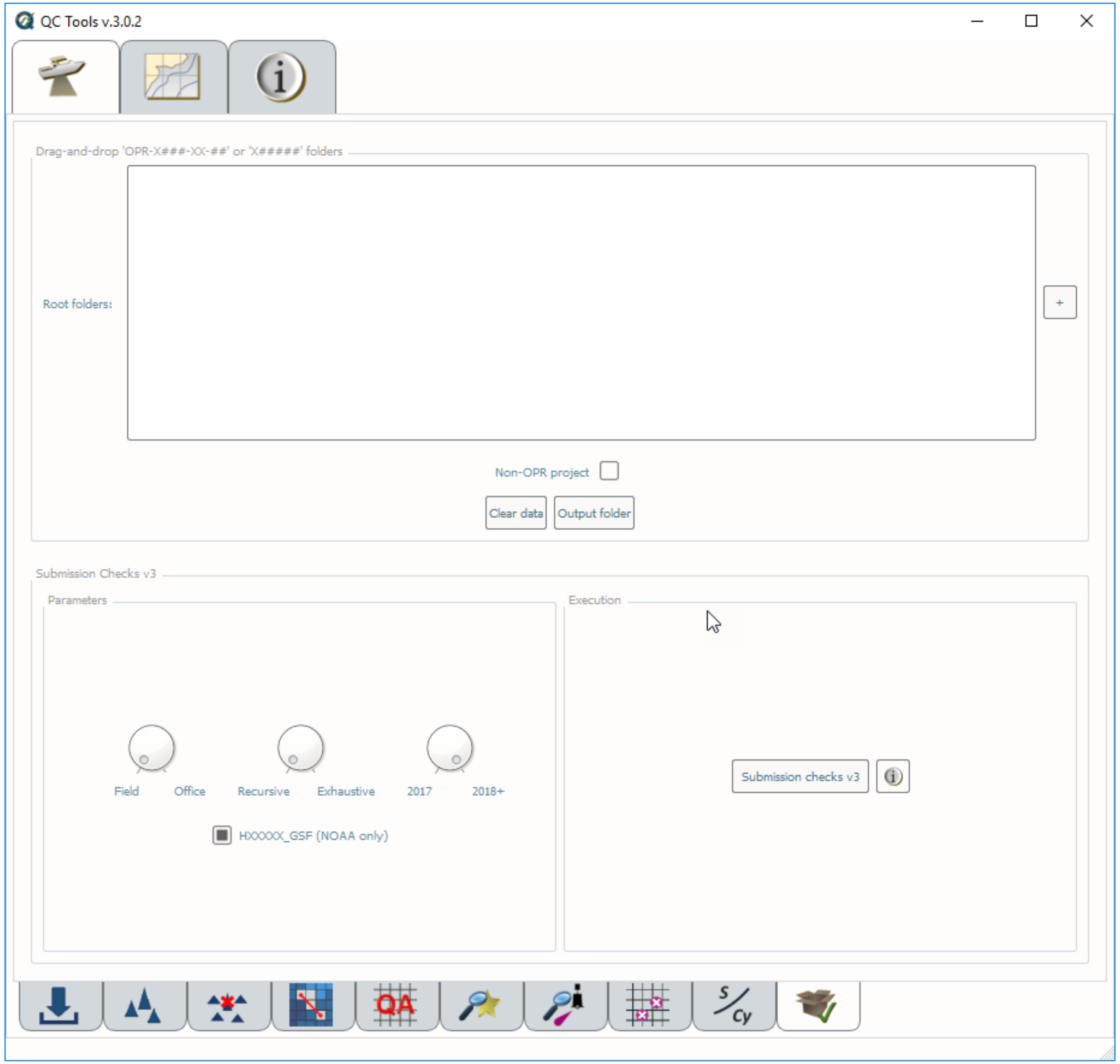
Submissions Checks

Algorithms and how to use

Submissions Checks



Appendix I: Data Directory Structure

- OPR-X###-XX-##
  - HXXXXX
    - Raw
      - Features
      - MBES
      - Positioning
      - SBES
      - SSS
      - SVP
      - WC
    - Processed
      - GNSS_Data
      - SBET
      - Multimedia
      - Reports
        - Project
          - DAPR
            - Report
            - Appendices
          - HVCR
            - Digital_A-Vertical_Control_Report
            - Digital_B-Horizontal_Control_Data
              - ATON_Data
              - Base_Station_Data
          - Project_Correspondence
        - Survey
          - Descriptive_Report
            - Appendices
              - I_Water_Levels
              - II_Supplemental_Survey_Records_Correspondence
            - Report
          - Public_Relations_Constituent_Products
          - Separates
            - I_Acquisition_Processing_Logs
              - Detached_Positions
            - II_Digital_Data
              - Crossline_Comparisons
              - Sound_Speed_Data_Summary
      - S-57_Files
        - Final_Feature_File
        - Side_Scan_Sonar_Contacts
      - Sonar_Data *
        - HXXXXX_GSF **
        - HXXXXX_MB
        - HXXXXX_SB
        - HXXXXX_SSS
        - HXXXXX_WC
        - VesselConfig
      - Surfaces_Mosaics
      - SVP
      - Water_Levels

**NOAA ONLY

* CARIS users:
Processed/Sonar_Data/HDCS_Data/HXXXXX_MB
Processed/Sonar_Data/HDCS_Data/HXXXXX_SB
Processed/Sonar_Data/HDCS_Data/HXXXXX_SSS
Processed/Sonar_Data/HDCS_Data/HXXXXX_WC
Processed/Sonar_Data/HDCS_Data/VesselConfig

CHART REVIEW

Chart Review

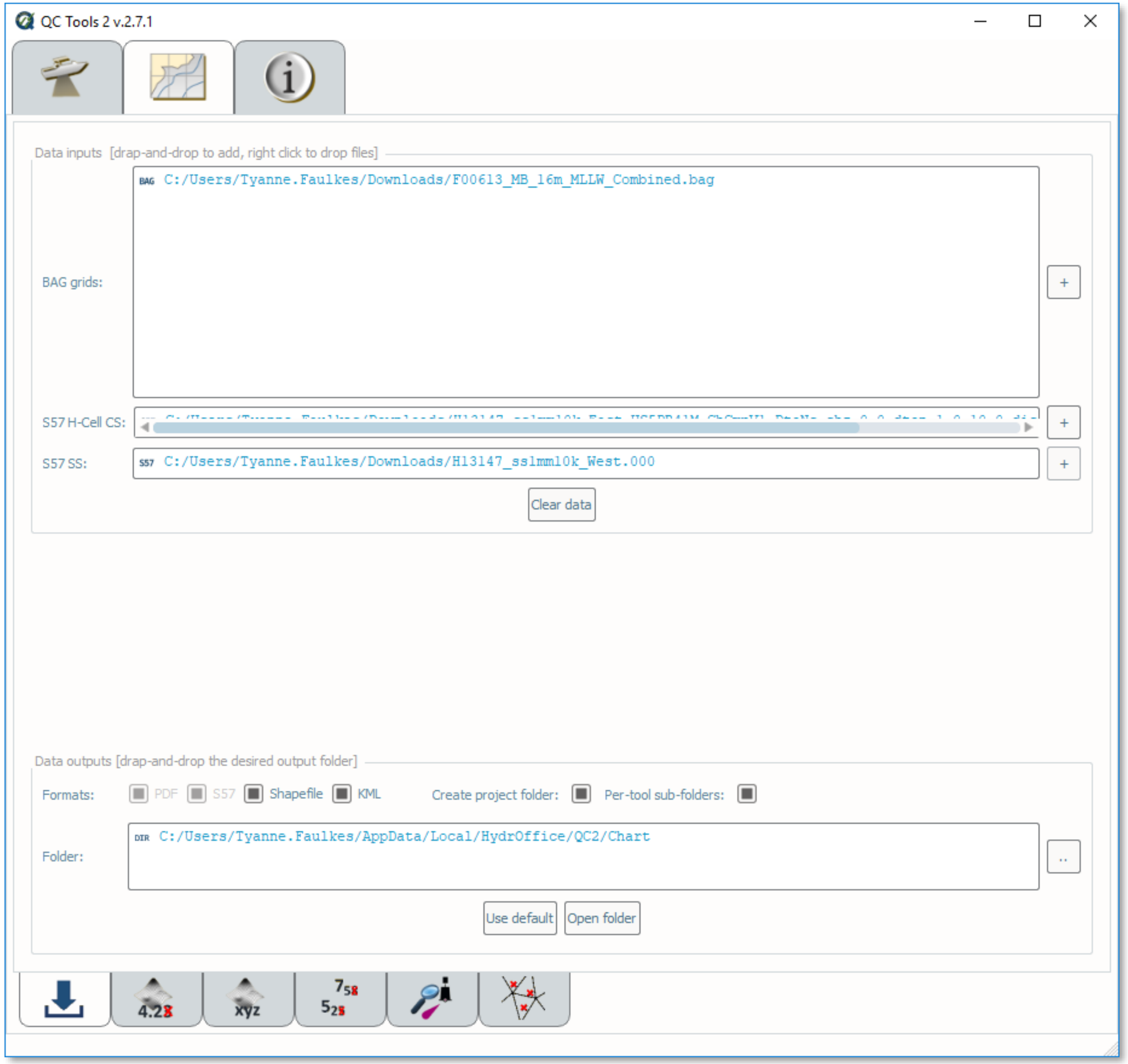


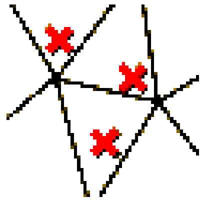
Chart Review

BAG Truncate

Grid XYZ

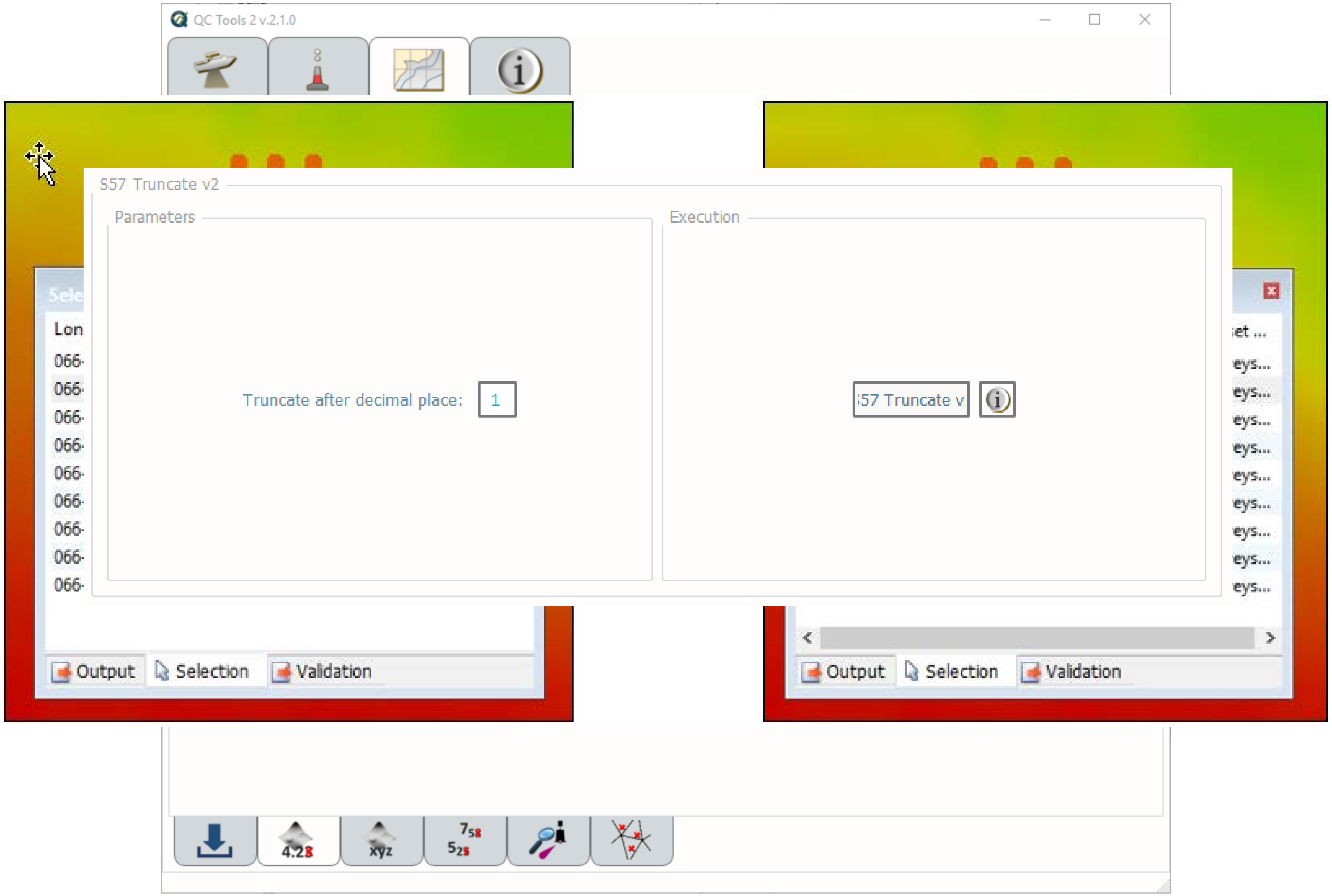
S57 Truncate

Feature Scan

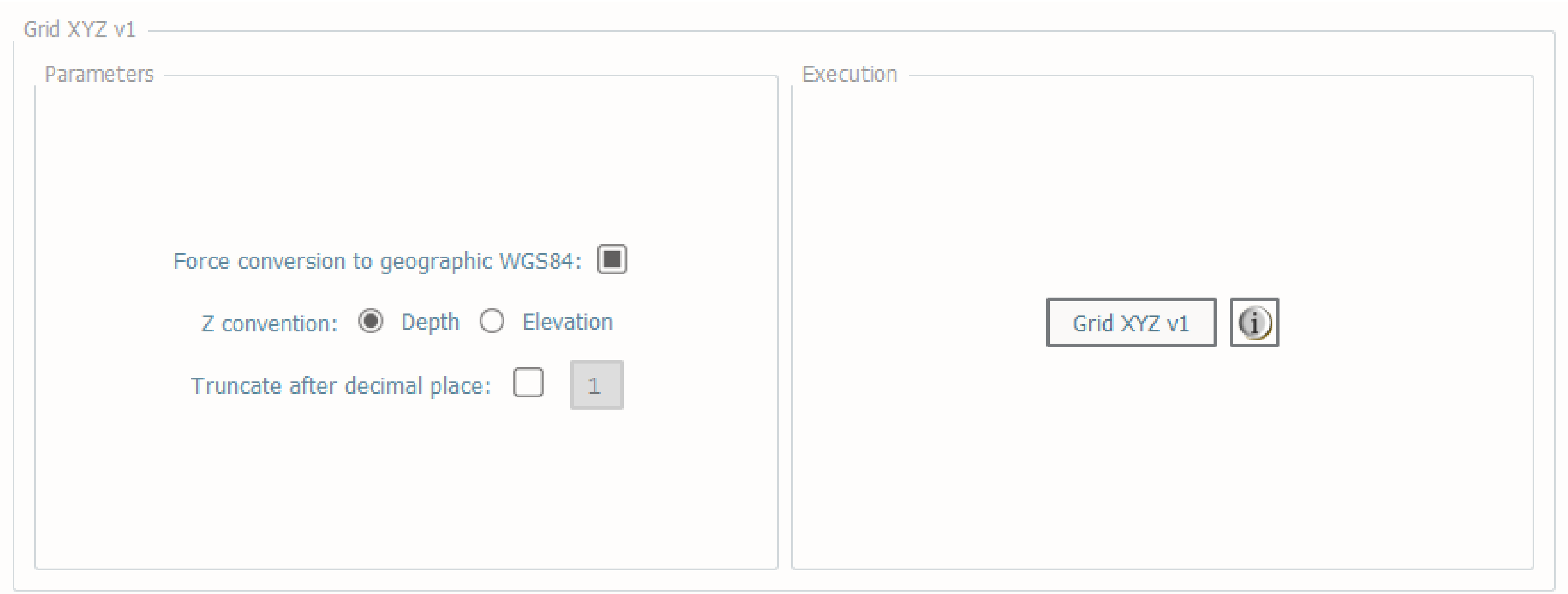


Triangle Rule

BAG/S-57 TRUNCATE

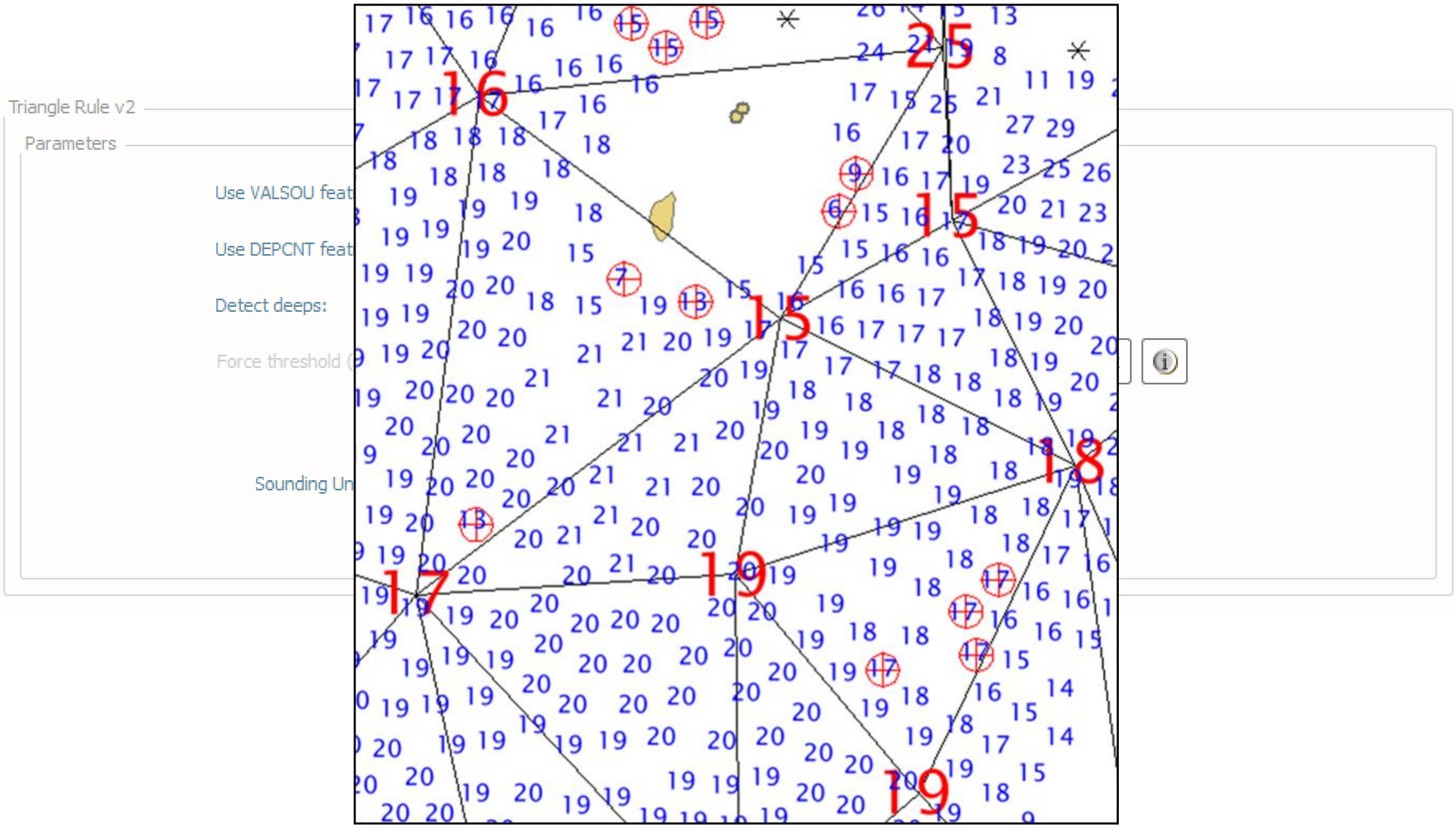


GRID XYZ



Grid XYZ v1
Parameters
Execution
Force conversion to geographic WGS84:
Z convention:
Depth
Elevation
Truncate after decimal place:
1
Grid XYZ v1

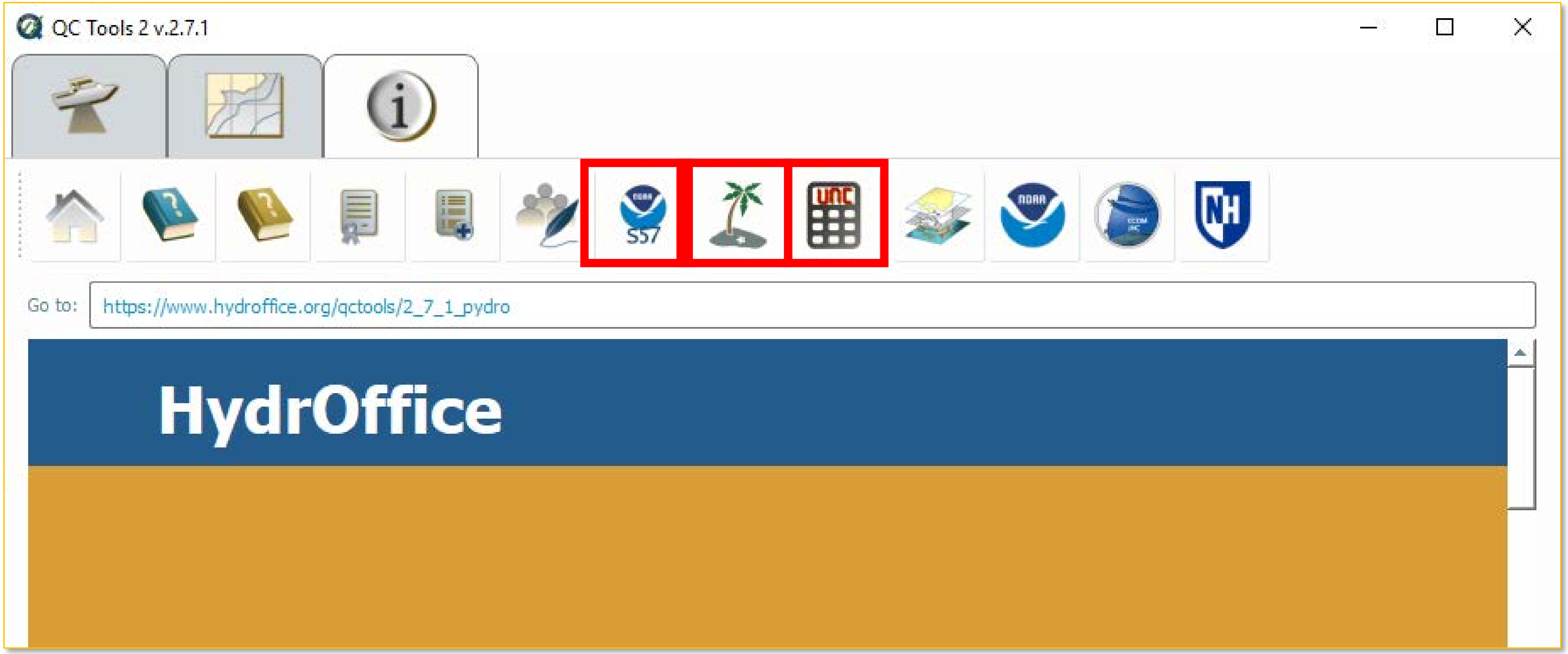
Feature Scan & Triangle Rule



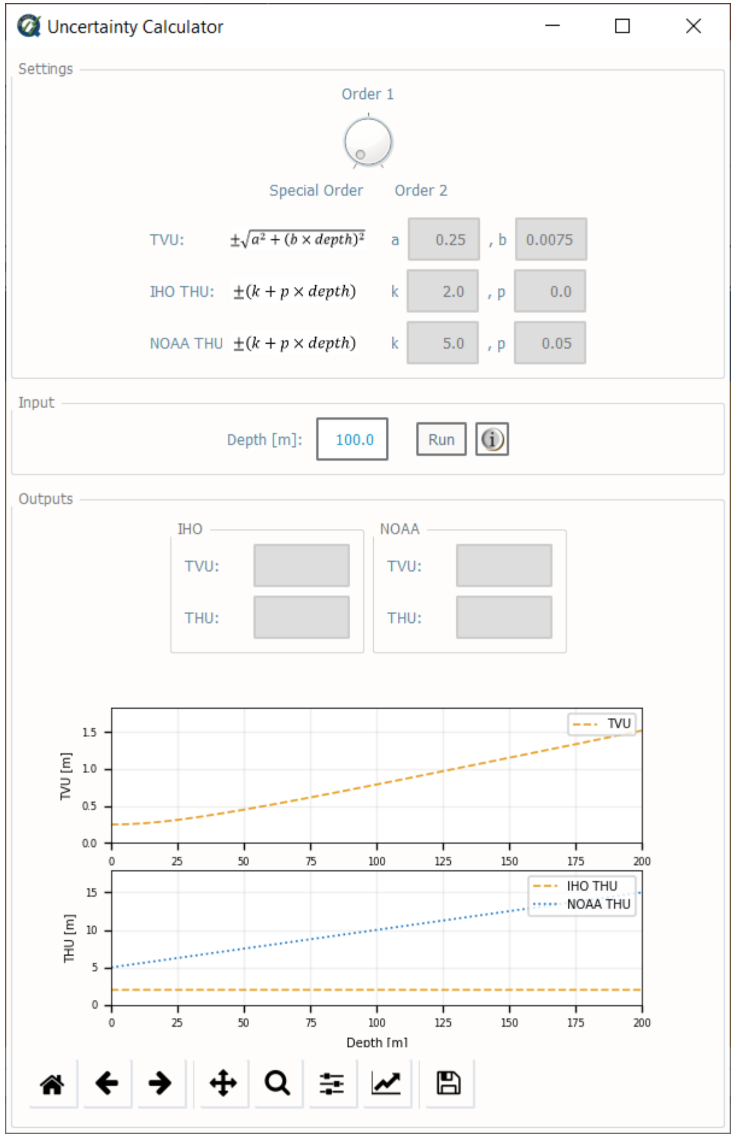
Standalone Tools

RorI, Uncertainty Calculator, NOAA CARIS Files

STANDALONE TOOLS



Standalone Tools: Uncertainty Calculator

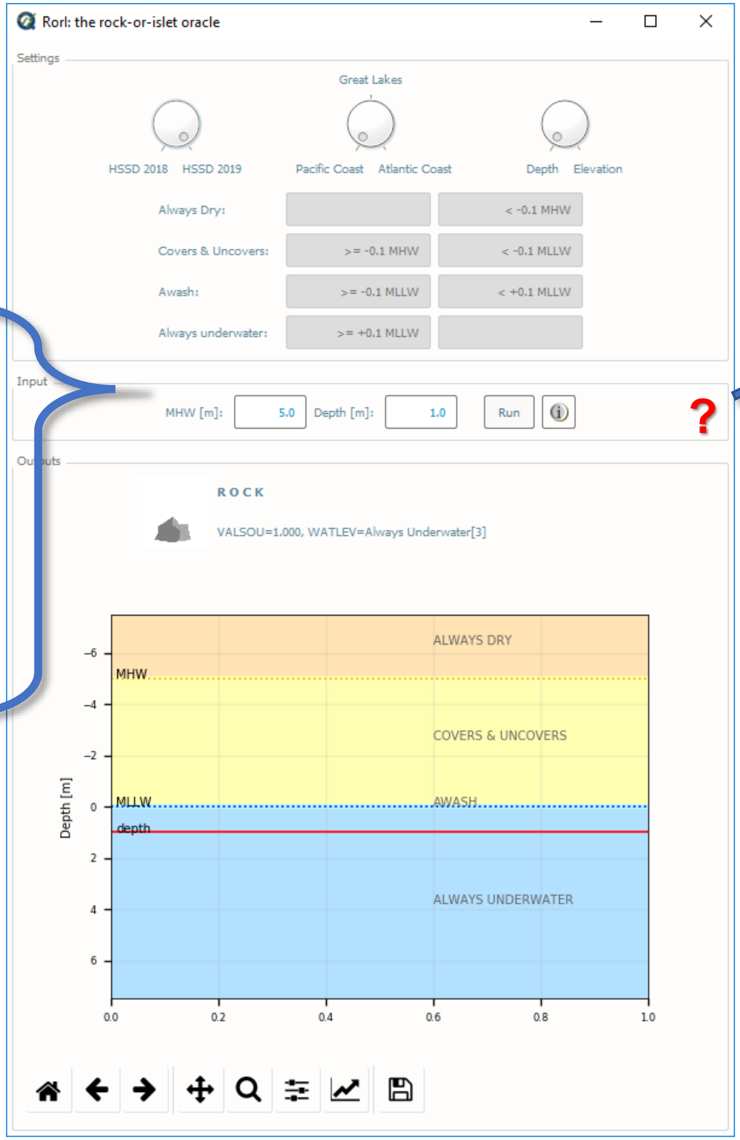


Demo

STANDALONE TOOLS: RORI

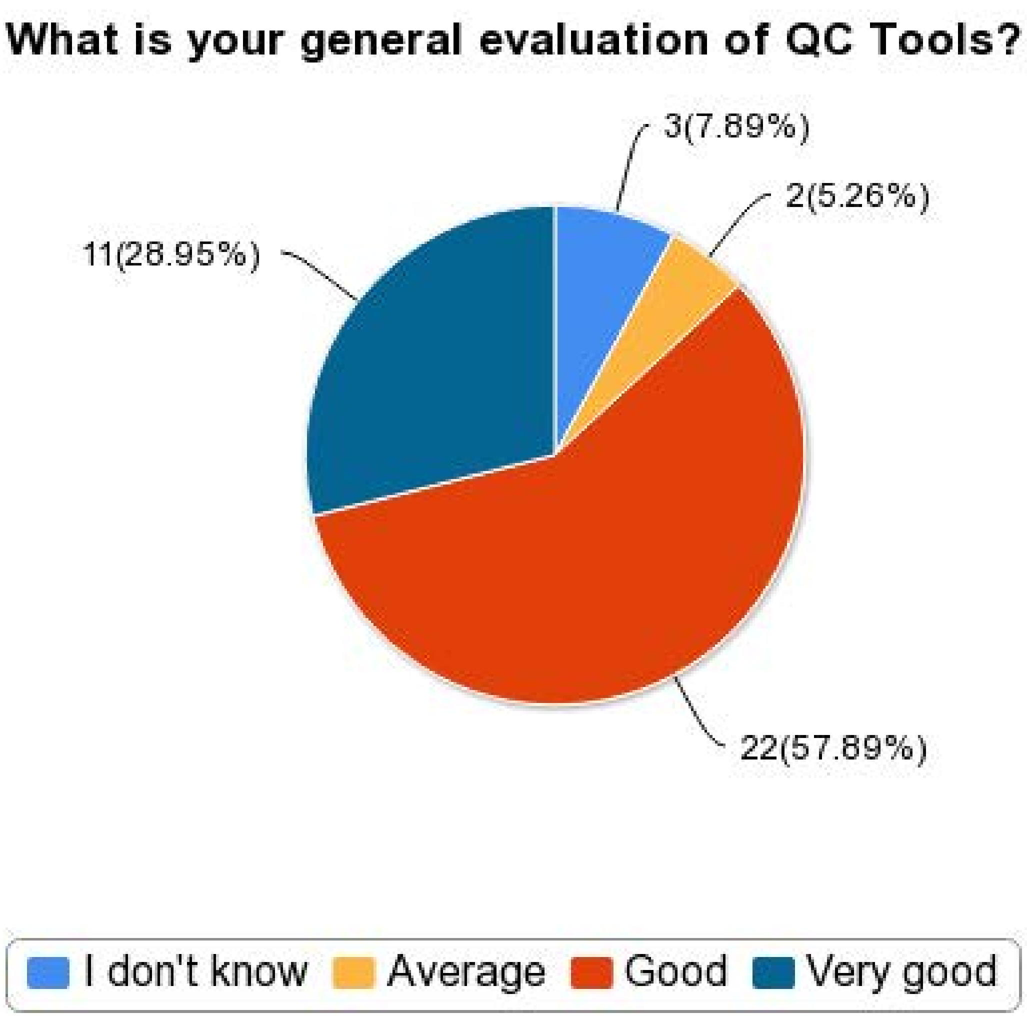
Classification	Always Underwater	Awash	Covers & Uncovers	Always Dry
Elevation (VALSOU or HEIGHT)	> 0.1 m below chart datum (e.g., MLLW or LWD[†])	< 0.1 m above chart datum to 0.1 m below chart datum	0.1 m above chart datum to 0.1 m above MHW	> 0.1 m SPOR (e.g., MHW)
S-57 Object	UWTROC OBSTRN WRECKS	UWTROC OBSTRN WRECKS	UWTROC OBSTRN WRECKS	LNDARE & LNDELV* OBSTRN** WRECKS**
WATLEV Value	3	5	4	none

[†]In the Great Lakes, rocks, obstructions, and wrecks are defined in relation to Low Water Datum.
*A rock becomes an islet at 0.1 meters above MHW. LNDARE point or area objects are used to characterize islets. Elevation for islets is encoded using the object LNDELV, with attribute ELEVAT, and are shown relative to the SPOR.
**When the depth of an obstruction or wreck is greater than 0.1 meters above MHW, HEIGHT attribution is required rather than VALSOU. As with ELEVAT, heights are shown relative to MHW datum. In this situation, WATLEV and VALSOU are left null.

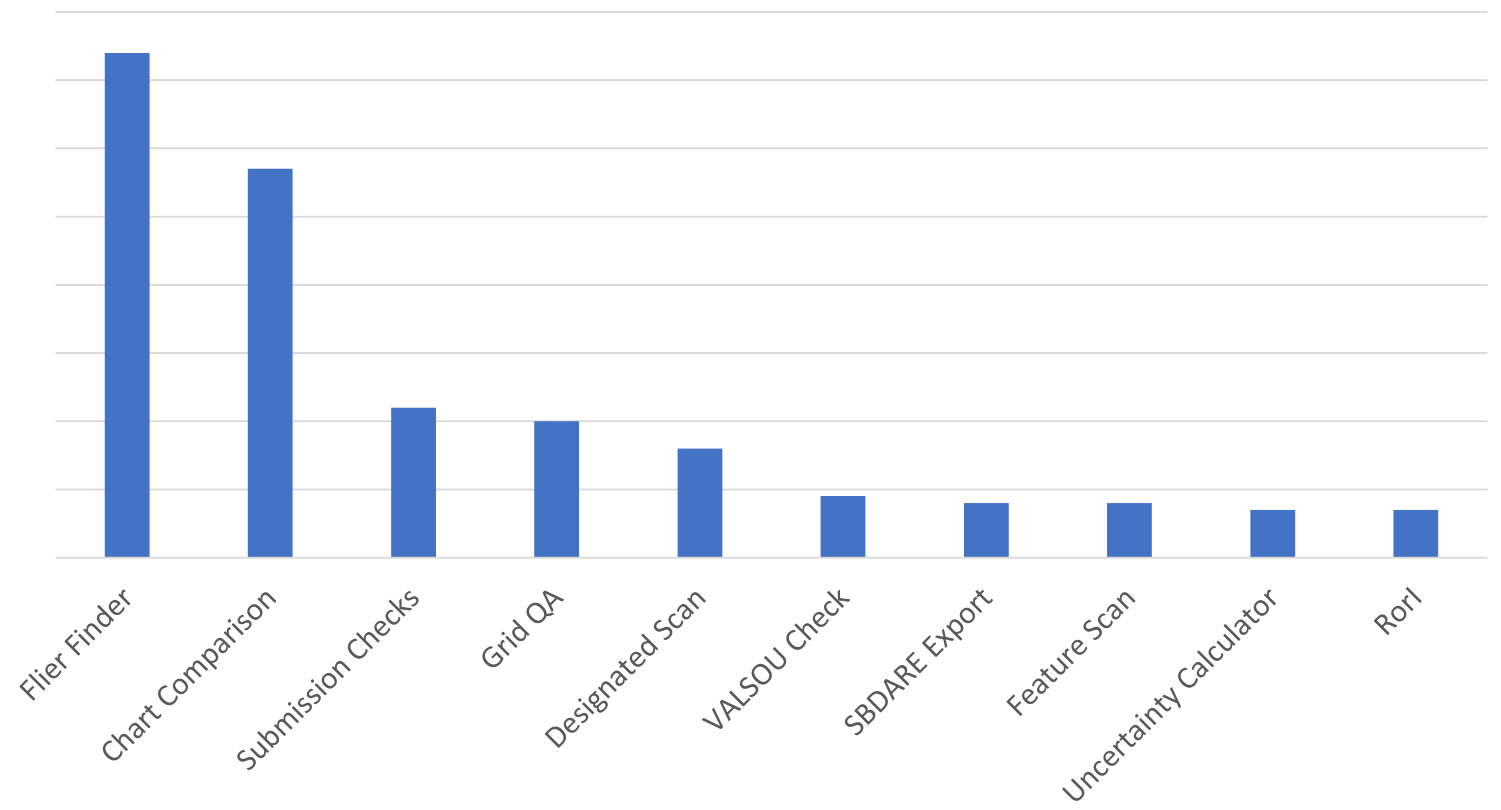


?

Demo


What is your general evaluation of QC Tools?
3(7.89%)
2(5.26%)
11(28.95%)
22(57.89%)
I don't know
Average
Good
Very good

Which tool to improve first?



THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

v0

CA Tools

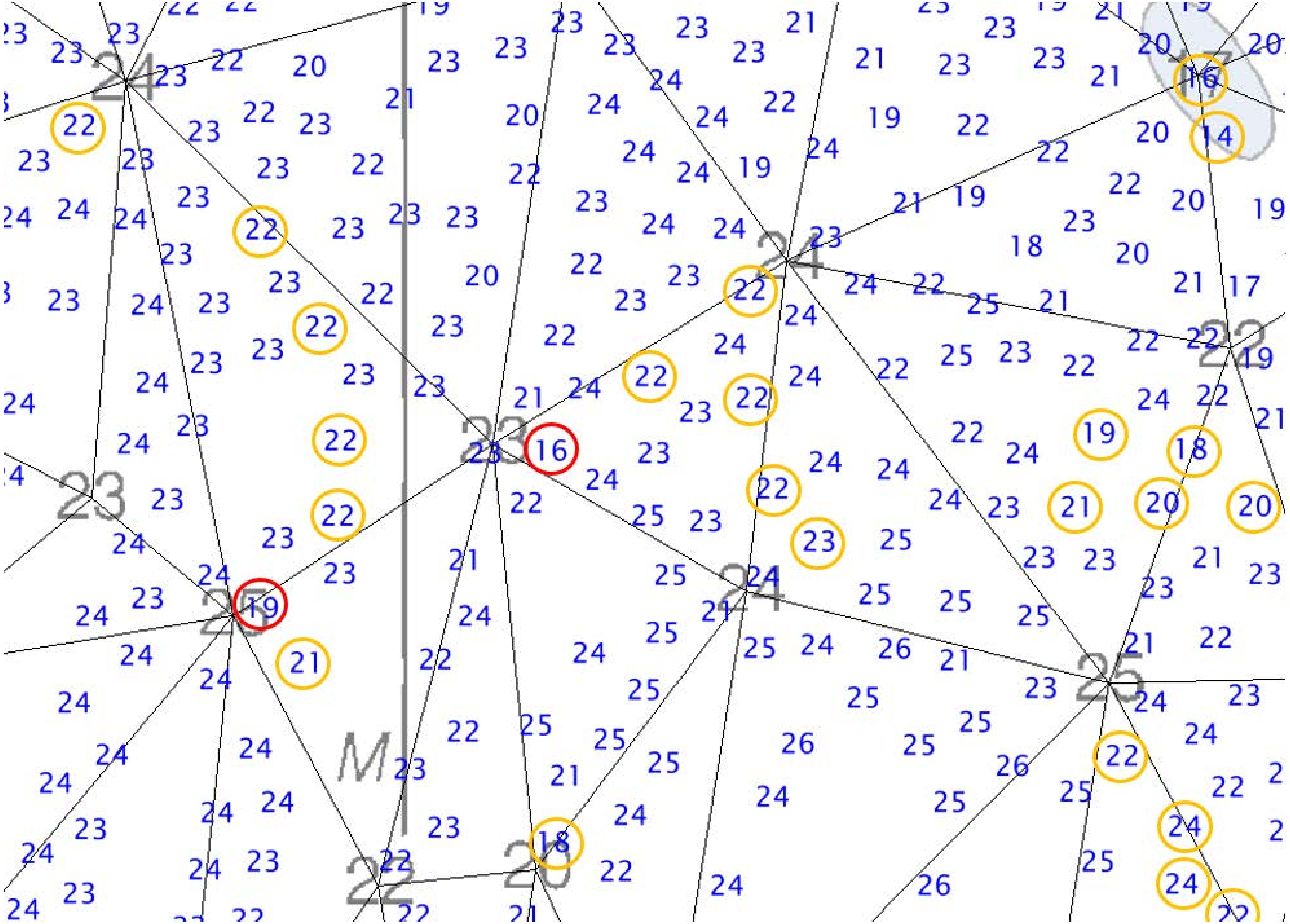
G. Masetti & T. Faulkes

Canberra, June 18-20 2019

CA Tools

Performs **chart adequacy tasks** by comparing survey data and current ENCs

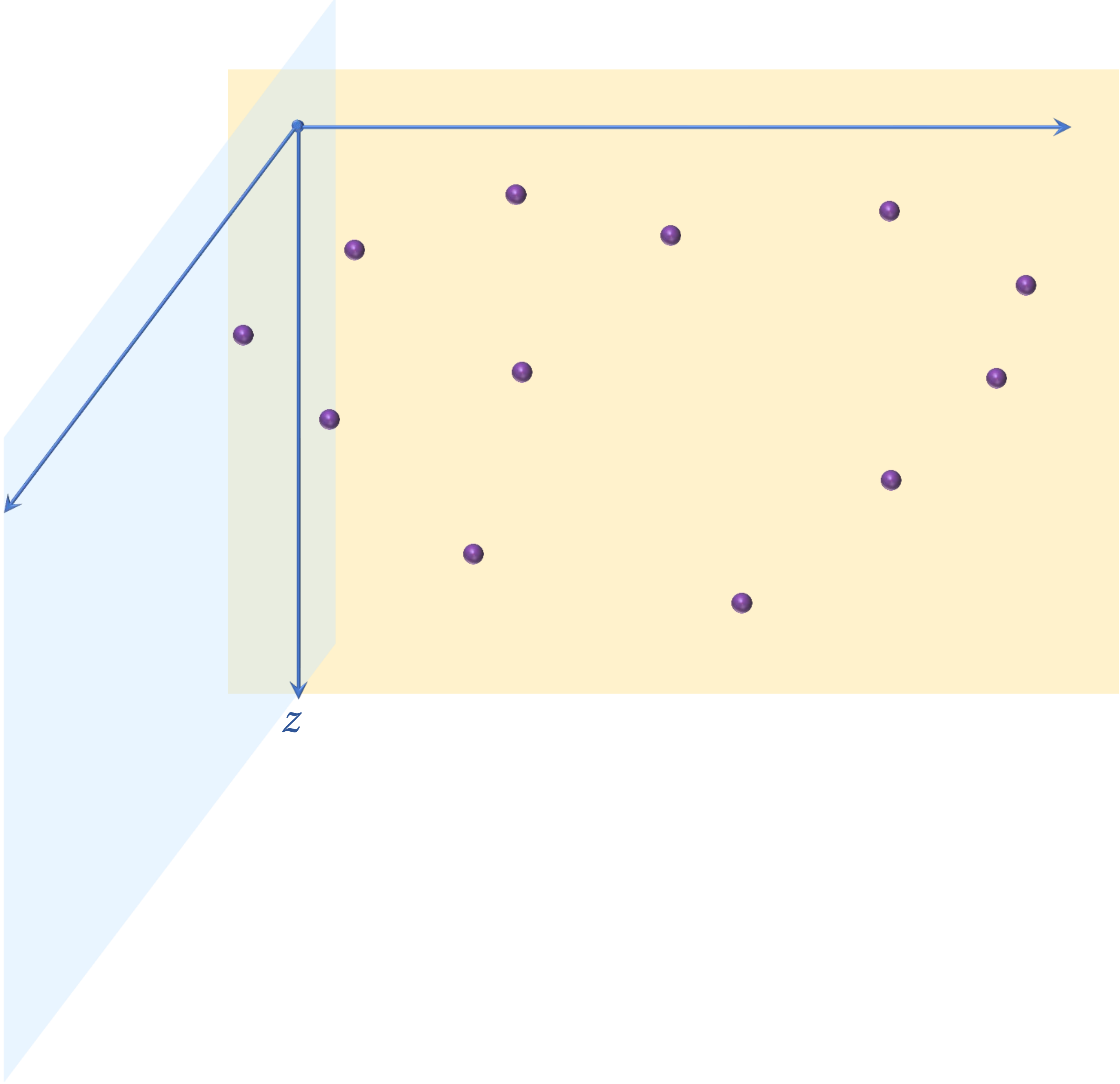
Chart Comparison


M

TIN Creation

- From several features in the input ENC:
  - SOUNDG points.
  - DEPCNT lines with valid VALDCO attribute.
  - DRGARE polygons with valid DRVAL1 attribute.
  - Point features with valid VALSOU attribute.
  - COALNE and SLCONS lines.
  - DEPARE polygons (only for ENC cell boundaries).

- Augmented by interpolating the linear features (at 1 cm @ compilation scale).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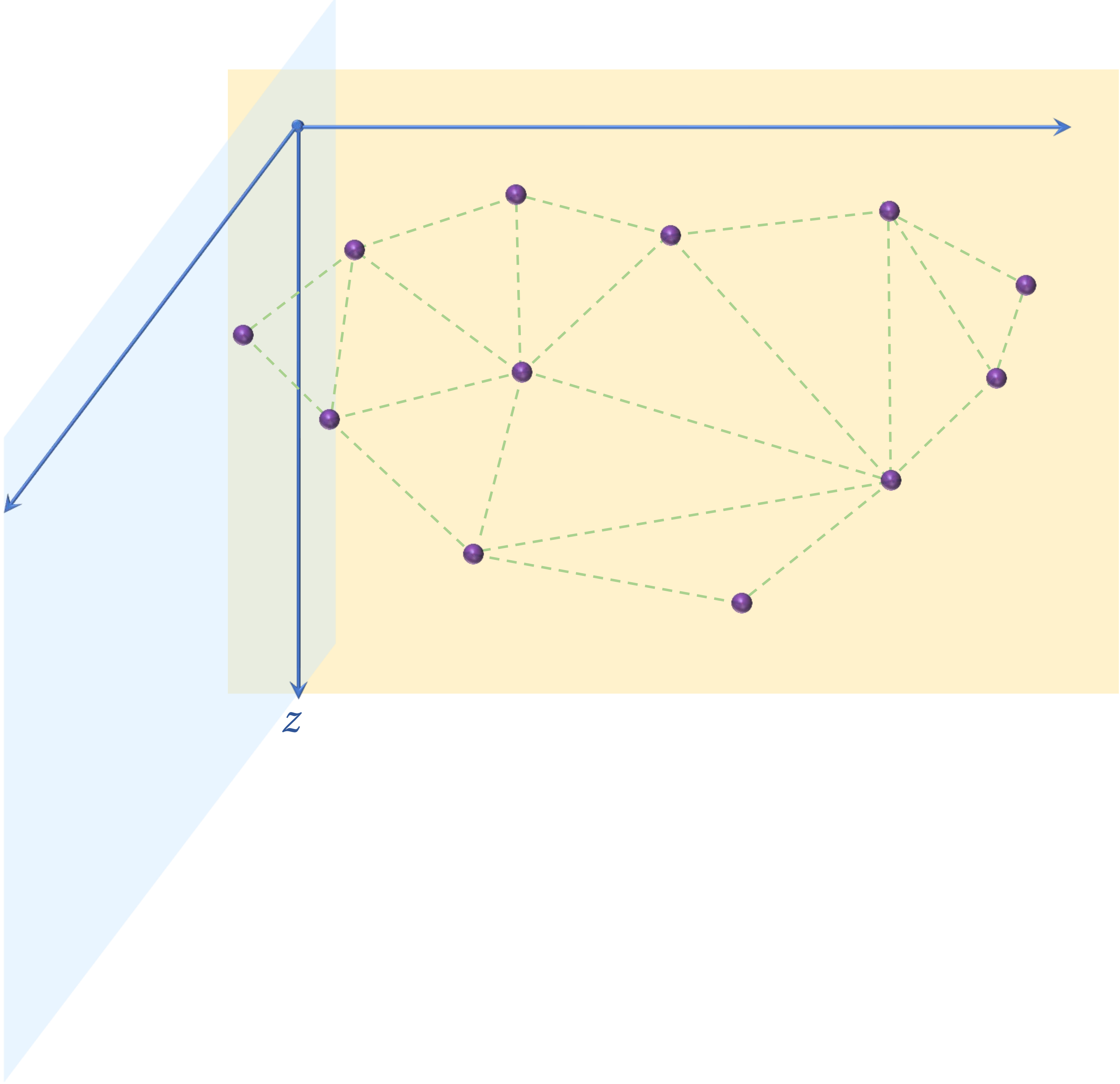
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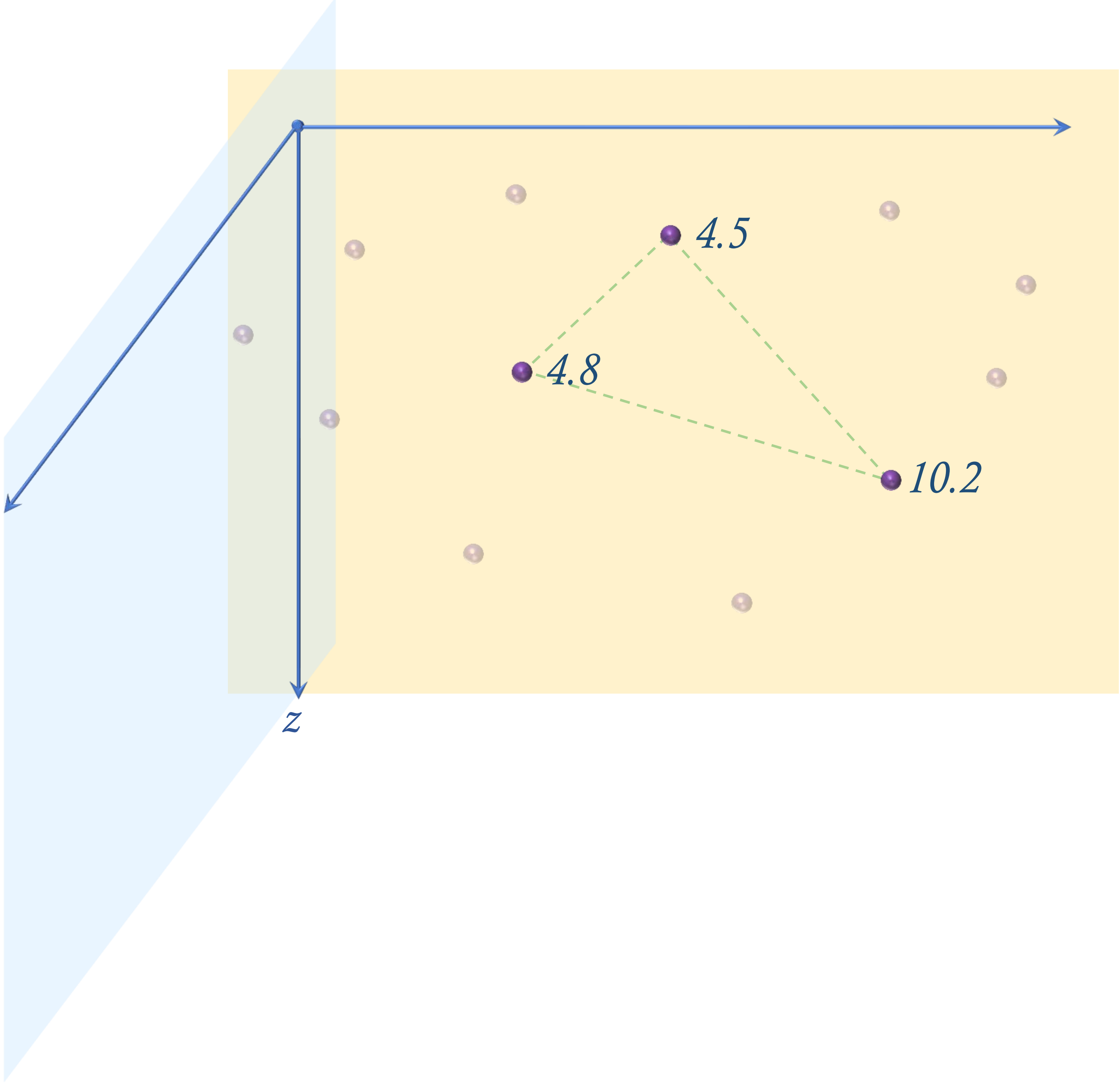
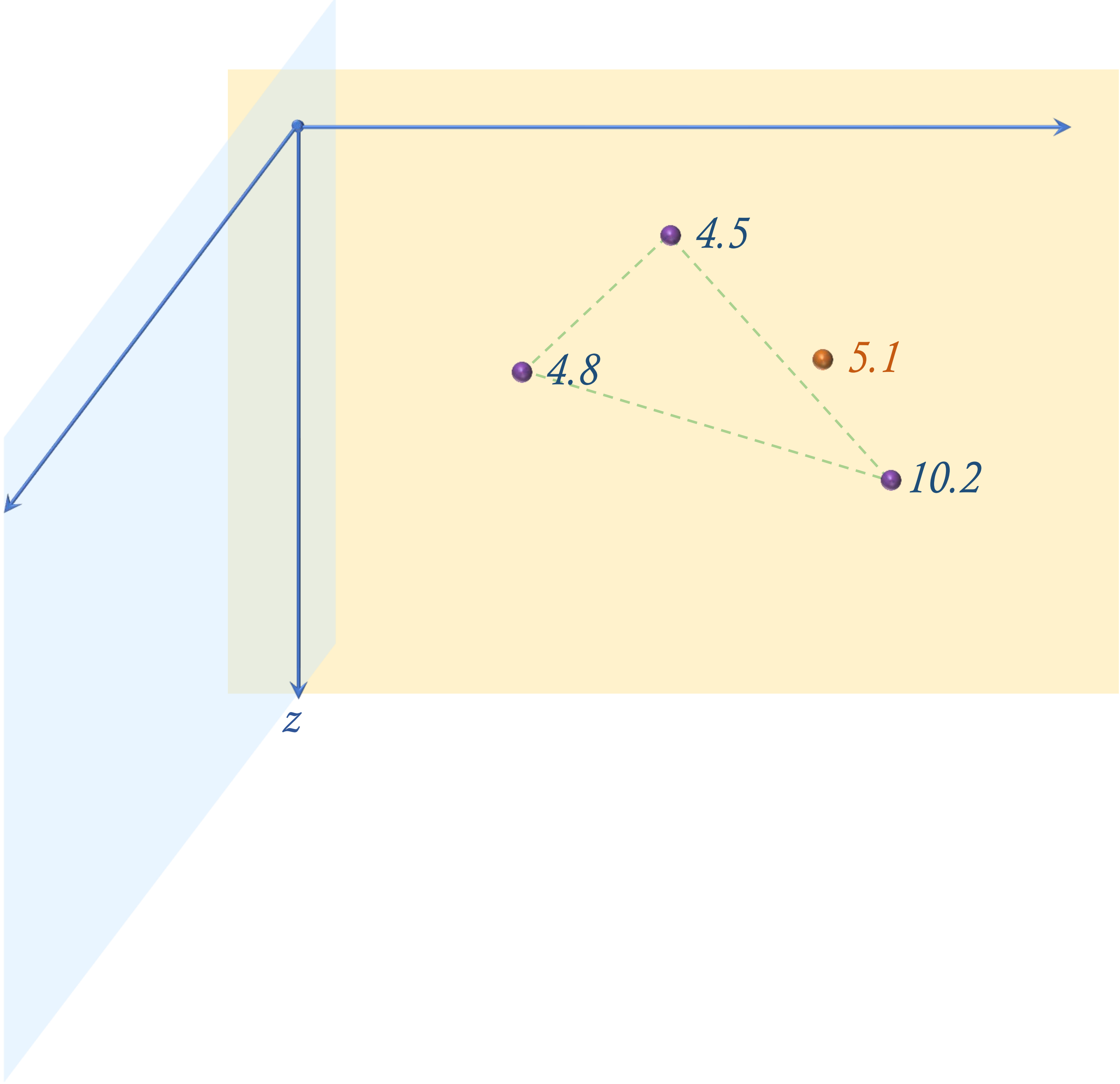
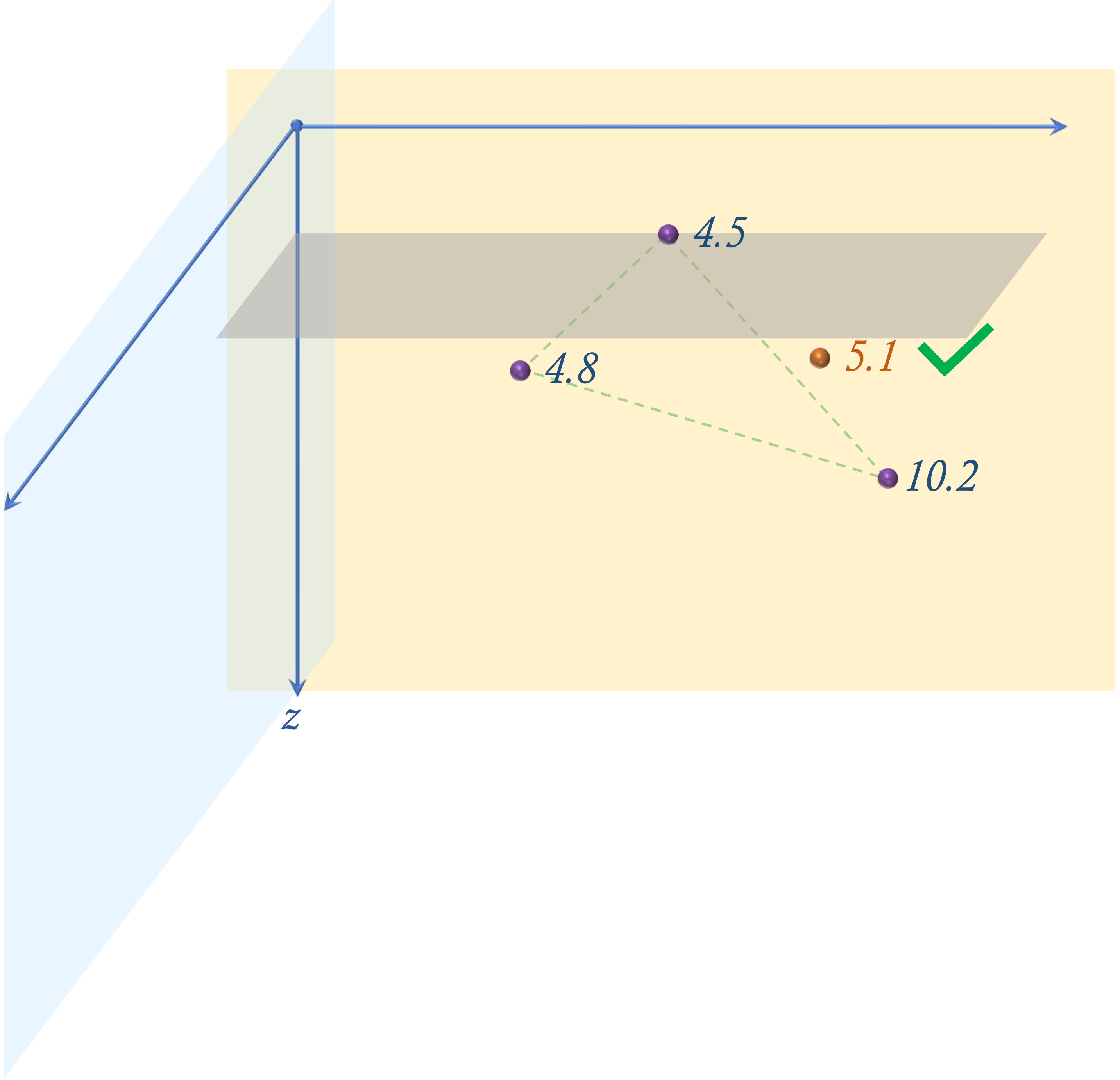
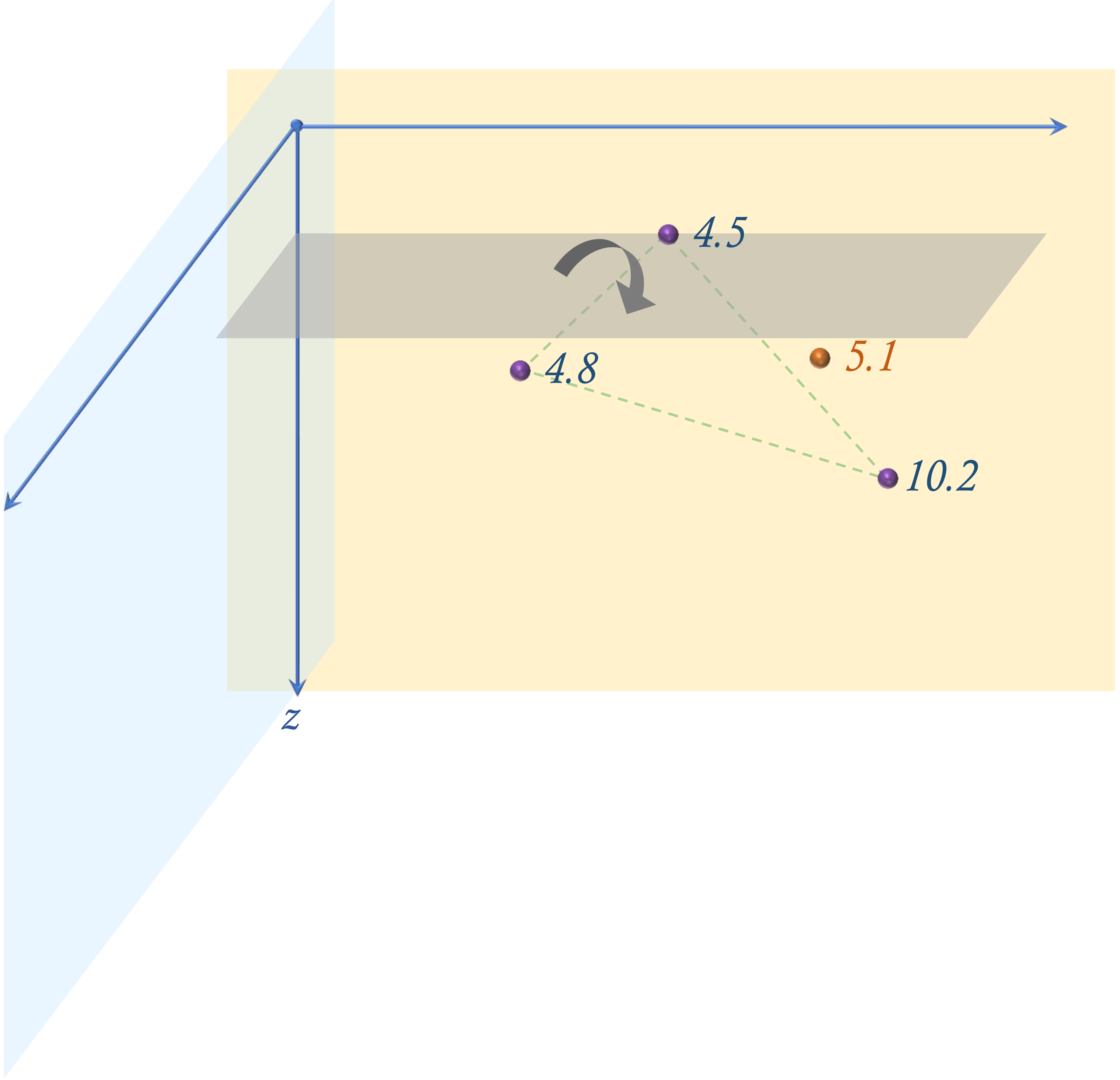

4.5
4.8
10.2
z


4.5
5.1
4.8
10.2
z


4.5
4.8
5.1
10.2
z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4.8
5.1
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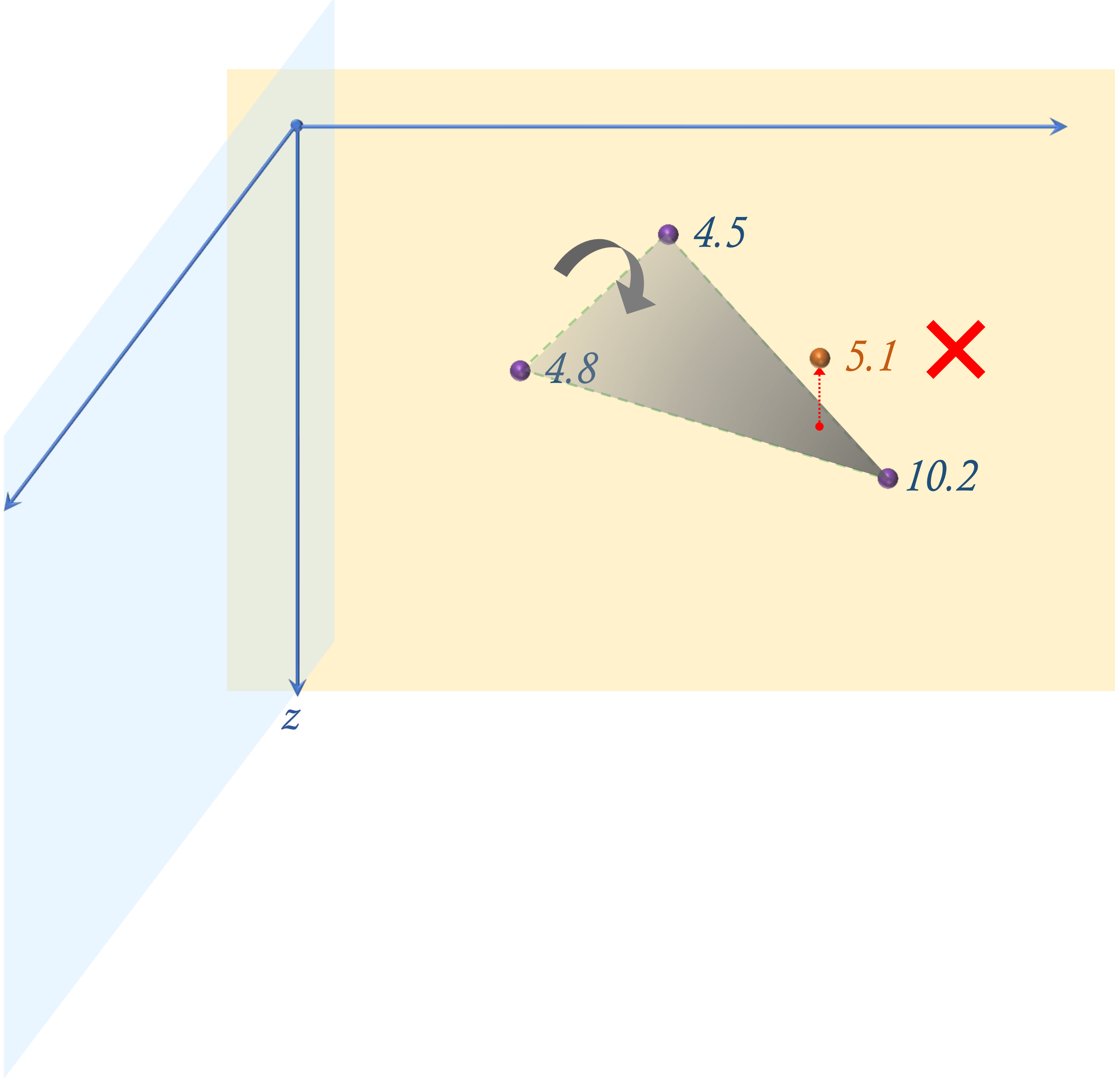
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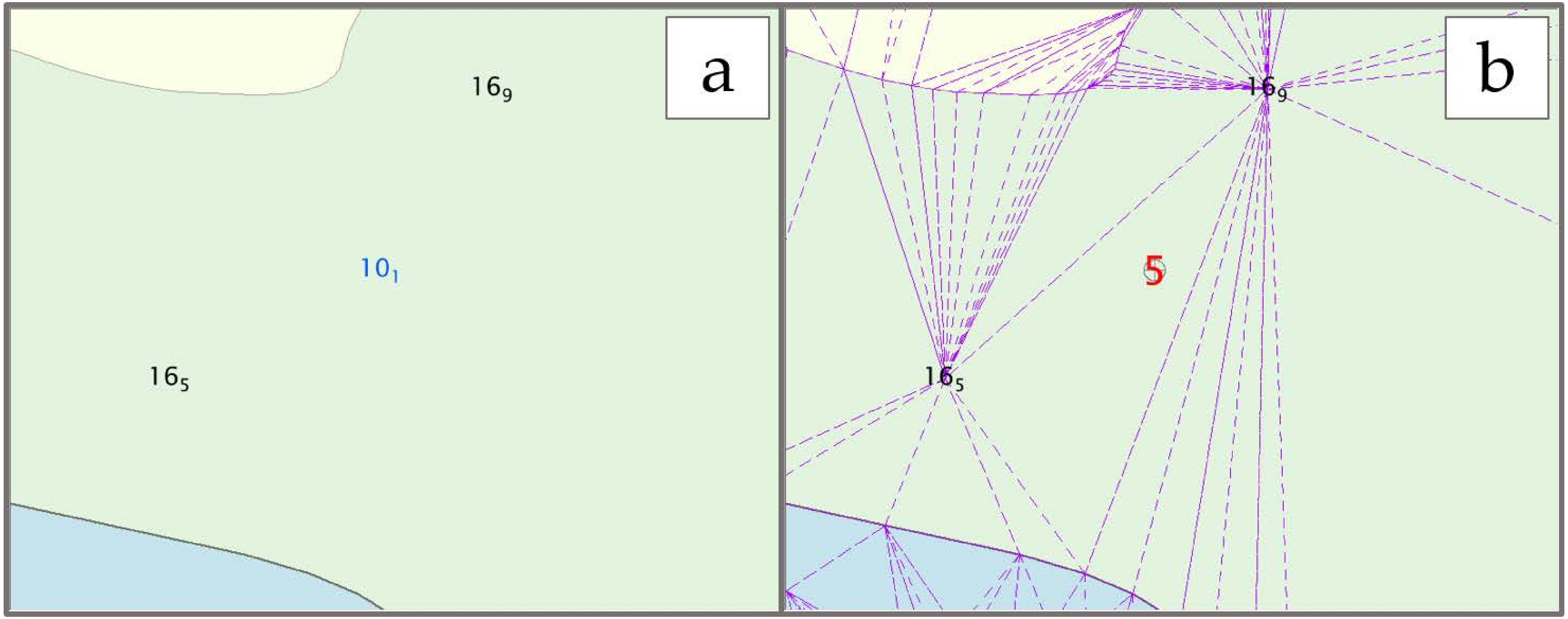
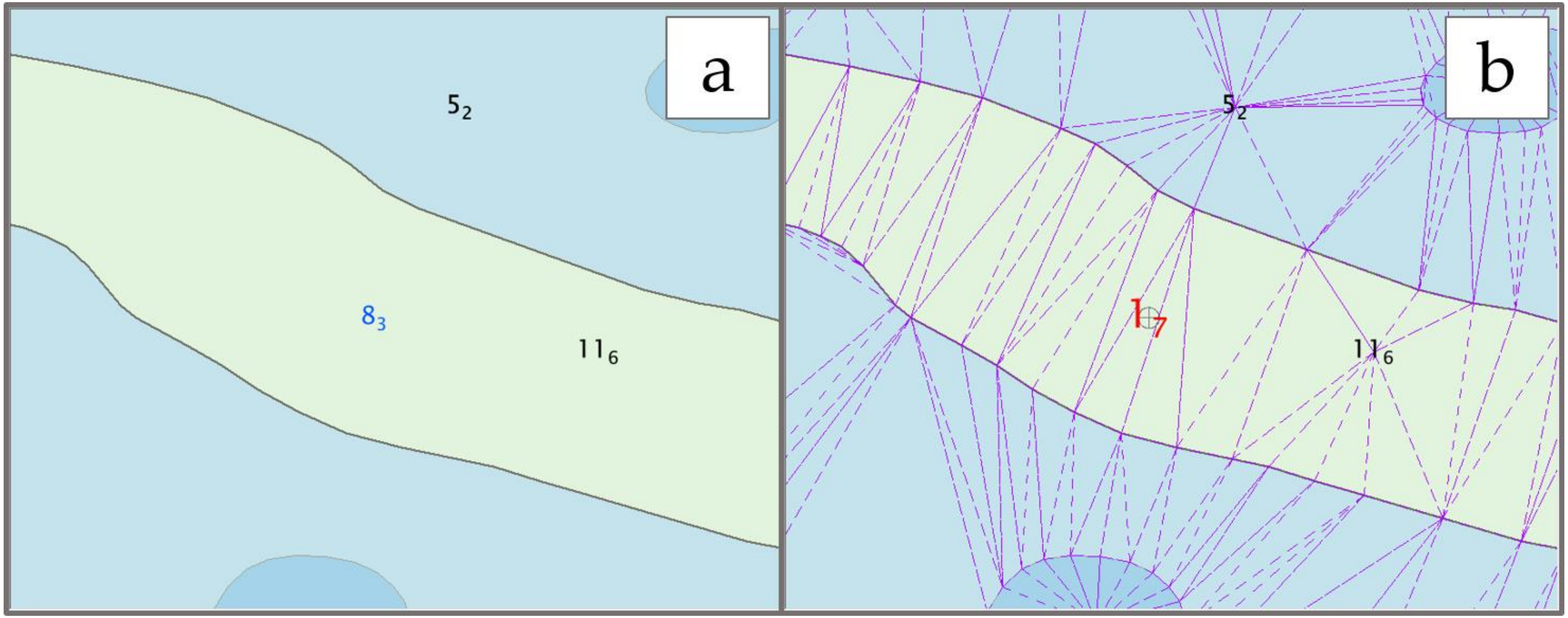
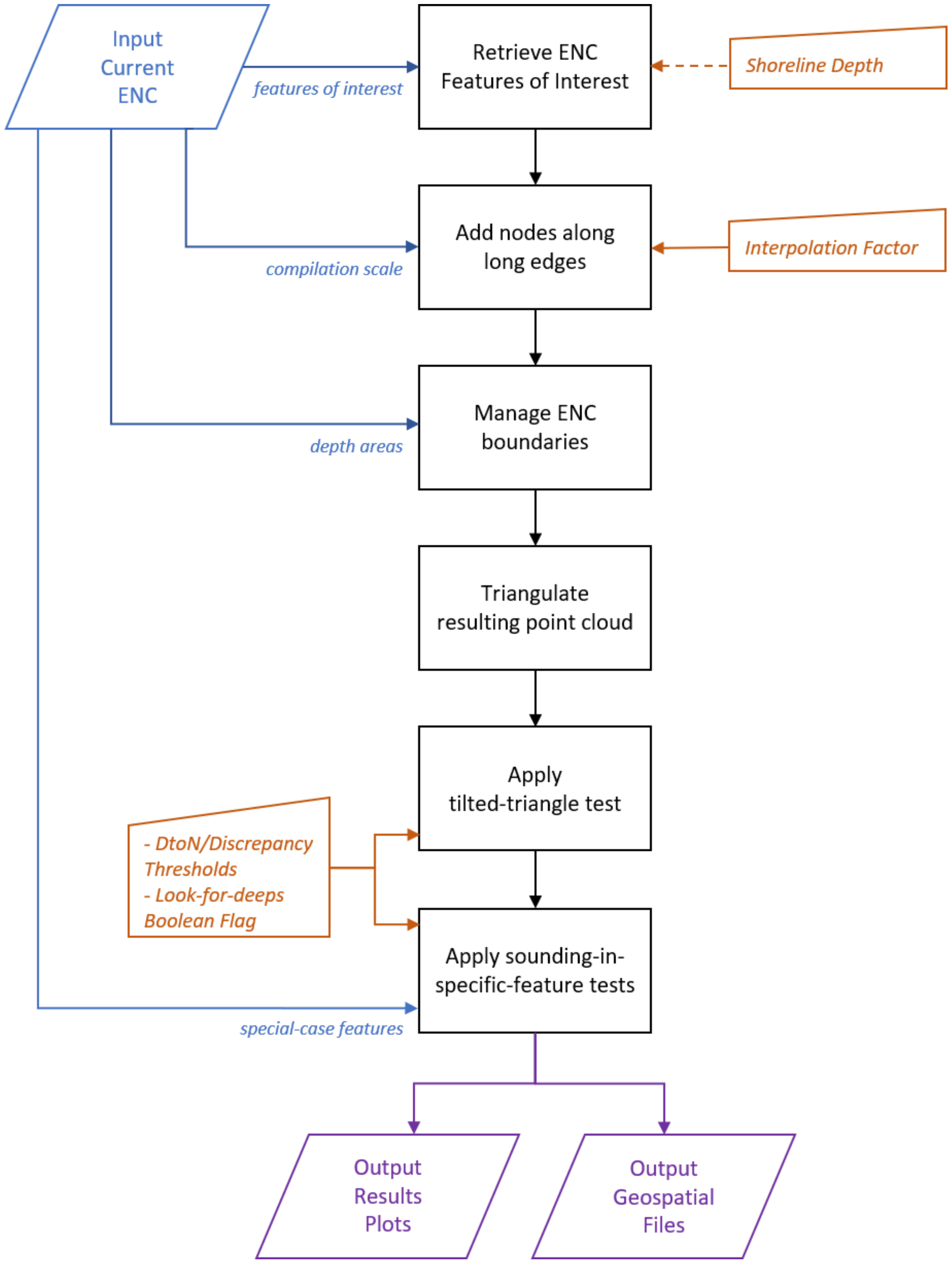
4.8
5.1
10.2
z

TILTED TRIANGLE



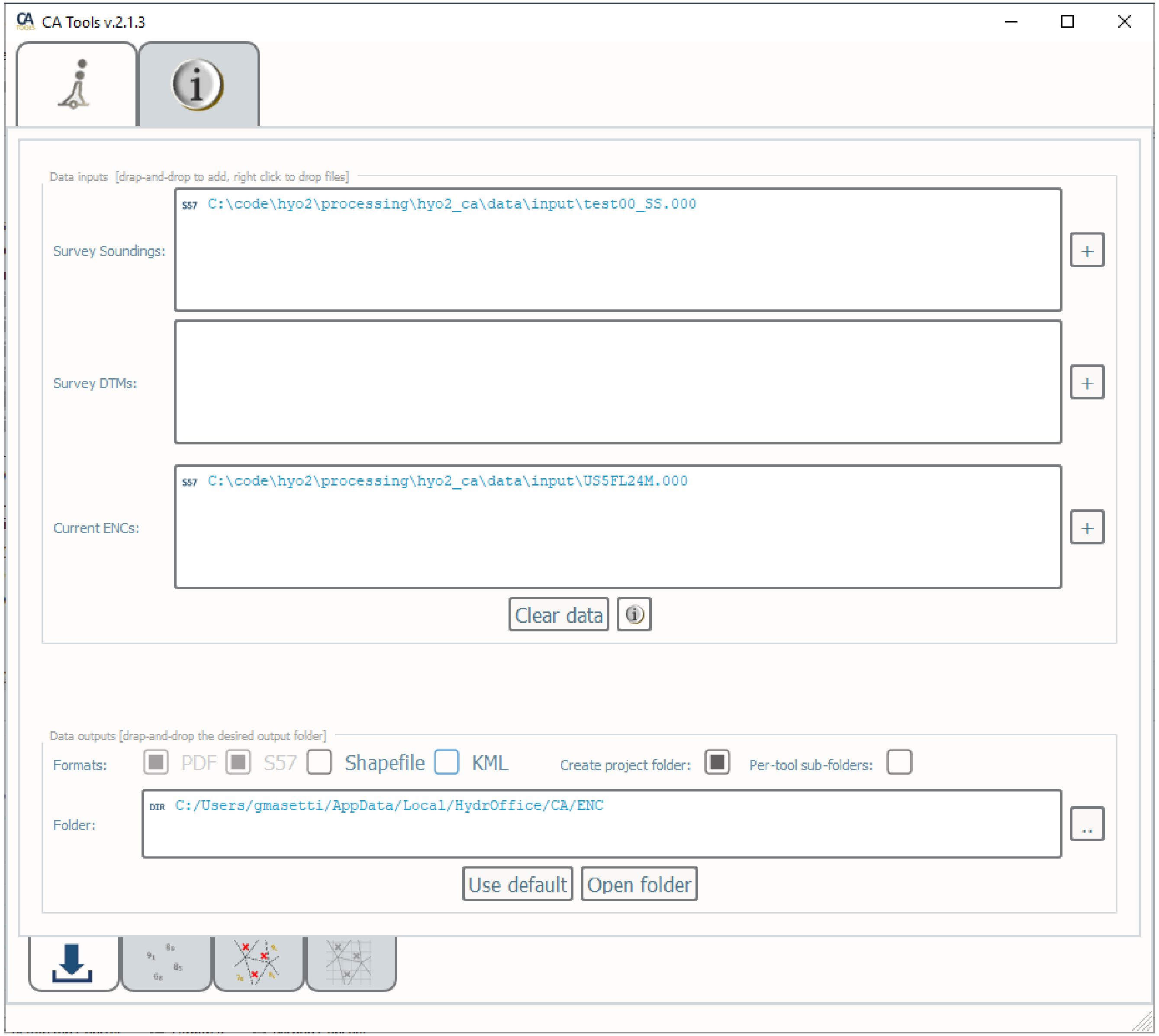
Flat Triangles → Point-In-Polygon Test



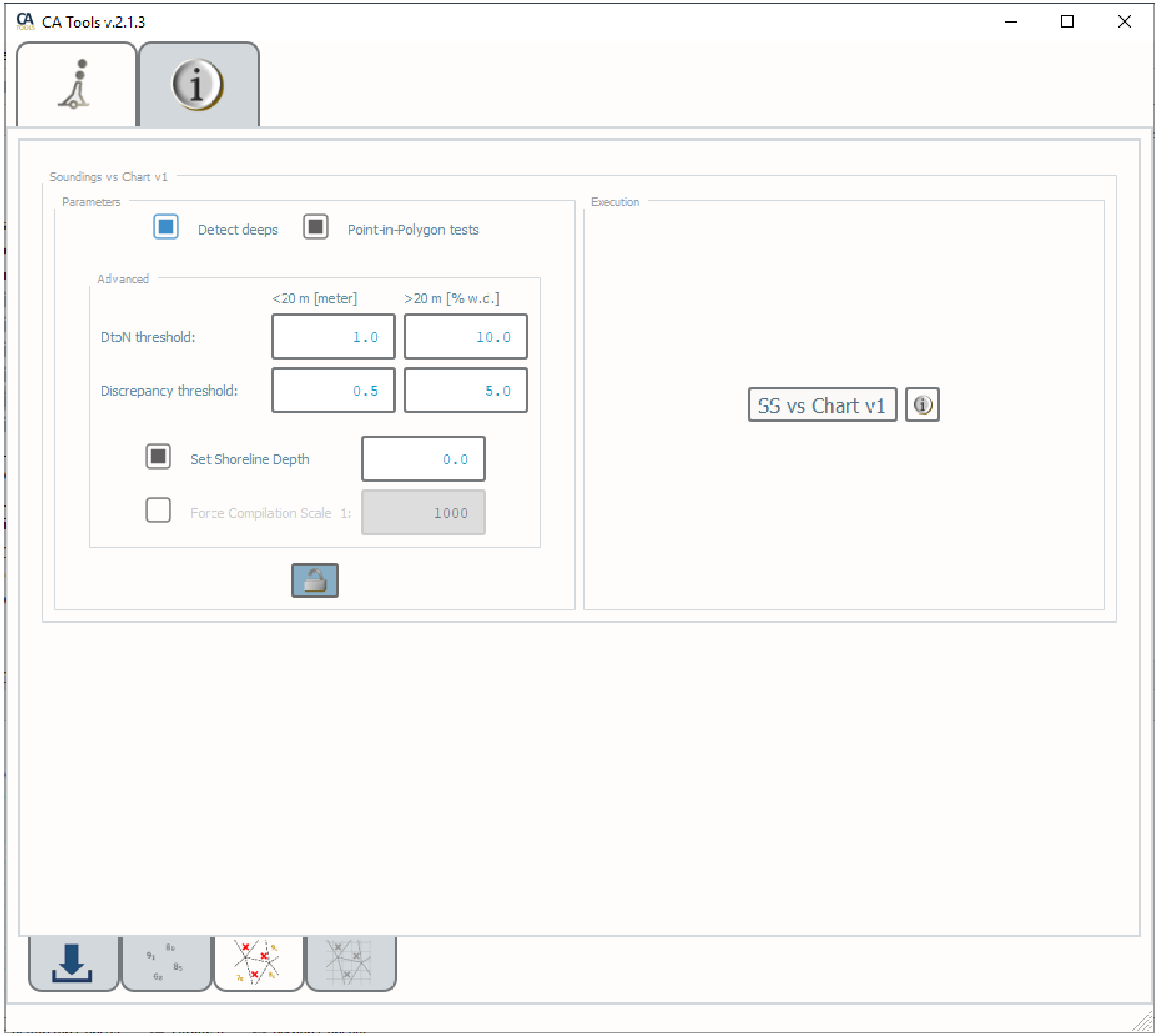


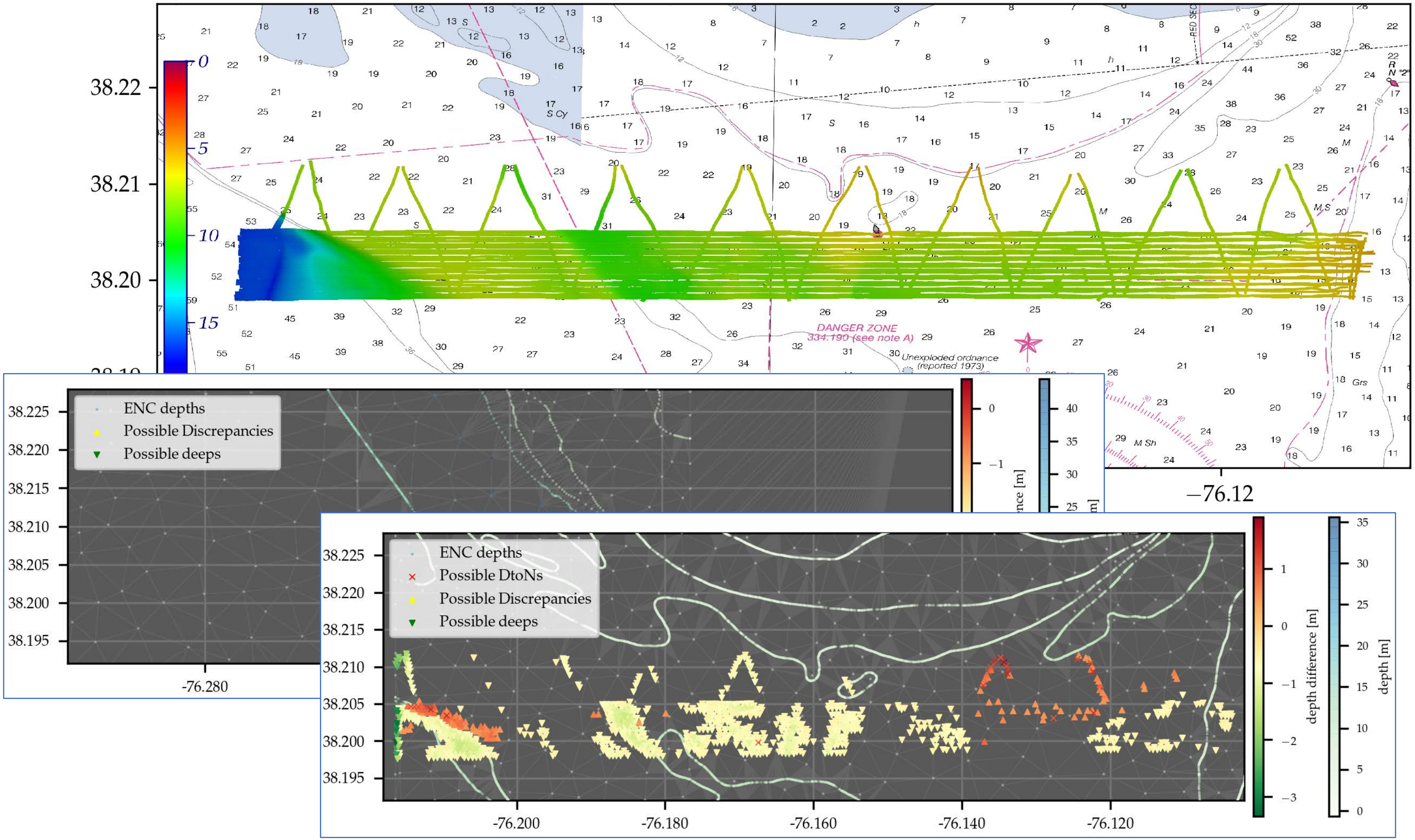
Input Current ENC
features of interest
Retrieve ENC Features of Interest
Shoreline Depth
compilation scale
Add nodes along long edges
Interpolation Factor
depth areas
Manage ENC boundaries
Triangulate resulting point cloud
Apply tilted-triangle test
- DtoN/Discrepancy Thresholds
- Look-for-deeps Boolean Flag
Apply sounding-in-specific-feature tests
special-case features
Output Results Plots
Output Geospatial Files

Input Data

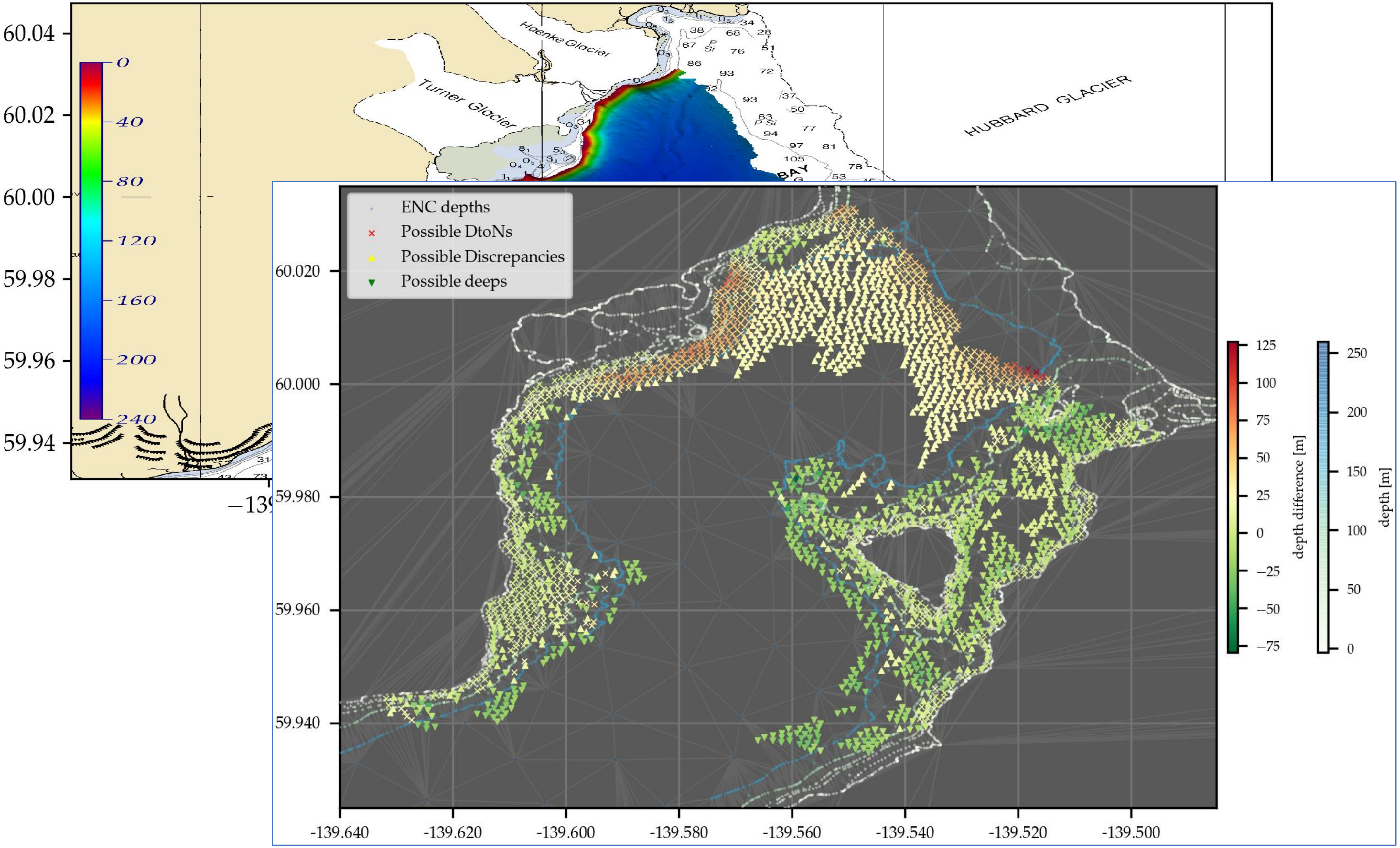

CA Tools v.2.1.3
Data inputs [drag-and-drop to add, right click to drop files]
Survey Soundings:
C:\code\hyo2\processing\hyo2_ca\data\input\test00_SS.000
Survey DTMs:
Current ENCs:
C:\code\hyo2\processing\hyo2_ca\data\input\US5FL24M.000
Clear data
Data outputs [drag-and-drop the desired output folder]
Formats:
PDF
S57
Shapefile
KML
Create project folder:
Per-tool sub-folders:
Folder:
C:/Users/gmasetti/AppData/Local/HydrOffice/CA/ENC
Use default
Open folder

Settings & Execution

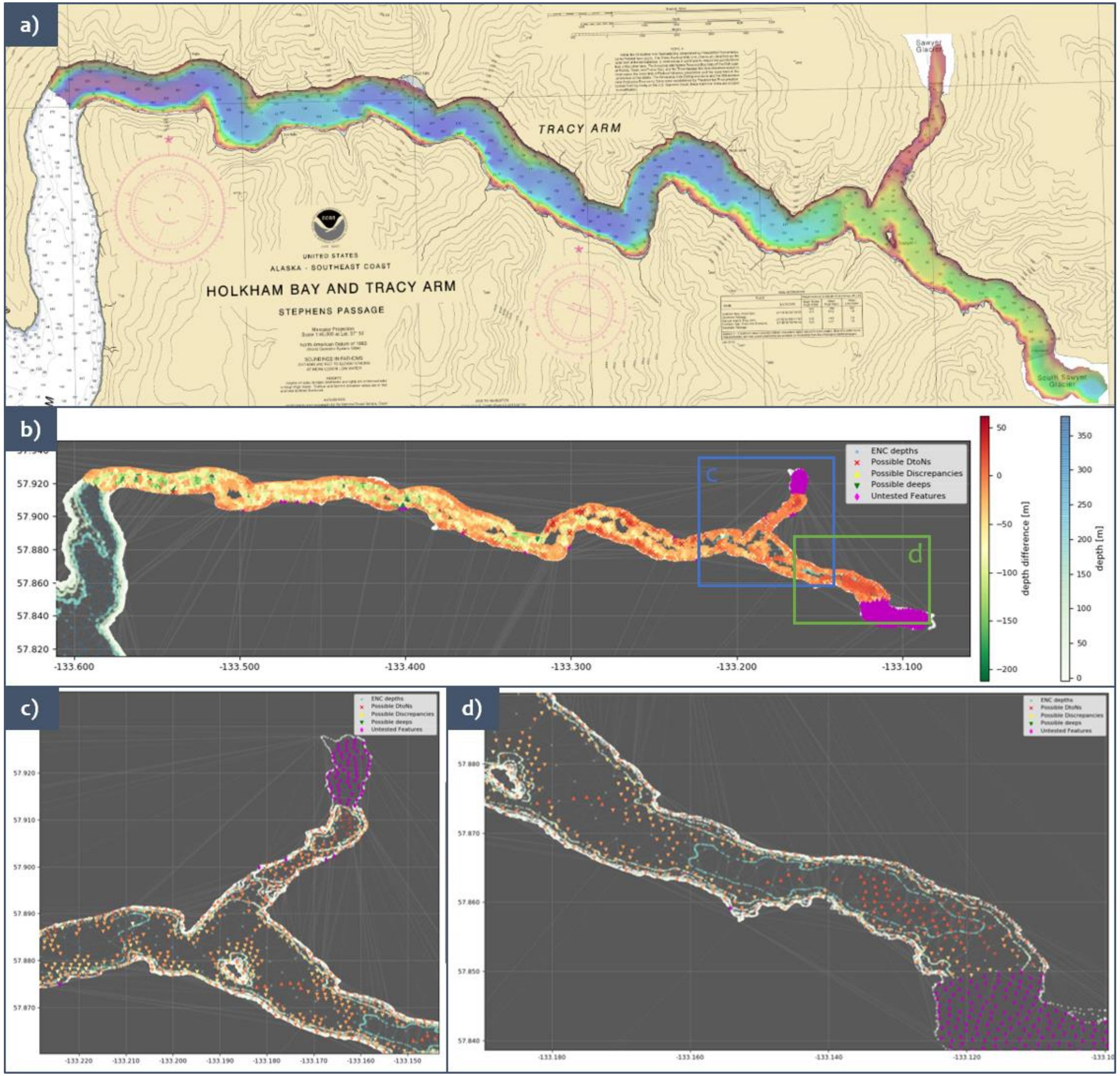




38.22
38.21
38.20
−76.12
DANGER ZONE
334.190 (see note A)
Unexploded ordnance
(reported 1973)
ENC depths
Possible Discrepancies
Possible deeps
-76.280
ENC depths
Possible DtoNs
Possible Discrepancies
Possible deeps
-76.200
-76.180
-76.160
-76.140
-76.120
depth difference [m]
depth [m]



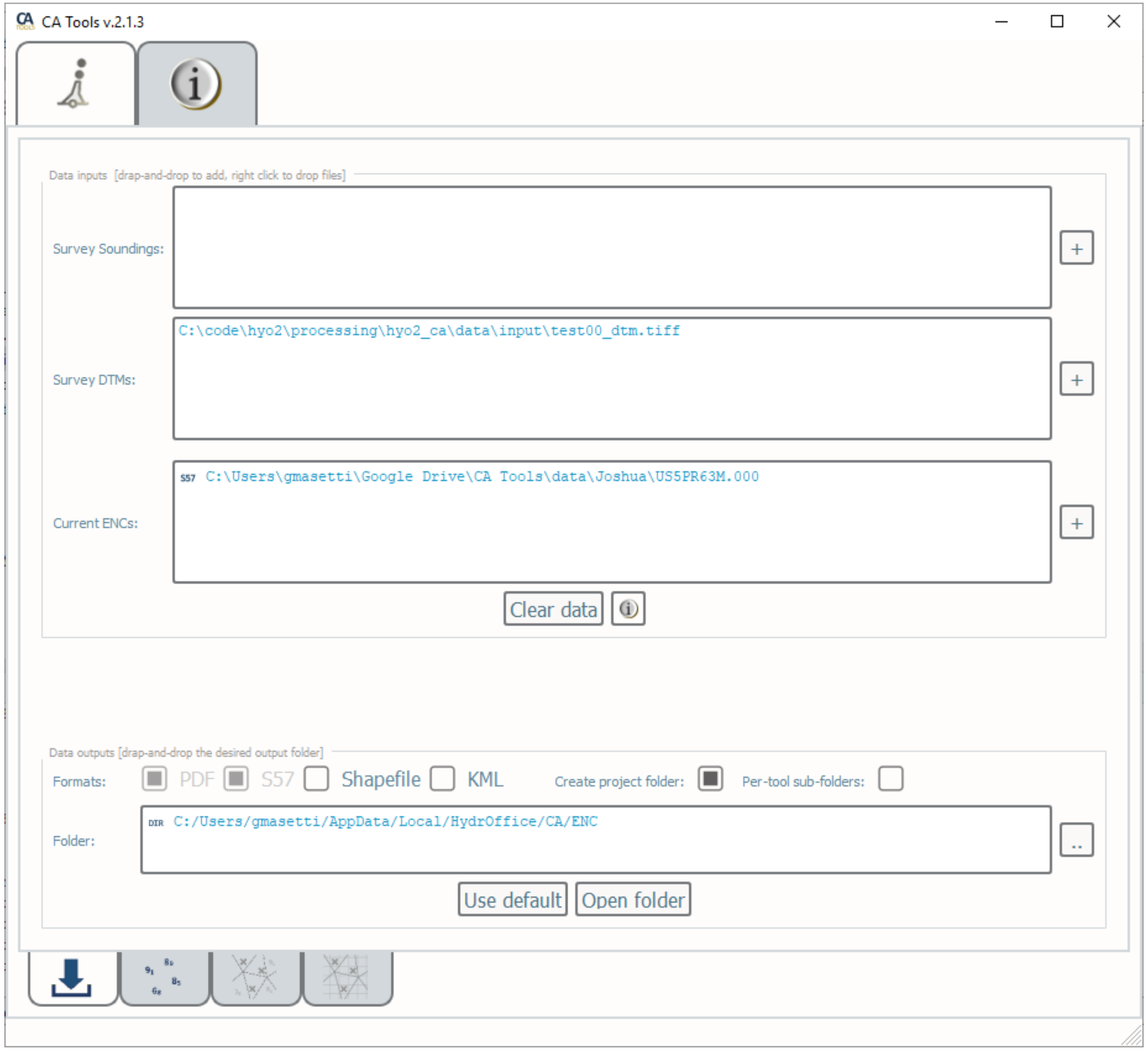
60.04
60.02
60.00
59.98
59.96
59.94
0
40
80
120
160
200
240
Haenke Glacier
Turner Glacier
HUBBARD GLACIER
ENC depths
Possible DtoNs
Possible Discrepancies
Possible deeps
60.020
60.000
59.980
59.960
59.940
-139.640
-139.620
-139.600
-139.580
-139.560
-139.540
-139.520
-139.500
depth difference [m]
125
100
75
50
25
0
−25
−50
−75
depth [m]
250
200
150
100
50
0



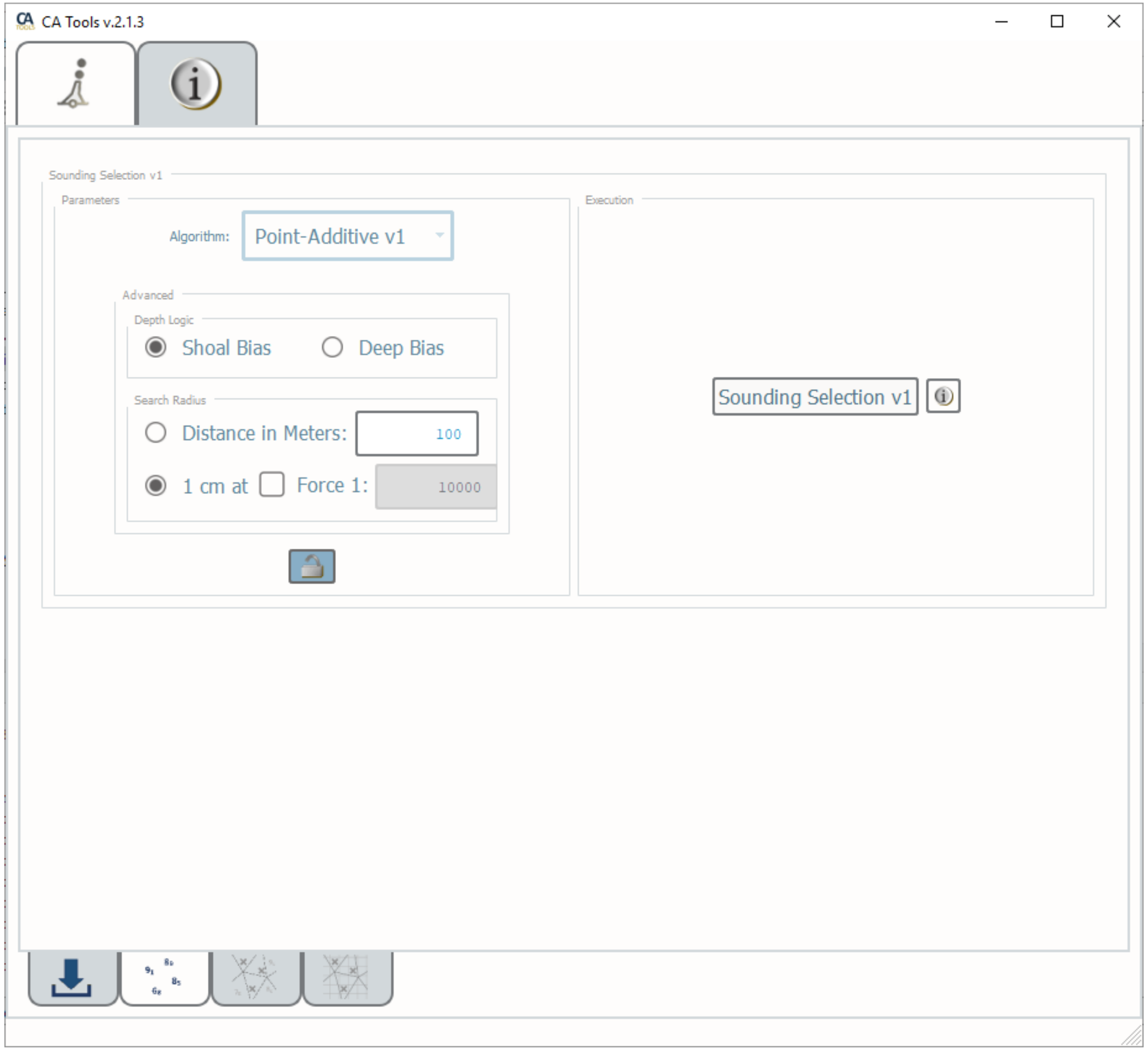
a)
TRACY ARM
UNITED STATES
ALASKA - SOUTHEAST COAST
HOLKHAM BAY AND TRACY ARM
STEPHENS PASSAGE
Sawyer Glacier
South Sawyer Glacier
b)
c
d
ENC depths
Possible DtoNs
Possible Discrepancies
Possible deeps
Untested Features
depth difference [m]
depth [m]
c)
d)

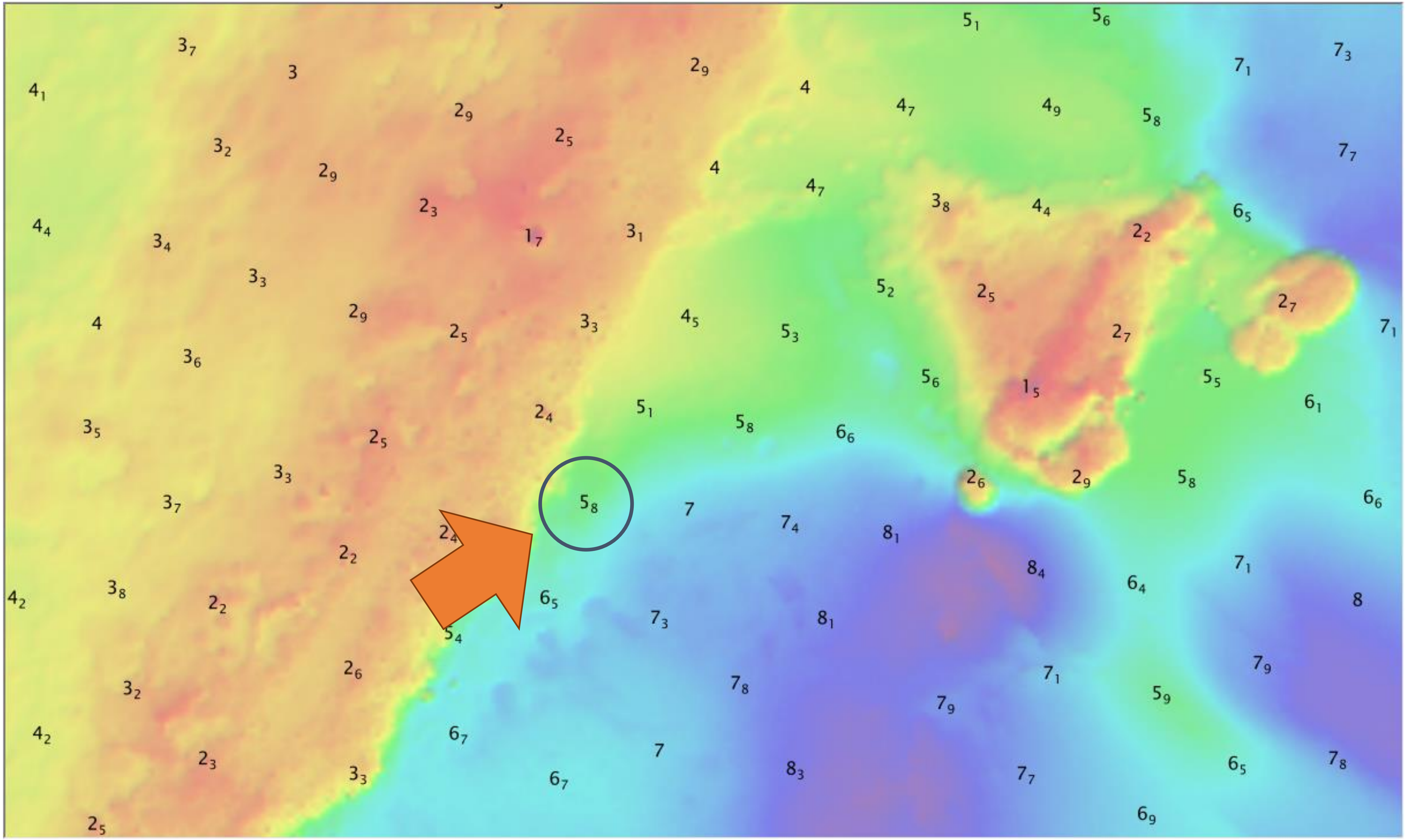
Soundings Selection

INPUT DATA


CA Tools v.2.1.3
Data inputs [drap-and-drop to add, right click to drop files]
Survey Soundings:
Survey DTMs:
C:\code\hyo2\processing\hyo2_ca\data\input\test00_dtm.tiff
Current ENCs:
S57 C:\Users\gmasetti\Google Drive\CA Tools\data\Joshua\US5PR63M.000
Clear data
Data outputs [drap-and-drop the desired output folder]
Formats:
PDF
S57
Shapefile
KML
Create project folder:
Per-tool sub-folders:
Folder:
DIR C:/Users/gmasetti/AppData/Local/HydrOffice/CA/ENC
Use default
Open folder

Settings & Execution





5_1
5_6
3_7
7_3
3
2_9
7_1
4_1
4
4_7
4_9
5_8
2_9
2_5
3_2
7_7
2_9
4
4_7
3_8
4_4
6_5
2_3
4_4
1_7
3_1
3_4
2_2
3_3
5_2
2_5
2_7
2_9
4
3_3
4_5
5_3
2_7
7_1
2_5
3_6
5_6
1_5
5_5
6_1
2_4
5_1
5_8
3_5
2_5
6_6
3_3
2_6
2_9
5_8
5_8
6_6
3_7
7
7_4
8_1
2_4
2_2
8_4
7_1
6_4
4_2
3_8
2_2
6_5
7_3
8_1
8
5_4
2_6
7_1
7_9
3_2
7_8
7_9
5_9
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2_3
3_3
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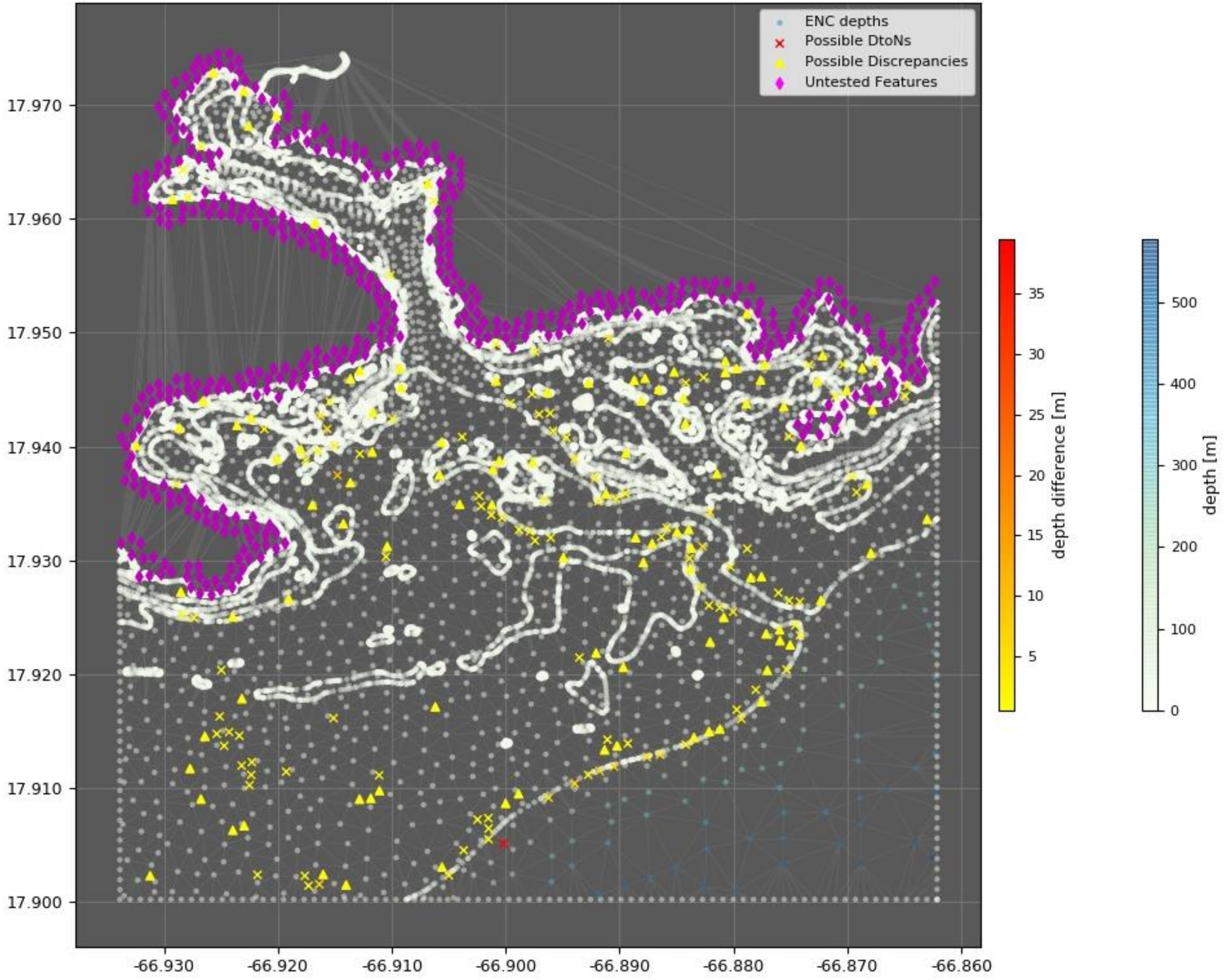
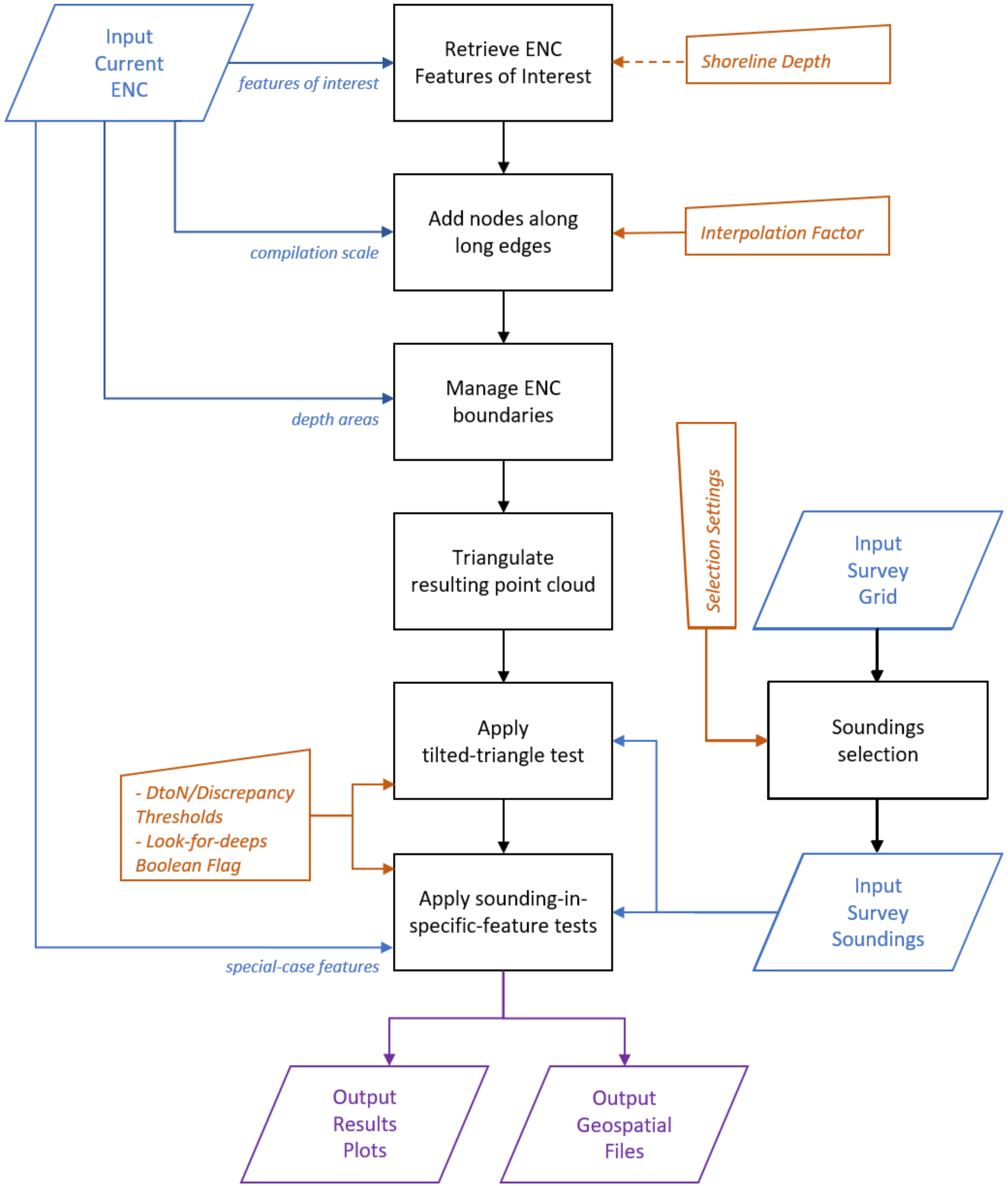
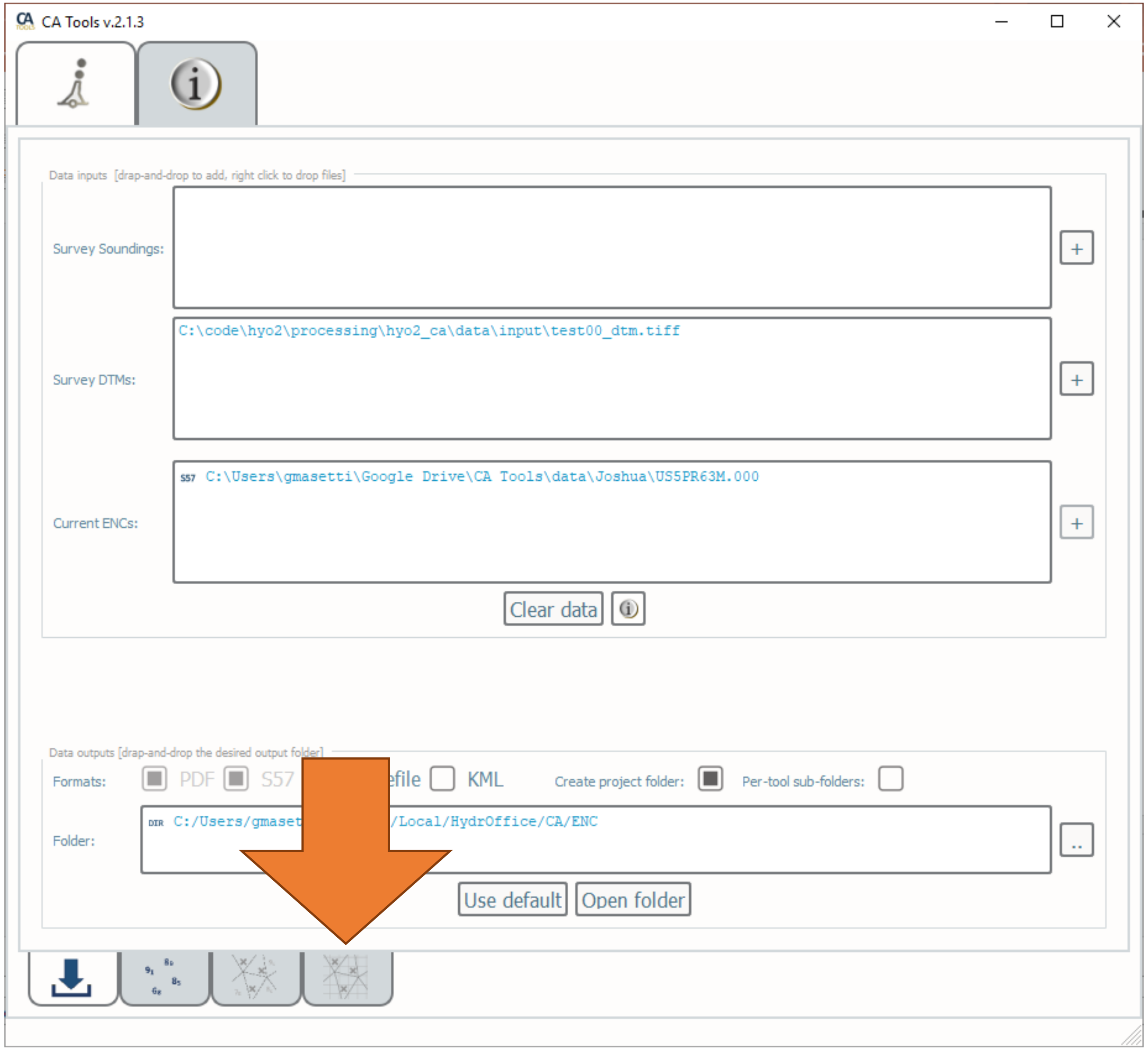
7_7
6_5
7_8
6_7
6_9
2_5



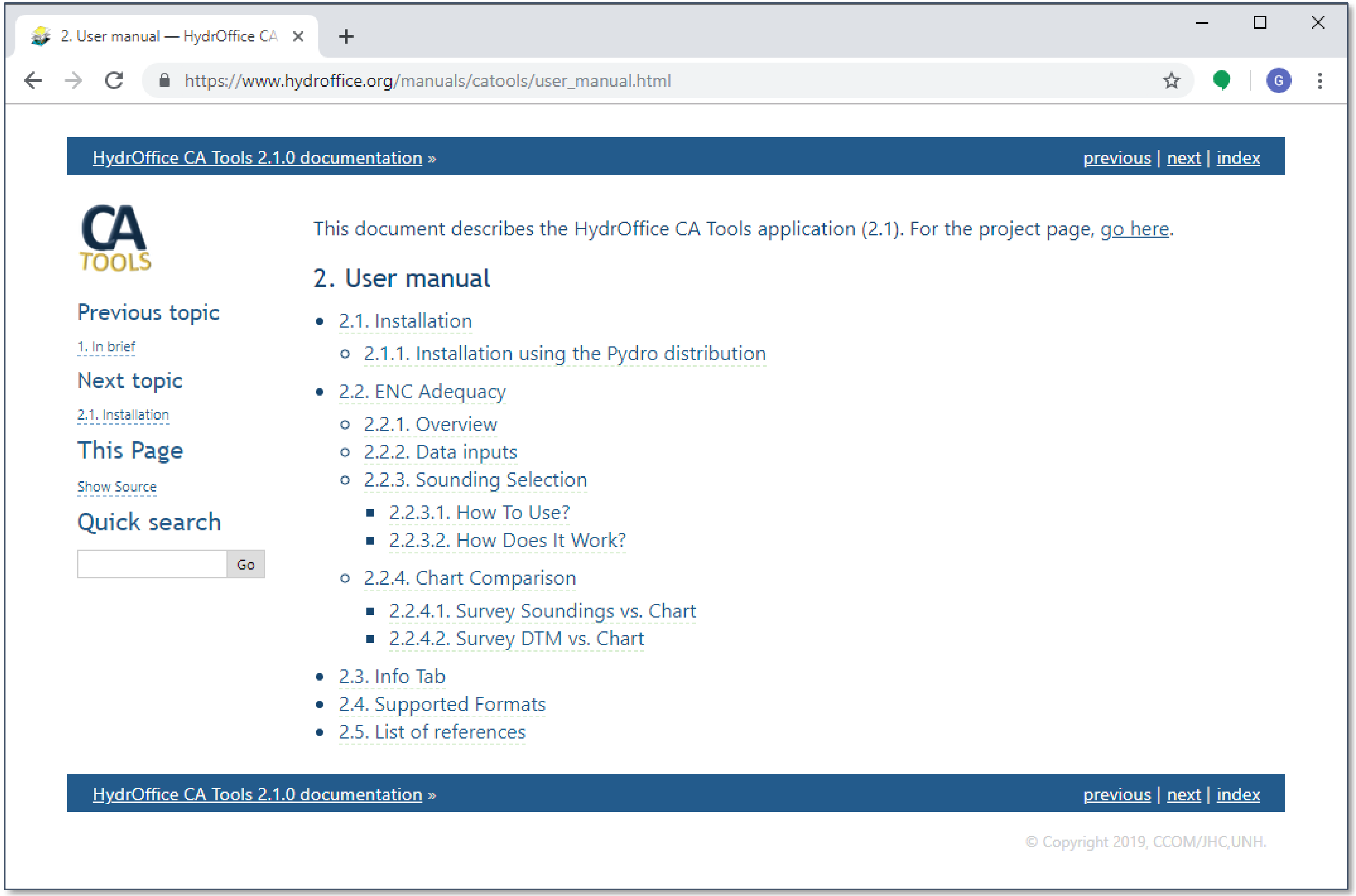
ENC depths
Possible DtoNs
Possible Discrepancies
Untested Features
17.970
17.960
17.950
17.940
17.930
17.920
17.910
17.900
-66.930
-66.920
-66.910
-66.900
-66.890
-66.880
-66.870
-66.860
depth difference [m]
35
30
25
20
15
10
5
depth [m]
500
400
300
200
100
0


Input Current ENC
features of interest
Retrieve ENC Features of Interest
Shoreline Depth
Add nodes along long edges
compilation scale
Interpolation Factor
Manage ENC boundaries
depth areas
Selection Settings
Triangulate resulting point cloud
Input Survey Grid
Apply tilted-triangle test
Soundings selection
- DtoN/Discrepancy Thresholds
- Look-for-deeps Boolean Flag
Apply sounding-in-specific-feature tests
Input Survey Soundings
special-case features
Output Results Plots
Output Geospatial Files

Coming Development



More Info? Read the Manual!


2. User manual — HydrOffice CA

https://www.hydroffice.org/manuals/catools/user_manual.html

HydrOffice CA Tools 2.1.0 documentation » previous | next | index

CA TOOLS

Previous topic

1. In brief

Next topic

2.1. Installation

This Page

Show Source

Quick search

Go

This document describes the HydrOffice CA Tools application (2.1). For the project page, go here.

2. User manual

- 2.1. Installation
  - 2.1.1. Installation using the Pydro distribution
- 2.2. ENC Adequacy
  - 2.2.1. Overview
  - 2.2.2. Data inputs
  - 2.2.3. Sounding Selection
    - 2.2.3.1. How To Use?
    - 2.2.3.2. How Does It Work?
  - 2.2.4. Chart Comparison
    - 2.2.4.1. Survey Soundings vs. Chart
    - 2.2.4.2. Survey DTM vs. Chart
- 2.3. Info Tab
- 2.4. Supported Formats
- 2.5. List of references

HydrOffice CA Tools 2.1.0 documentation » previous | next | index

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

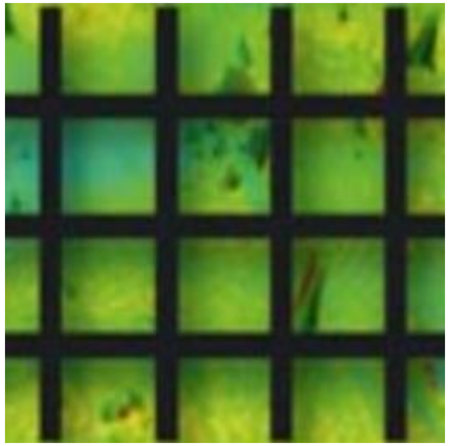
V0

BAG & BAG Explorer

G. Masetti & T. Faulkes

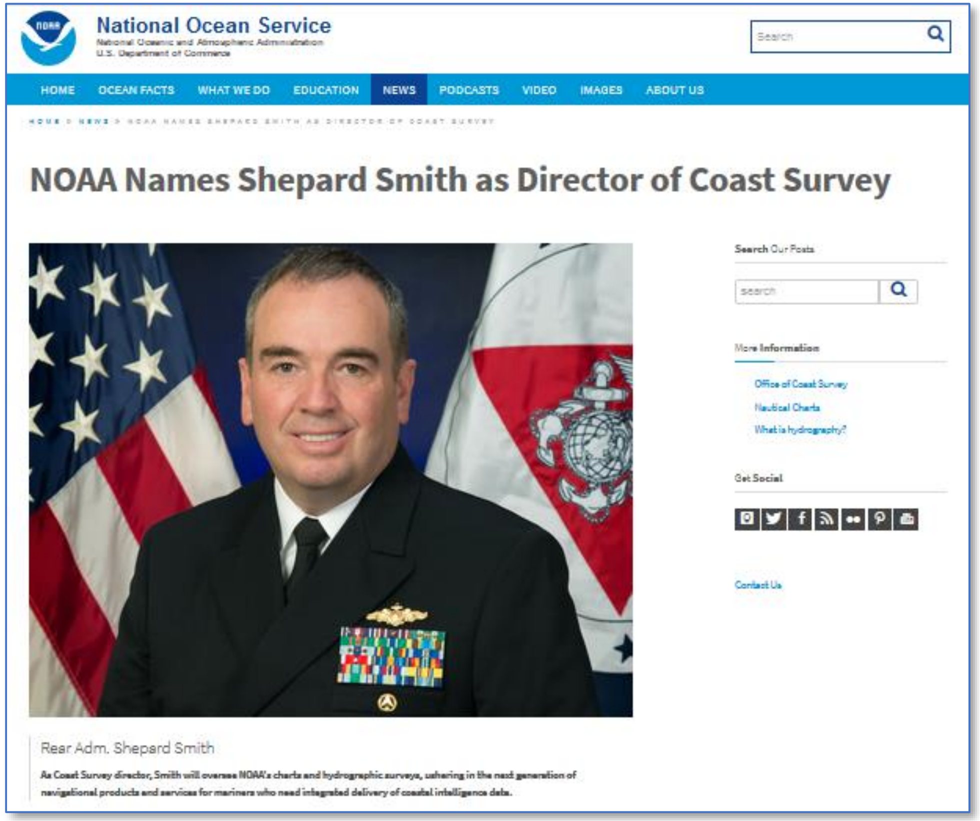
Canberra, June 18-20 2019

BAG



The **B**athymetric
Attributed **G**rid format

ORIGIN



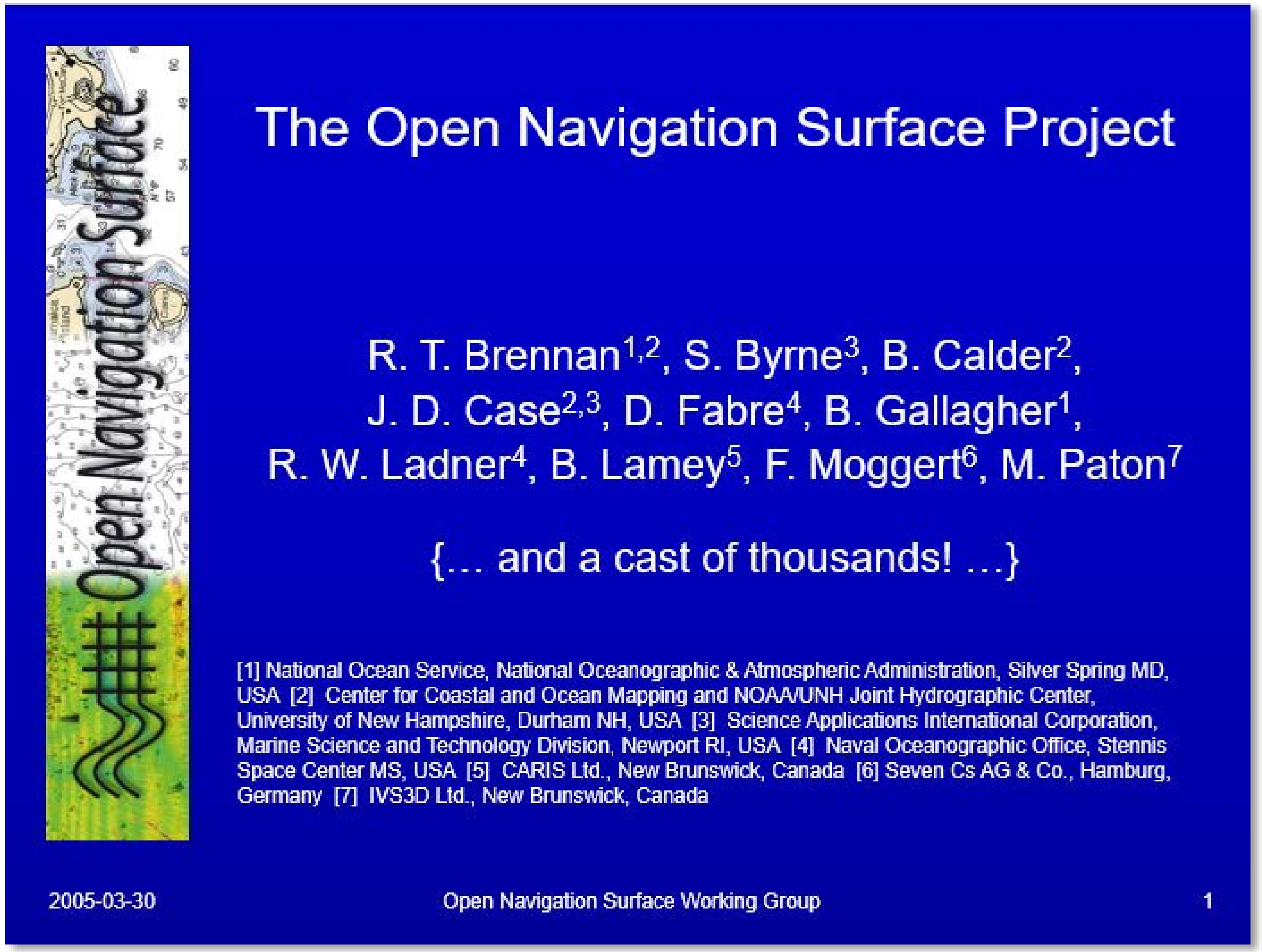
- S.M. Smith, [*"The Navigation Surface: A Multipurpose Bathymetric Database"*](), MS thesis, University of New Hampshire, 2003.

History

- 2004 – First workshop.
  - Initial specifications for the BAG format.

History

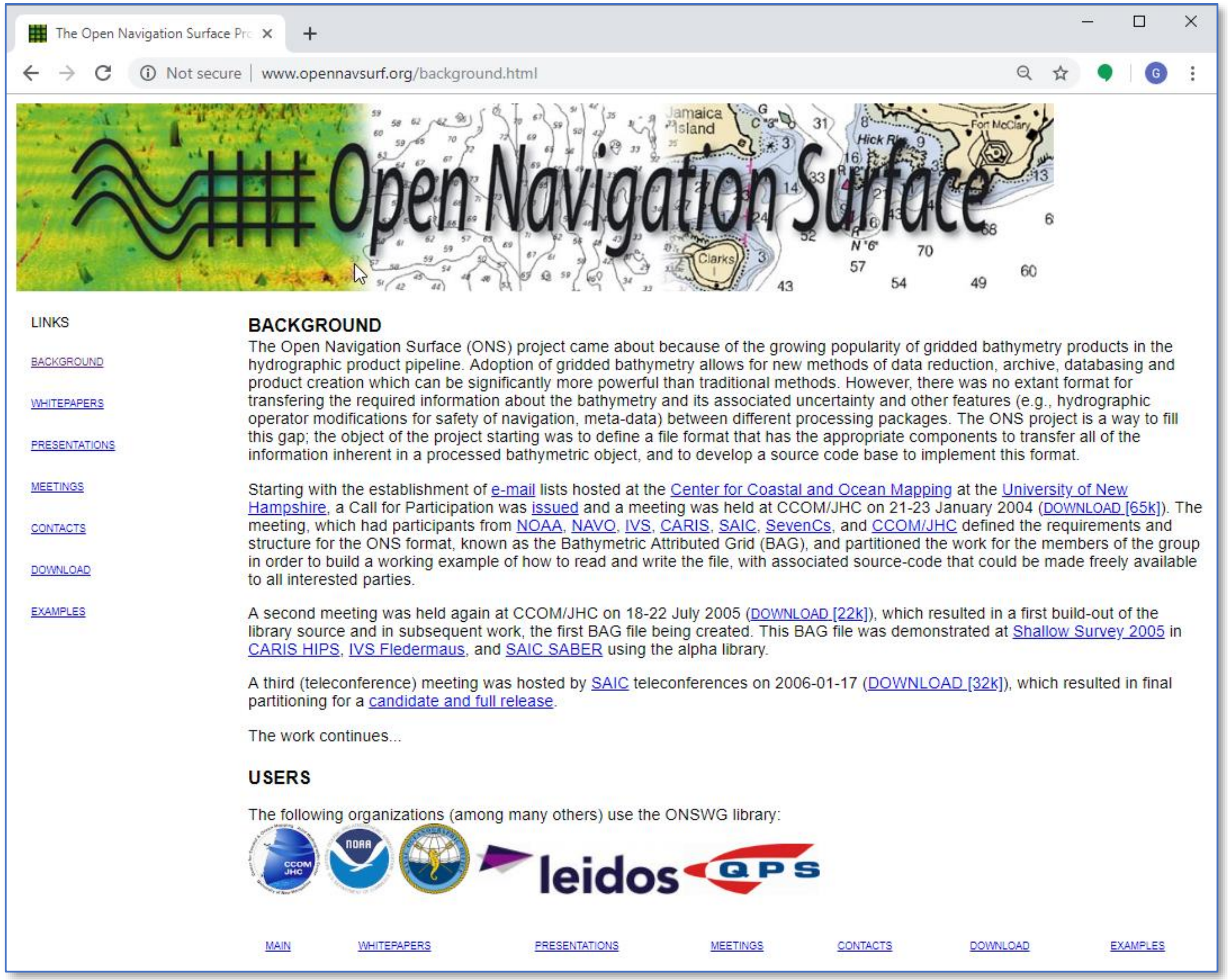
- 2005 – US Hydro Conference:



History

- **2006-04-07 – v.1.0.1: First release.**
- 2009 – v.1.1: Expanded XML metadata and optional datasets.
- 2009 – v.1.2: Nominal Depth as depth correction type (NAVOCEANO).
- 2011 – v.1.4: Added compression.
- 2012 – v.1.5: New XML Schema to follow current ISO standards.
- 2013 – v.1.5.1: Added node and elevation solution groups (SAIC).
- **2016-07-05 – v.1.6: Added support for variable resolution grids.**

PRESENT


The Open Navigation Surface Pr
Not secure | www.opennavsurf.org/background.html

Open Navigation Surface

LINKS

BACKGROUND

WHITEPAPERS

PRESENTATIONS

MEETINGS

CONTACTS

DOWNLOAD

EXAMPLES

BACKGROUND

The Open Navigation Surface (ONS) project came about because of the growing popularity of gridded bathymetry products in the hydrographic product pipeline. Adoption of gridded bathymetry allows for new methods of data reduction, archive, databasing and product creation which can be significantly more powerful than traditional methods. However, there was no extant format for transfering the required information about the bathymetry and its associated uncertainty and other features (e.g., hydrographic operator modifications for safety of navigation, meta-data) between different processing packages. The ONS project is a way to fill this gap; the object of the project starting was to define a file format that has the appropriate components to transfer all of the information inherent in a processed bathymetric object, and to develop a source code base to implement this format.

Starting with the establishment of e-mail lists hosted at the Center for Coastal and Ocean Mapping at the University of New Hampshire, a Call for Participation was issued and a meeting was held at CCOM/JHC on 21-23 January 2004 (DOWNLOAD [65k]). The meeting, which had participants from NOAA, NAVO, IVS, CARIS, SAIC, SevenCs, and CCOM/JHC defined the requirements and structure for the ONS format, known as the Bathymetric Attributed Grid (BAG), and partitioned the work for the members of the group in order to build a working example of how to read and write the file, with associated source-code that could be made freely available to all interested parties.

A second meeting was held again at CCOM/JHC on 18-22 July 2005 (DOWNLOAD [22k]), which resulted in a first build-out of the library source and in subsequent work, the first BAG file being created. This BAG file was demonstrated at Shallow Survey 2005 in CARIS HIPS, IVS Fledermaus, and SAIC SABER using the alpha library.

A third (teleconference) meeting was hosted by SAIC teleconferences on 2006-01-17 (DOWNLOAD [32k]), which resulted in final partitioning for a candidate and full release.

The work continues...

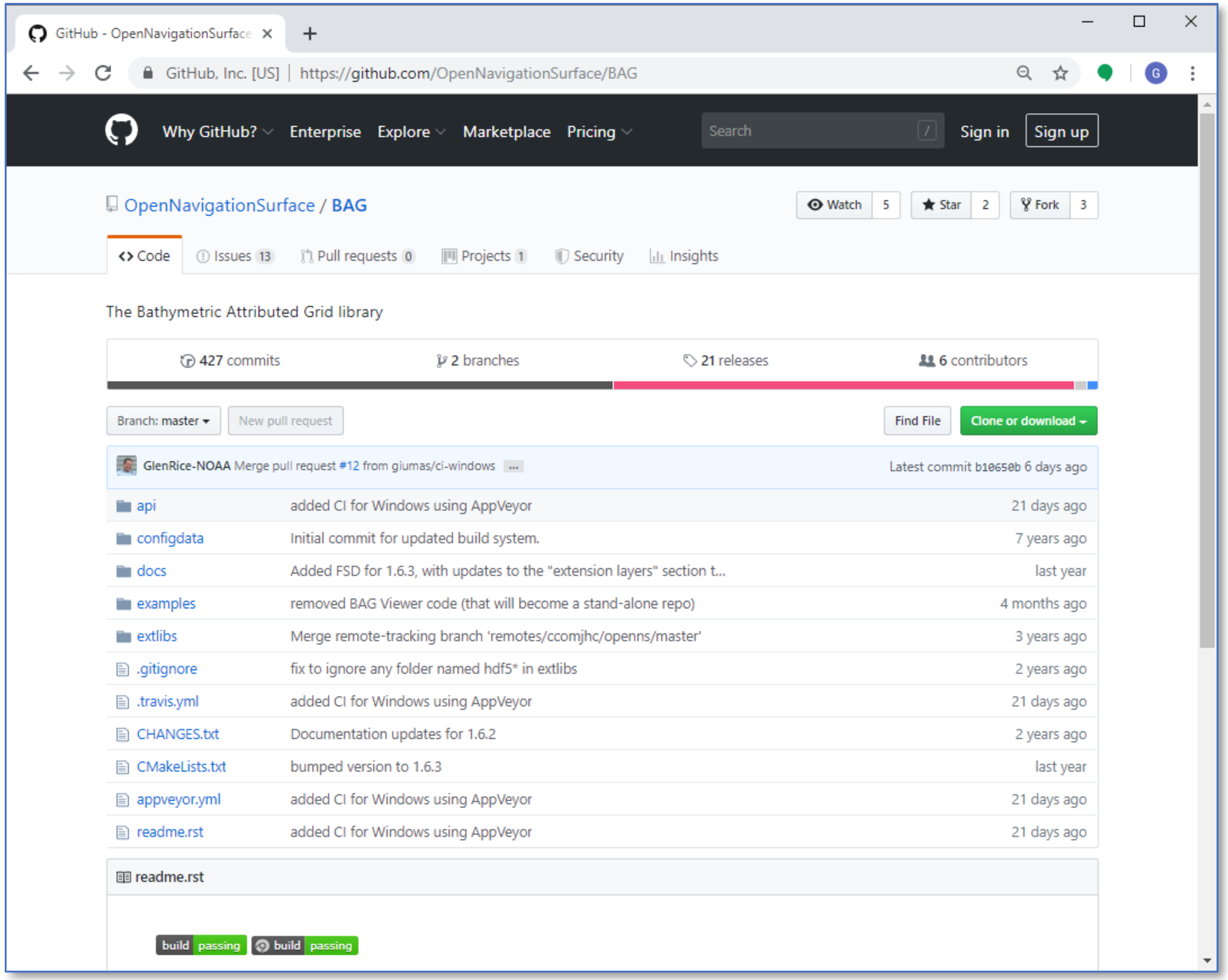
USERS

The following organizations (among many others) use the ONSWG library:

CCOM JHC NOAA leidos QPS

MAIN WHITEPAPERS PRESENTATIONS MEETINGS CONTACTS DOWNLOAD EXAMPLES

Present



- Current Release: 1.6.4 (May 5, 2018)

Format Specification Document

Open Navigation Surface

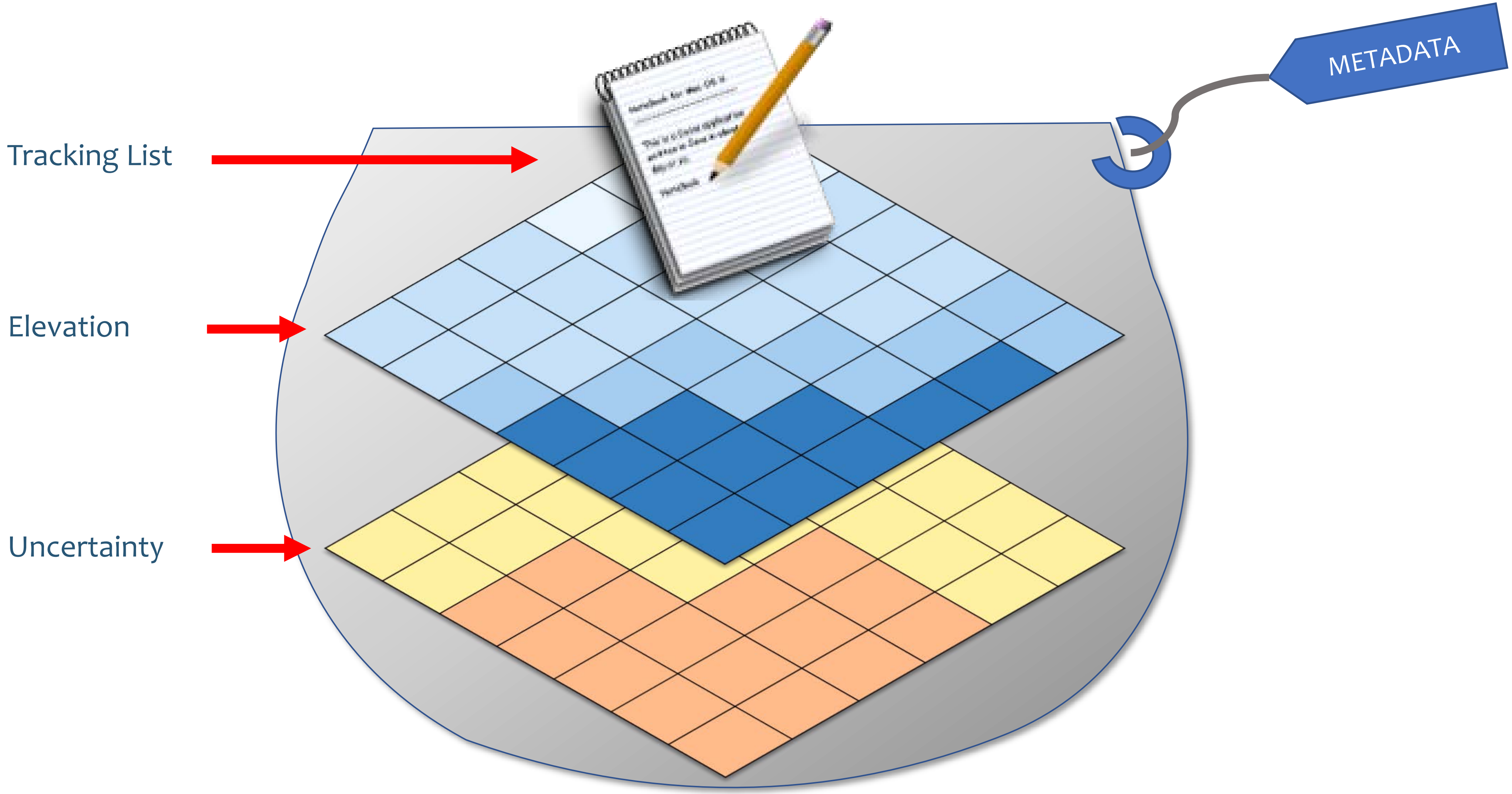
Format Specification Document

Description of Bathymetric Attributed Grid Object (BAG)
Version 1.6

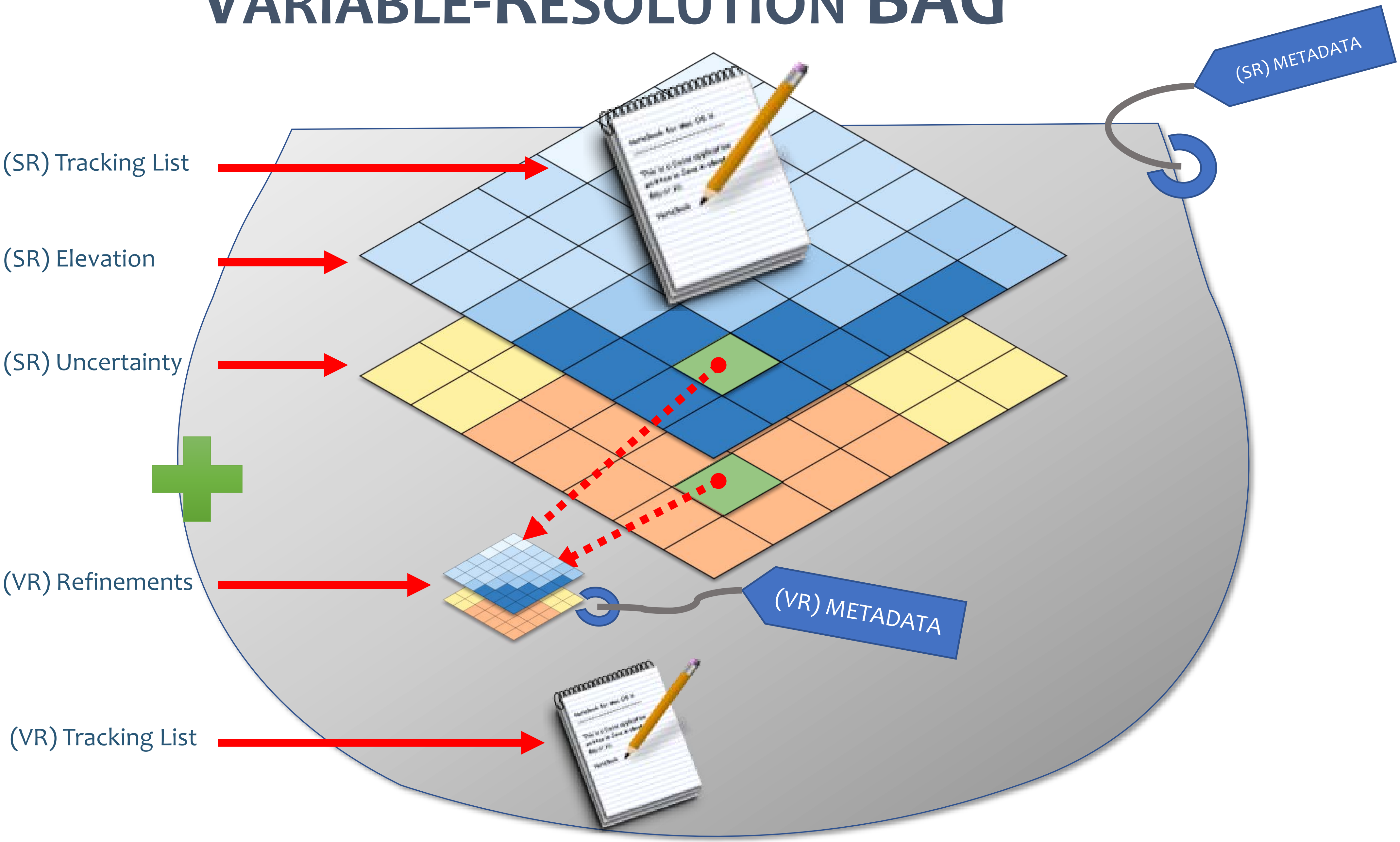
Document Version
RELEASE 1.6.3

by
Open Navigation Surface Working Group
(ONSWG)

SINGLE-RESOLUTION BAG



VARIABLE-RESOLUTION BAG



ELEVATION LAYER

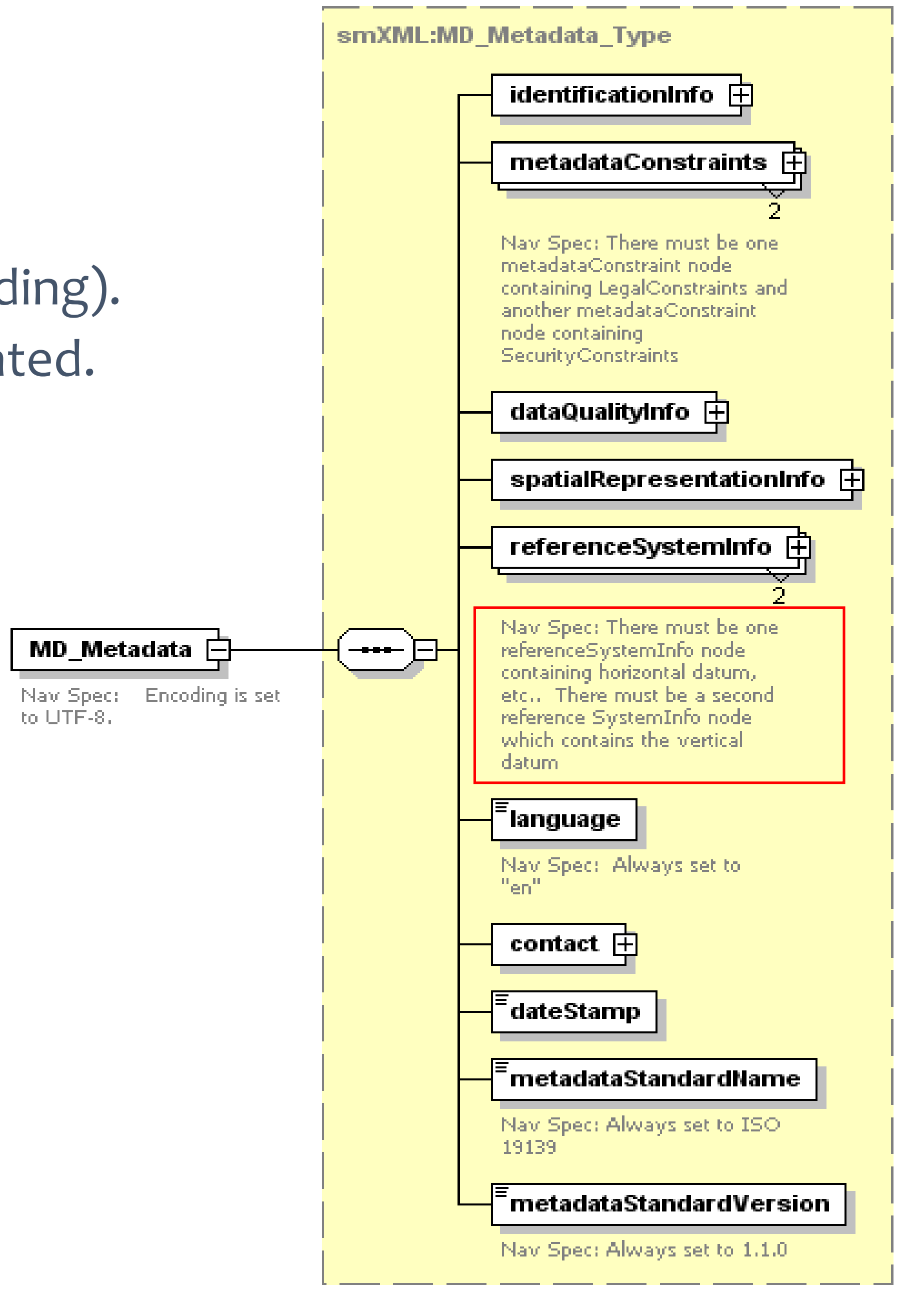
- Each value defines elevation at an exactly specified geographic point.
- The metadata provides the description of the *depth correction type*:
    - True depth, corrected for sound speed.
    - Nominal depth at assumed sound speed of 1,500 m/s.
    - Nominal depth at assumed sound speed of 4,800 ft/s.
    - Corrected depth using Carter’s tables.
    - Corrected depth using Matthew’s tables.
    - Unknown depth correction type of mixture of above types.

UNCERTAINTY LAYER

- Co-aligned with the elevation layer.
- The metadata provides the description of the *uncertainty type*:
  - Unknown
  - Raw standard deviation of soundings that contributed to the node.
  - Standard deviation of soundings captured by a CUBE hypothesis.
  - NOAA standard product uncertainty V1.0 (a blend of CUBE uncertainty and other measures).
  - Estimated standard deviation based on historical/archive data.
  - Average of all of the contributing sounding TPEs within a node.

Metadata

- ISO 19115 (geospatial metadata) and ISO 19139 (XML encoding).
- Embedded in the BAG file to ensure that cannot be separated.
- Validated using Libxml2.



Metadata

Open issues:

- Many of the fields are free-text, and therefore open to interpretation.
- The current definition of S-102 has some changes to the metadata schema that require changes to the BAG file format to be compliant. However, by the defining document, S-102 should be compatible with BAG (rather than the other way round).

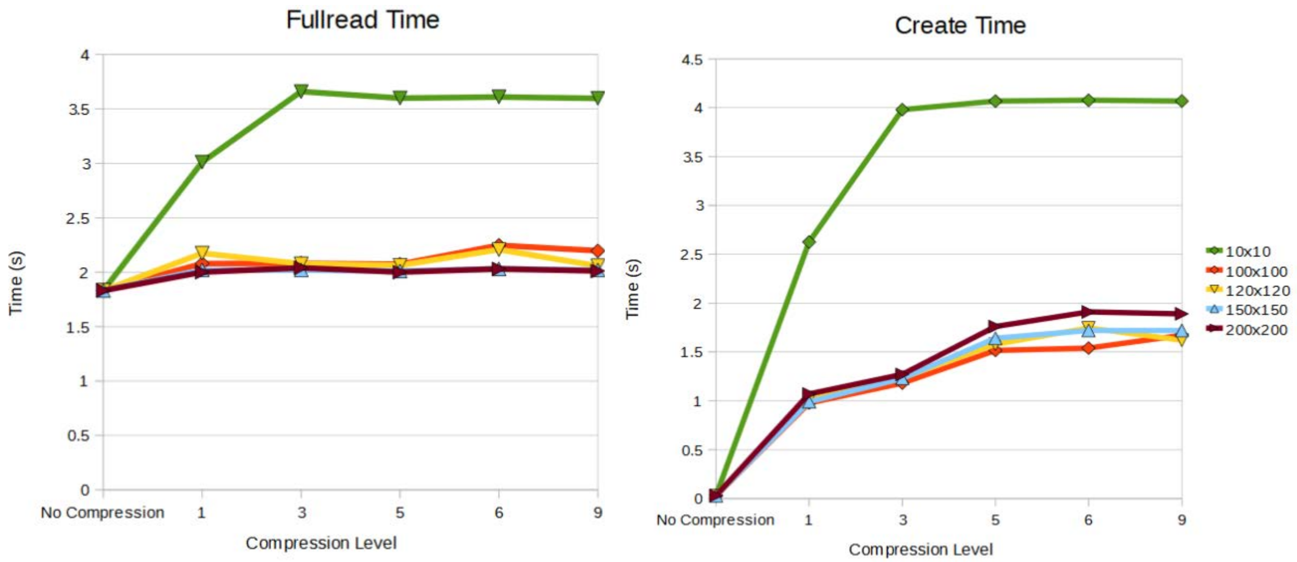
Tracking List

- Recording the original contents makes the base grid fail-safe.
- 6 column:
  - Row and column location of the node (2 uint32_ts).
  - Original depth and uncertainty (2 floats).
  - A reason code indicating why the modification was made (uint8_t).
  - An index number indicating the item in the metadata lineage (uint16_t).

```
/* some basic tracking list codes */
enum bagTrackCode
{
    bagManualEdit,
    bagDesignatedSndg,
    bagRecubedSurfaces,
    bagDeleteNode
} ;
```

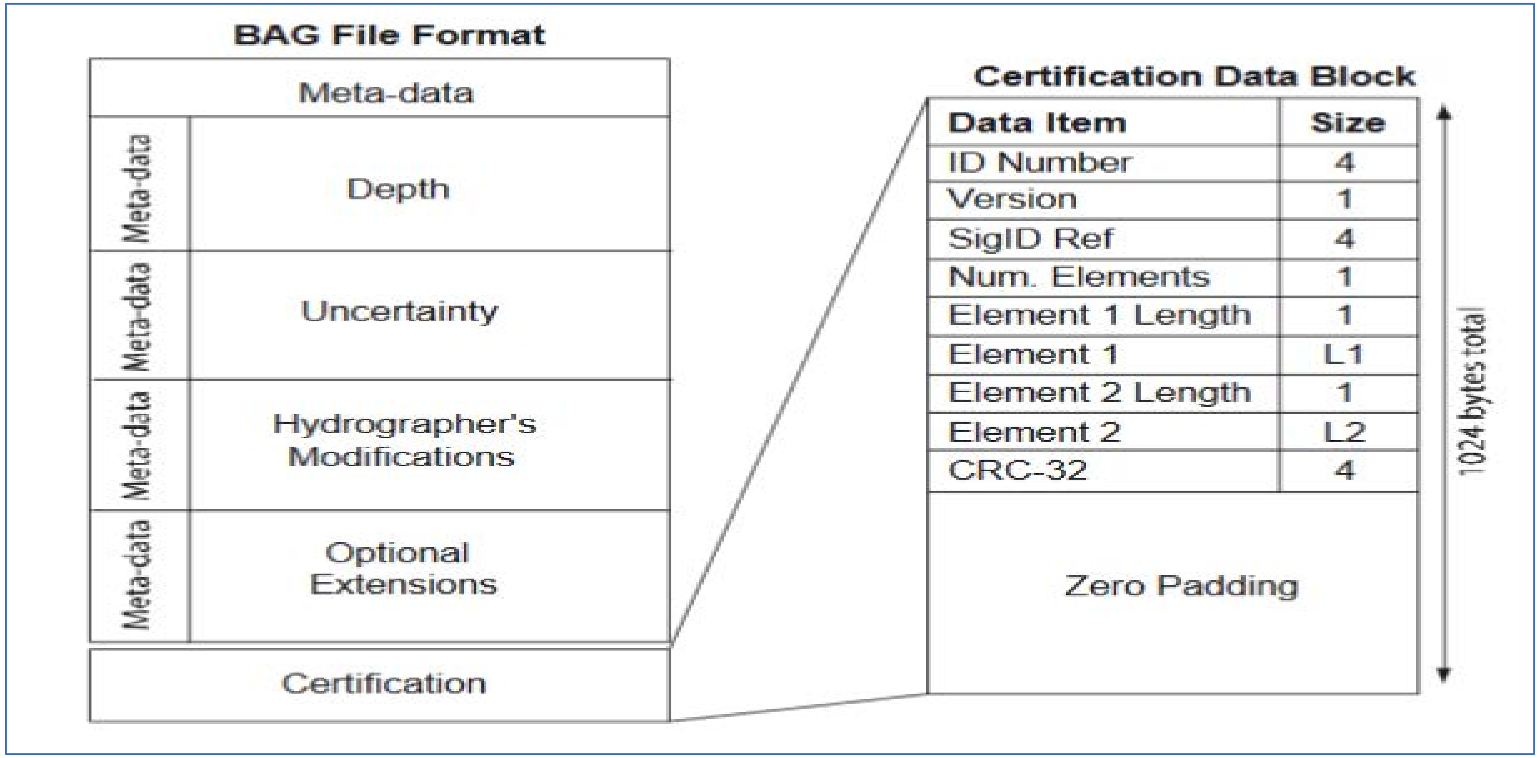
HDF5 Compression

- Two variables control the compression:
  - The *compression level* (0-9).
  - The *chunk size*, the atomic object on which the compression is executed.
- Variability between nearby nodes is typically low for hydrographic data sets.
- Default values after testing:
  - Chunk size: 100x100.
  - Compression level: 1



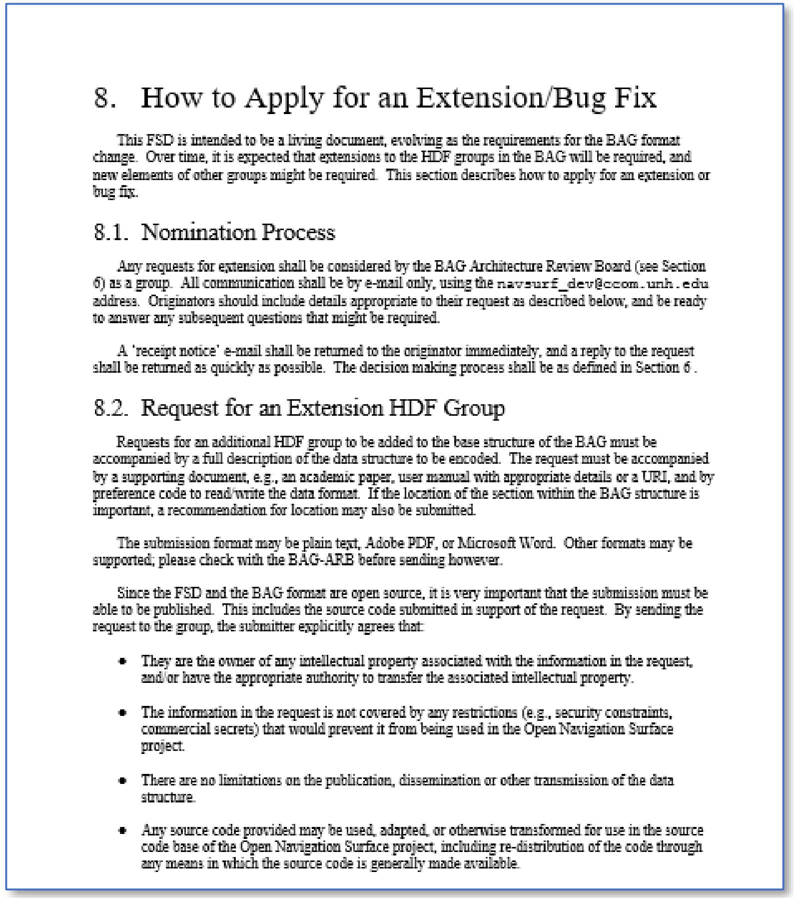
DIGITAL SIGNATURE (OPTIONAL)

- A section of fixed length at the end of a BAG file.
- Implemented using BeeCrypt library for FIPS DSS 186-2.



ARCHITECTURE BOARD

- The board is composed of members of the ONSWG.
- It coordinates bug-reports, change requests, and new features.



8. How to Apply for an Extension/Bug Fix

This FSD is intended to be a living document, evolving as the requirements for the BAG format change. Over time, it is expected that extensions to the HDF groups in the BAG will be required, and new elements of other groups might be required. This section describes how to apply for an extension or bug fix.

8.1. Nomination Process

Any requests for extension shall be considered by the BAG Architecture Review Board (see Section 6) as a group. All communication shall be by e-mail only, using the `navsurf_dev@ccom.unh.edu` address. Originators should include details appropriate to their request as described below, and be ready to answer any subsequent questions that might be required.

A 'receipt notice' e-mail shall be returned to the originator immediately, and a reply to the request shall be returned as quickly as possible. The decision making process shall be as defined in Section 6 .

8.2. Request for an Extension HDF Group

Requests for an additional HDF group to be added to the base structure of the BAG must be accompanied by a full description of the data structure to be encoded. The request must be accompanied by a supporting document, e.g., an academic paper, user manual with appropriate details or a URI, and by preference code to read/write the data format. If the location of the section within the BAG structure is important, a recommendation for location may also be submitted.

The submission format may be plain text, Adobe PDF, or Microsoft Word. Other formats may be supported; please check with the BAG-ARB before sending however.

Since the FSD and the BAG format are open source, it is very important that the submission must be able to be published. This includes the source code submitted in support of the request. By sending the request to the group, the submitter explicitly agrees that:

- They are the owner of any intellectual property associated with the information in the request, and/or have the appropriate authority to transfer the associated intellectual property.
- The information in the request is not covered by any restrictions (e.g., security constraints, commercial secrets) that would prevent it from being used in the Open Navigation Surface project.
- There are no limitations on the publication, dissemination or other transmission of the data structure.
- Any source code provided may be used, adapted, or otherwise transformed for use in the source code base of the Open Navigation Surface project, including re-distribution of the code through any means in which the source code is generally made available.

License

*The Open Navigation Surface is **free software**.*

There are no restrictions on use or adaptation of the source code, although we would prefer if you contributed modifications, extensions and bug-fixes back to the project rather than releasing a (potentially incompatible) version of your own.

The software comes with no warranty, express or implied, as to fitness for any purpose. That is, the code is provided for your convenience, and you agree by downloading the code distribution that the Open Navigation Surface Working Group and its members are not responsible for any loss or damage, of whatever kind, that may be caused to you by the use of this software, or by you because of your use of this software.

Tools

- BAG Viewer, basic Qt OpenGL viewer.
- BAG Explorer, a plugin of HDF Compass.
- Any HDF5-aware tool (e.g., HDF Compass, HDF View).

FUTURE

Enumerated Value	Description
Unknown	"Unknown" - The uncertainty layer is an unknown type
Raw_Std_Dev	"Raw Standard Deviation" - Raw standard deviation of soundings that contributed to the node
CUBE_Std_Dev	"CUBE Standard Deviation " - Standard deviation of soundings captured by a CUBE hypothesis (i.e., CUBE's standard output of uncertainty)
Product_Uncert	"Product Uncertainty" - NOAA standard product uncertainty V1.0 (a blend of CUBE uncertainty and other measures).
Historical_Std_Dev	"Historical Standard Deviation " – Estimated standard deviation based on historical/archive data.

Table 1: TABLE OF UNCERTAINTY TYPES

- Fix issue with *Product Uncertainty Description*:
  - *CARIS standard uncertainty*. Larger of CUBE's uncertainty output and the standard deviation of all soundings in a bin around the node, reported at 95% CI assuming Gaussian statistics.
  - *Leidos standard uncertainty*. Larger of CUBE's uncertainty output and the average vertical uncertainty of all of the soundings that make up the primary hypothesis in CUBE, reported at 95% CI assuming Gaussian statistics.
  - *Generalized standard uncertainty*. Uncertainty derived from geostatistical estimation or other methods, described with a statement in the metadata.

FUTURE

- Fix issue with geo-referencing:
  - WKT geo-referencing convention:
    - *EPSG 9606* (adopted solution).
    - *EPSG 9607*.
  - Conflicting metadata information:
    - South-west and northeast bounding corners.
    - Sample spacing.
    - Number of rows/columns.

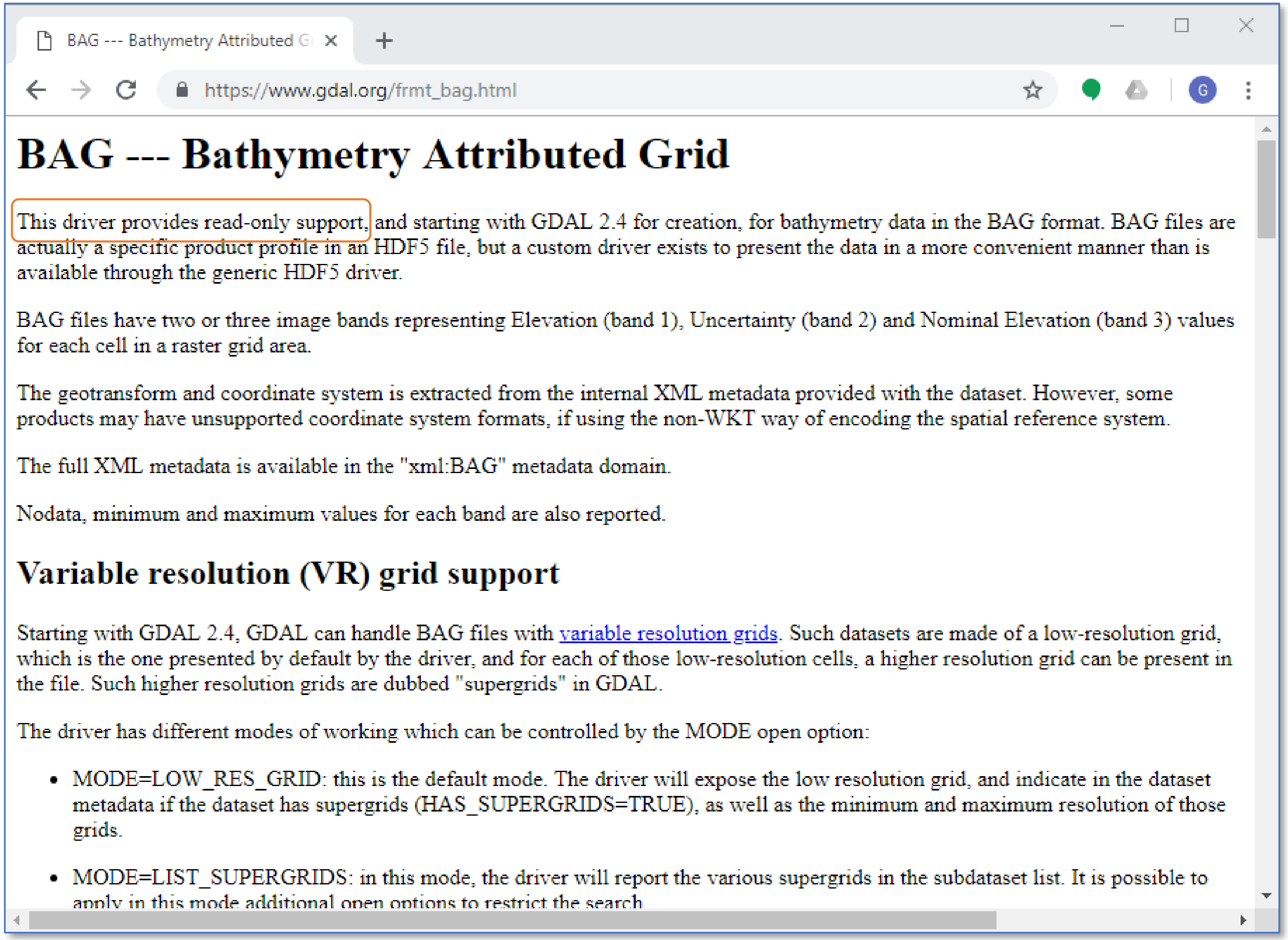
```xml
<gmd:numberOfDimensions>
<gmd:axisDimensionProperties>
  <gmd:MD_Dimension>
    <gmd:dimensionName>
    <gmd:dimensionSize>
      <gco:Integer>10</gco:Integer>
    </gmd:dimensionSize>
    <gmd:resolution>
      <gco:Measure uom="Metres">110</gco:Measure>
    </gmd:resolution>
  </gmd:MD_Dimension>
</gmd:axisDimensionProperties>
<gmd:axisDimensionProperties>
  <gmd:MD_Dimension>
    <gmd:dimensionName>
    <gmd:dimensionSize>
      <gco:Integer>11</gco:Integer>
    </gmd:dimensionSize>
    <gmd:resolution>
      <gco:Measure uom="Metres">110</gco:Measure>
    </gmd:resolution>
  </gmd:MD_Dimension>
</gmd:axisDimensionProperties>
<gmd:cellGeometry>
<gmd:transformationParameterAvailability>
<gmd:checkPointAvailability>
<gmd:cornerPoints>
  <gml:Point gml:id="id1">
    <gml:coordinates decimal="." cs="," ts=" ">629420.000000000000,1081410.000000000000 630630.000000000000,1082510.000000000000</gml:coordinates>
  </gml:Point>
</gmd:cornerPoints>
<gmd:pointInPixel>
  <gmd:MD_PixelOrientationCode>center</gmd:MD_PixelOrientationCode>
</gmd:pointInPixel>
```

IHO S-102
Bathymetric Surface Product Specification

Table 5 - Code defining how uncertainty was determined

Value	Definition
Unknown	"Unknown" - The uncertainty layer is an unknown type
Raw_Std_Dev	"Raw Standard Deviation" - Raw standard deviation of soundings that contributed to the node.
CUBE_Std_Dev	Dev "CUBE Standard Deviation " - Standard deviation of soundings captured by a CUBE hypothesis (i.e., CUBE's standard output of uncertainty)
Product_Uncert	"Product Uncertainty" - NOAA standard product uncertainty V1.0 (a blend of CUBE uncertainty and other measures).
Historical_Std_Dev	"Historical Standard Deviation " – Estimated standard deviation based on historical/archive data.

GDAL → Current Limitations



BAG --- Bathymetry Attributed Grid

This driver provides read-only support, and starting with GDAL 2.4 for creation, for bathymetry data in the BAG format. BAG files are actually a specific product profile in an HDF5 file, but a custom driver exists to present the data in a more convenient manner than is available through the generic HDF5 driver.

BAG files have two or three image bands representing Elevation (band 1), Uncertainty (band 2) and Nominal Elevation (band 3) values for each cell in a raster grid area.

The geotransform and coordinate system is extracted from the internal XML metadata provided with the dataset. However, some products may have unsupported coordinate system formats, if using the non-WKT way of encoding the spatial reference system.

The full XML metadata is available in the "xml:BAG" metadata domain.

Nodata, minimum and maximum values for each band are also reported.

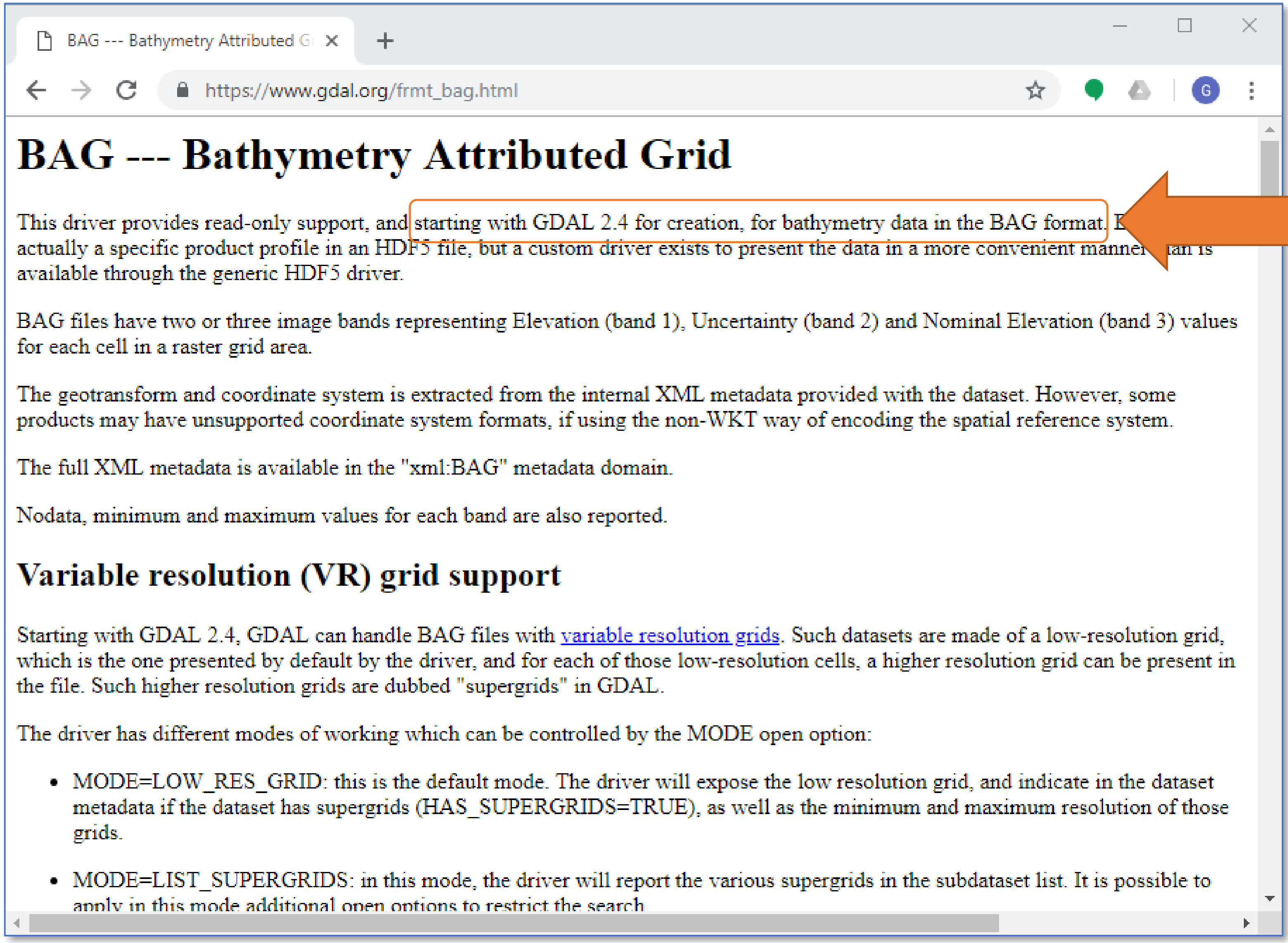
Variable resolution (VR) grid support

Starting with GDAL 2.4, GDAL can handle BAG files with variable resolution grids. Such datasets are made of a low-resolution grid, which is the one presented by default by the driver, and for each of those low-resolution cells, a higher resolution grid can be present in the file. Such higher resolution grids are dubbed "supergrids" in GDAL.

The driver has different modes of working which can be controlled by the MODE open option:

- MODE=LOW_RES_GRID: this is the default mode. The driver will expose the low resolution grid, and indicate in the dataset metadata if the dataset has supergrids (HAS_SUPERGRIDS=TRUE), as well as the minimum and maximum resolution of those grids.
- MODE=LIST_SUPERGRIDS: in this mode, the driver will report the various supergrids in the subdataset list. It is possible to apply in this mode additional open options to restrict the search

GDAL → Write Support



BAG --- Bathymetry Attributed G

https://www.gdal.org/frmt_bag.html

BAG --- Bathymetry Attributed Grid

This driver provides read-only support, and starting with GDAL 2.4 for creation, for bathymetry data in the BAG format. B actually a specific product profile in an HDF5 file, but a custom driver exists to present the data in a more convenient manner than is available through the generic HDF5 driver.

BAG files have two or three image bands representing Elevation (band 1), Uncertainty (band 2) and Nominal Elevation (band 3) values for each cell in a raster grid area.

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Nodata, minimum and maximum values for each band are also reported.

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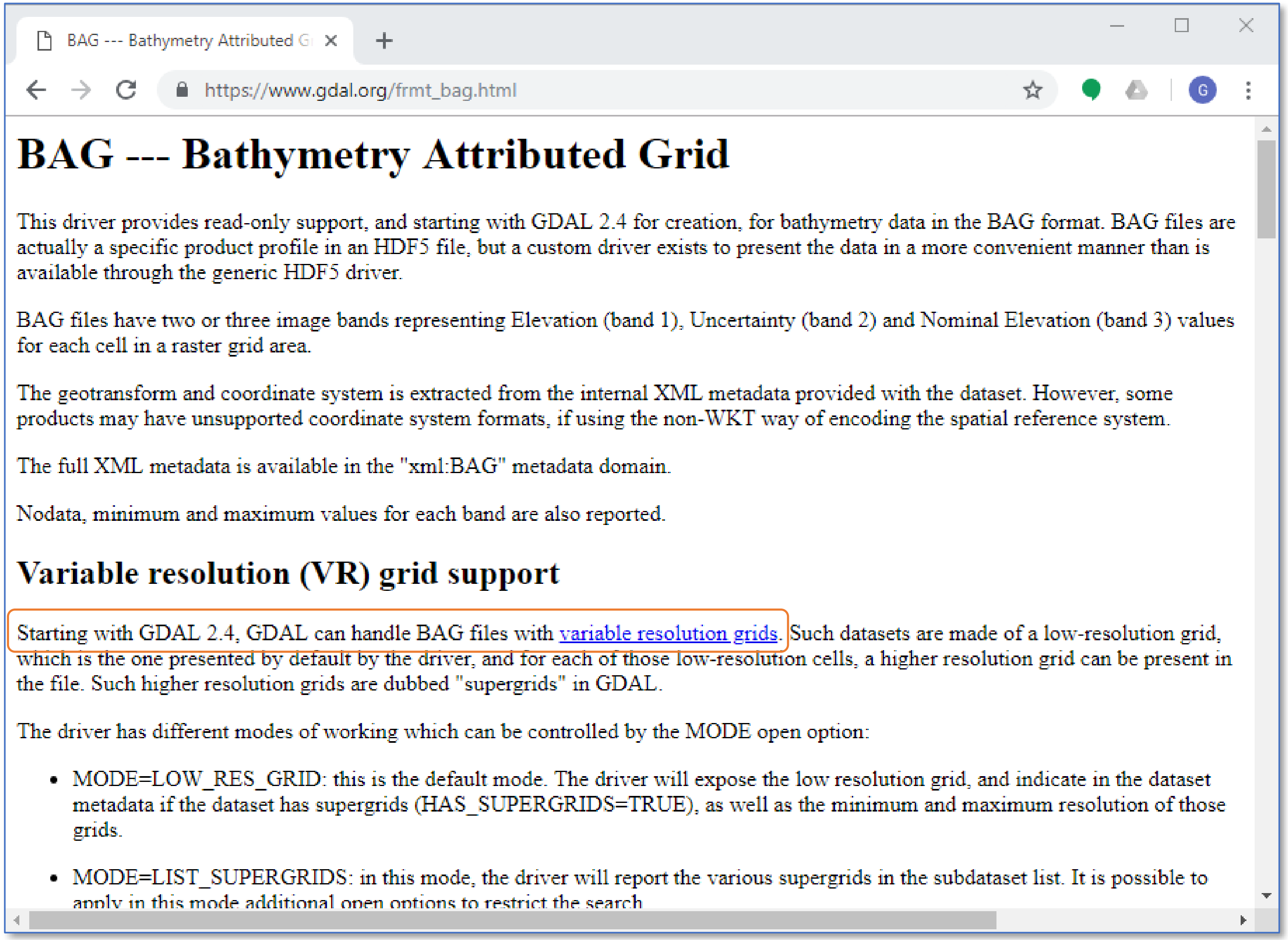
Spring 2019

GDAL → VR SUPPORT



BAG --- Bathymetry Attributed G

https://www.gdal.org/frmt_bag.html

BAG --- Bathymetry Attributed Grid

This driver provides read-only support, and starting with GDAL 2.4 for creation, for bathymetry data in the BAG format. BAG files are actually a specific product profile in an HDF5 file, but a custom driver exists to present the data in a more convenient manner than is available through the generic HDF5 driver.

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The full XML metadata is available in the "xml:BAG" metadata domain.

Nodata, minimum and maximum values for each band are also reported.

Variable resolution (VR) grid support

Starting with GDAL 2.4, GDAL can handle BAG files with variable resolution grids. Such datasets are made of a low-resolution grid, which is the one presented by default by the driver, and for each of those low-resolution cells, a higher resolution grid can be present in the file. Such higher resolution grids are dubbed "supergrids" in GDAL.

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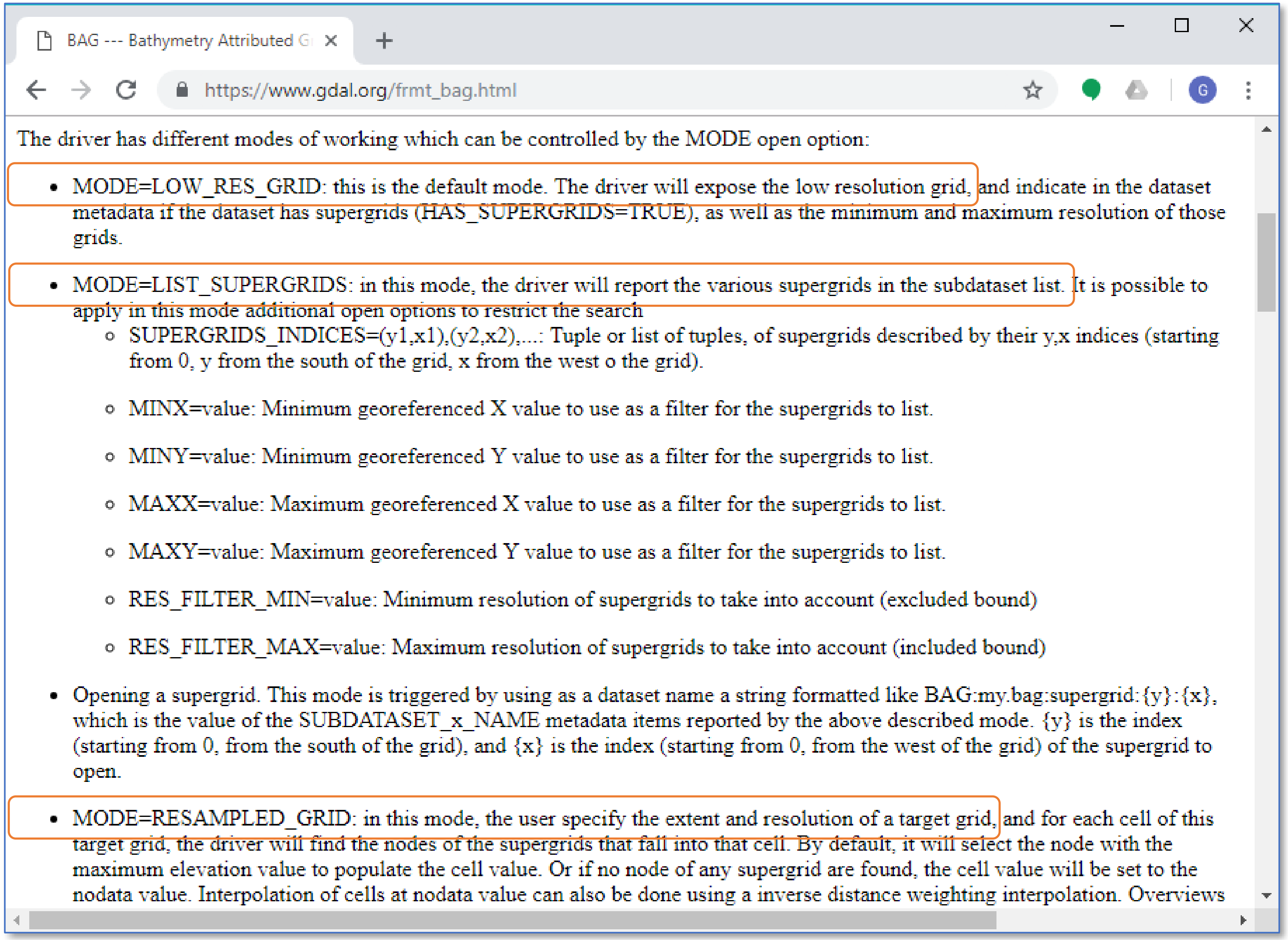
GDAL → VR SUPPORT



BAG --- Bathymetry Attributed G

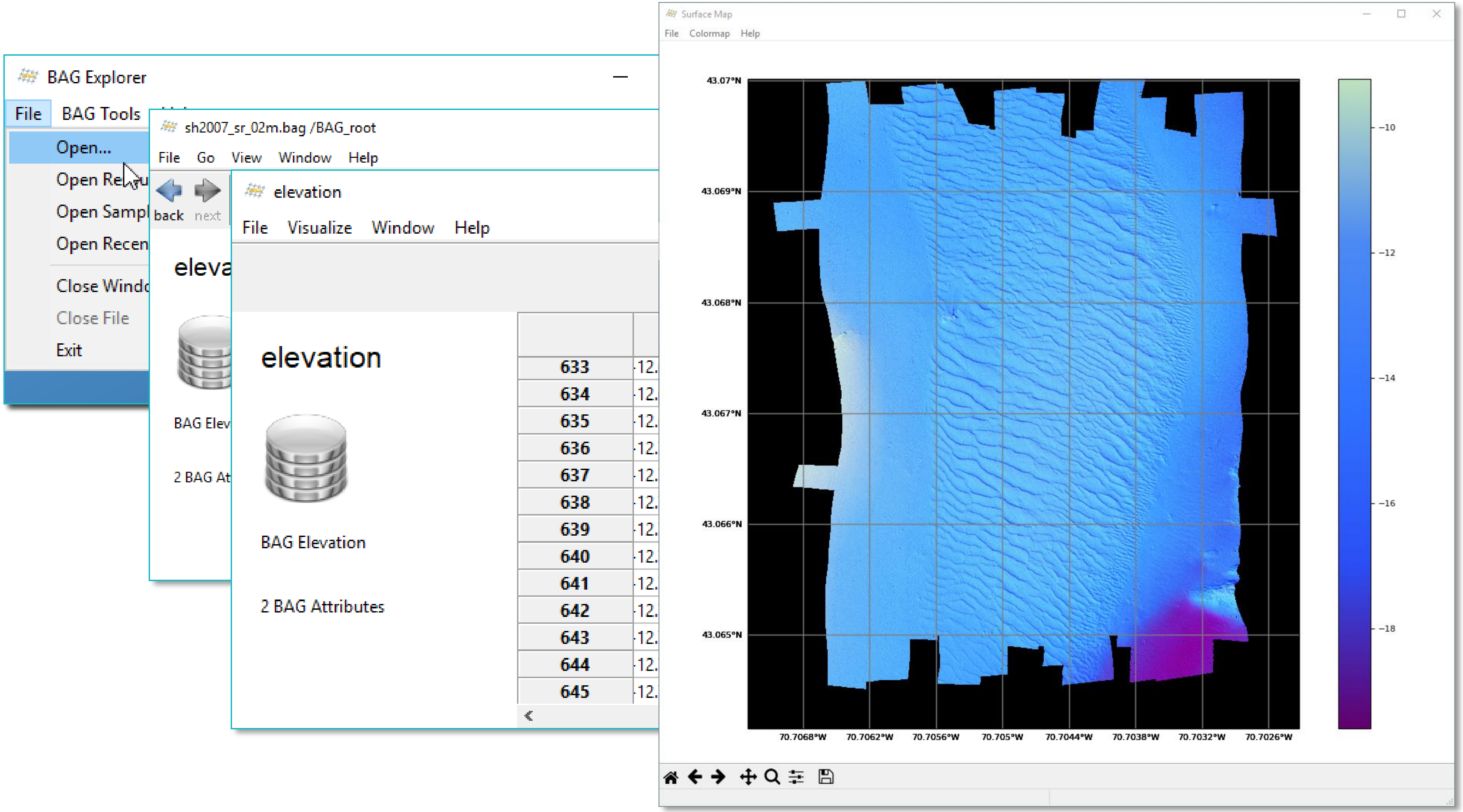
https://www.gdal.org/frmt_bag.html

The driver has different modes of working which can be controlled by the MODE open option:

- MODE=LOW_RES_GRID: this is the default mode. The driver will expose the low resolution grid, and indicate in the dataset metadata if the dataset has supergrids (HAS_SUPERGRIDS=TRUE), as well as the minimum and maximum resolution of those grids.
- MODE=LIST_SUPERGRIDS: in this mode, the driver will report the various supergrids in the subdataset list. It is possible to apply in this mode additional open options to restrict the search
  - SUPERGRIDS_INDICES=(y1,x1),(y2,x2),...: Tuple or list of tuples, of supergrids described by their y,x indices (starting from 0, y from the south of the grid, x from the west o the grid).
  - MINX=value: Minimum georeferenced X value to use as a filter for the supergrids to list.
  - MINY=value: Minimum georeferenced Y value to use as a filter for the supergrids to list.
  - MAXX=value: Maximum georeferenced X value to use as a filter for the supergrids to list.
  - MAXY=value: Maximum georeferenced Y value to use as a filter for the supergrids to list.
  - RES_FILTER_MIN=value: Minimum resolution of supergrids to take into account (excluded bound)
  - RES_FILTER_MAX=value: Maximum resolution of supergrids to take into account (included bound)
- Opening a supergrid. This mode is triggered by using as a dataset name a string formatted like BAG:my.bag:supergrid:{y}:{x}, which is the value of the SUBDATASET_x_NAME metadata items reported by the above described mode. {y} is the index (starting from 0, from the south of the grid), and {x} is the index (starting from 0, from the west of the grid) of the supergrid to open.
- MODE=RESAMPLED_GRID: in this mode, the user specify the extent and resolution of a target grid, and for each cell of this target grid, the driver will find the nodes of the supergrids that fall into that cell. By default, it will select the node with the maximum elevation value to populate the cell value. Or if no node of any supergrid are found, the cell value will be set to the nodata value. Interpolation of cells at nodata value can also be done using a inverse distance weighting interpolation. Overviews

BAG Explorer

A tool to explore the content of files in the **Bathymetric Attributed Grid** (BAG) format


BAG Explorer
File
BAG Tools
Open...
Open Re
Open Sampl
Open Recen
Close Windo
Close File
Exit
sh2007_sr_02m.bag /BAG_root
File Go View Window Help
back
next
eleva
BAG Elev
2 BAG At
elevation
File Visualize Window Help
elevation
BAG Elevation
2 BAG Attributes
633
634
635
636
637
638
639
640
641
642
643
644
645
Surface Map
File Colormap Help
43.07°N
43.069°N
43.068°N
43.067°N
43.066°N
43.065°N
70.7068°W
70.7062°W
70.7056°W
70.705°W
70.7044°W
70.7038°W
70.7032°W
70.7026°W
−10
−12
−14
−16
−18

BAG Explorer DEMO

www.hydroffice.org/bag

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

V0

Sound Speed Manager

G. Masetti & T. Faulkes

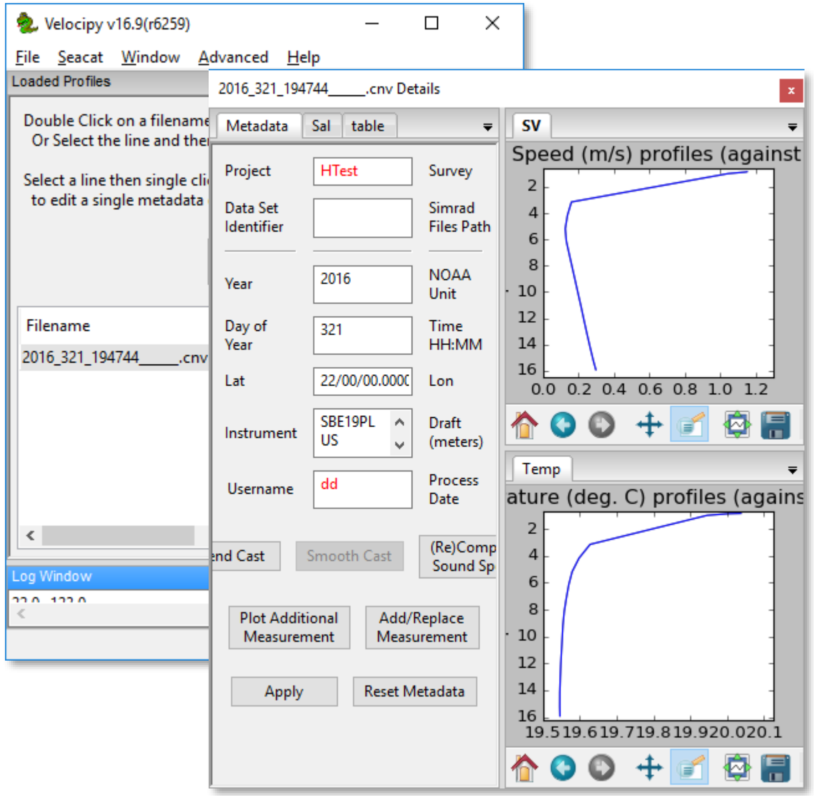
Canberra, June 18-20 2019

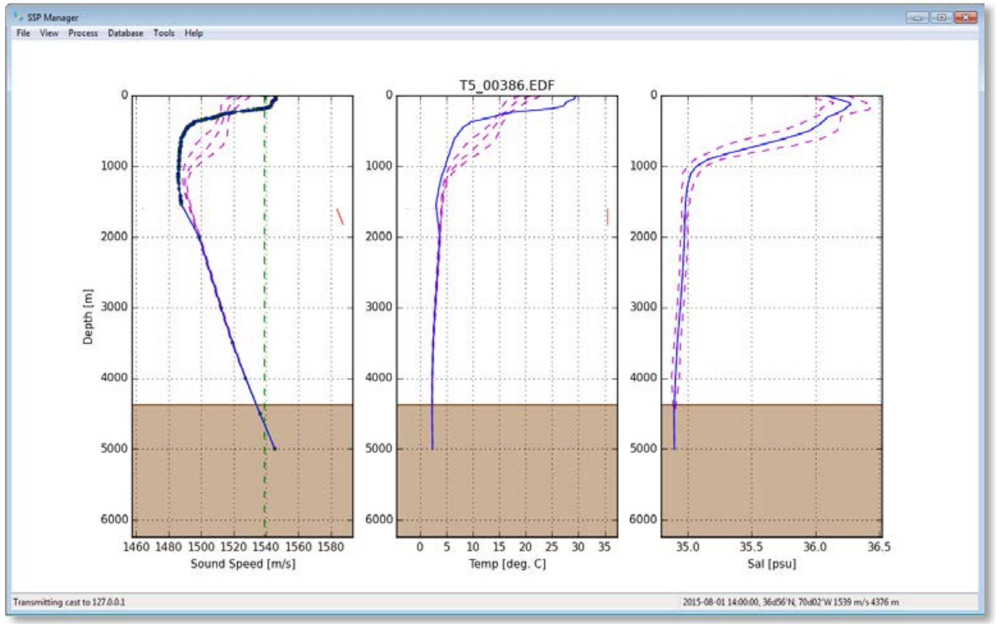
Sound Speed Manager

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

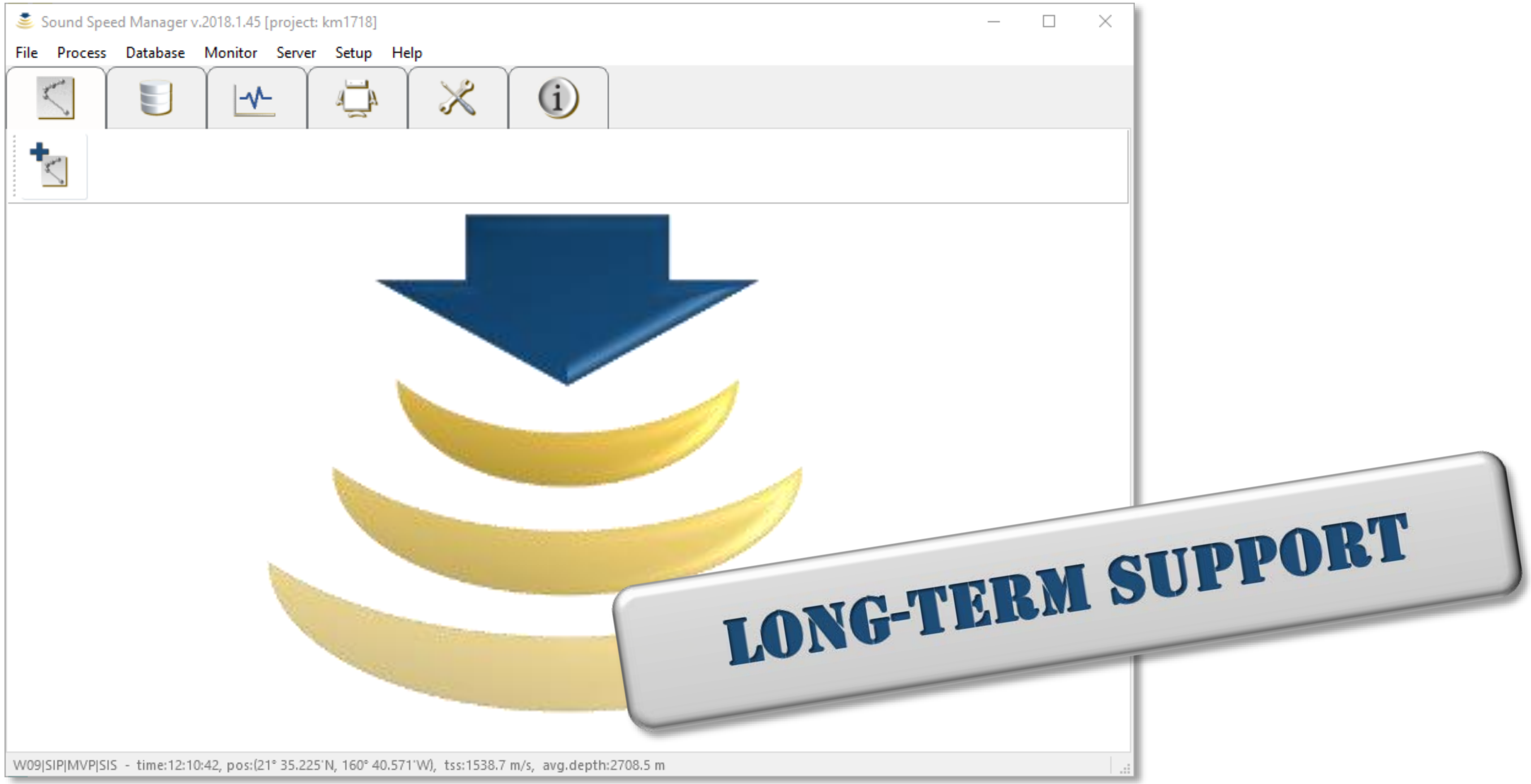
Ref.: Masetti, G. et al., *Sound Speed Manager: An open-source application to manage sound speed profiles*, International Hydrographic Review, vol. 17, pp. 31-40, 2017.

Collaborative Effort

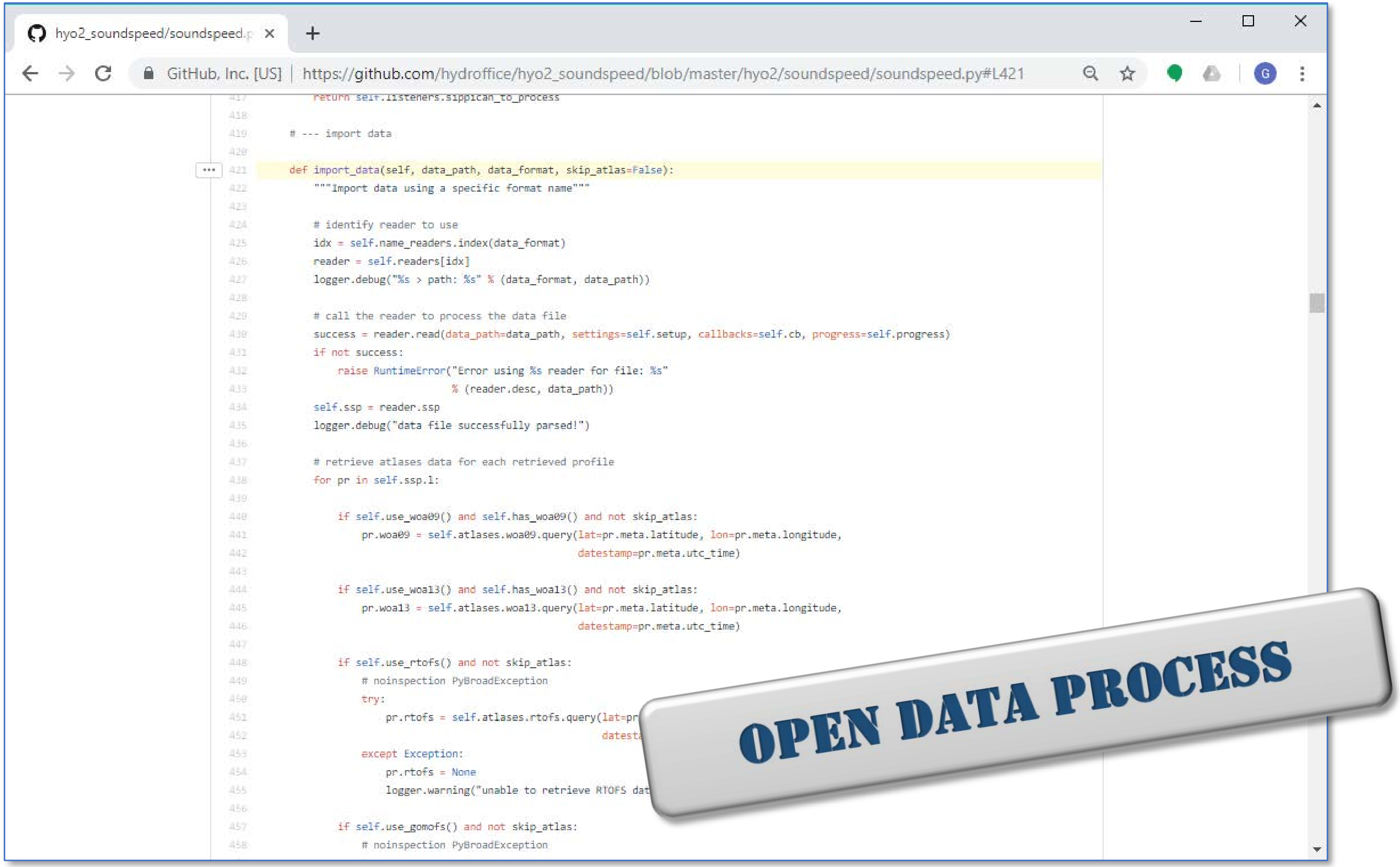




COLLABORATIVE EFFORT



OPEN SOURCE



hyo2_soundspeed/soundspeed.p
GitHub, Inc. [US]
https://github.com/hydroffice/hyo2_soundspeed/blob/master/hyo2/soundspeed/soundspeed.py#L421
# --- import data
def import_data(self, data_path, data_format, skip_atlas=False):
"""Import data using a specific format name"""
# identify reader to use
idx = self.name_readers.index(data_format)
reader = self.readers[idx]
logger.debug("%s > path: %s" % (data_format, data_path))
# call the reader to process the data file
success = reader.read(data_path=data_path, settings=self.setup, callbacks=self.cb, progress=self.progress)
if not success:
raise RuntimeError("Error using %s reader for file: %s"
% (reader.desc, data_path))
self.ssp = reader.ssp
logger.debug("data file successfully parsed!")
# retrieve atlases data for each retrieved profile
for pr in self.ssp.l:
if self.use_woa09() and self.has_woa09() and not skip_atlas:
pr.woa09 = self.atlases.woa09.query(lat=pr.meta.latitude, lon=pr.meta.longitude,
datestamp=pr.meta.utc_time)
if self.use_woa13() and self.has_woa13() and not skip_atlas:
pr.woa13 = self.atlases.woa13.query(lat=pr.meta.latitude, lon=pr.meta.longitude,
datestamp=pr.meta.utc_time)
if self.use_rtofs() and not skip_atlas:
# noinspection PyBroadException
try:
except Exception:
pr.rtofs = None
if self.use_gomofs() and not skip_atlas:
# noinspection PyBroadException
OPEN DATA PROCESS

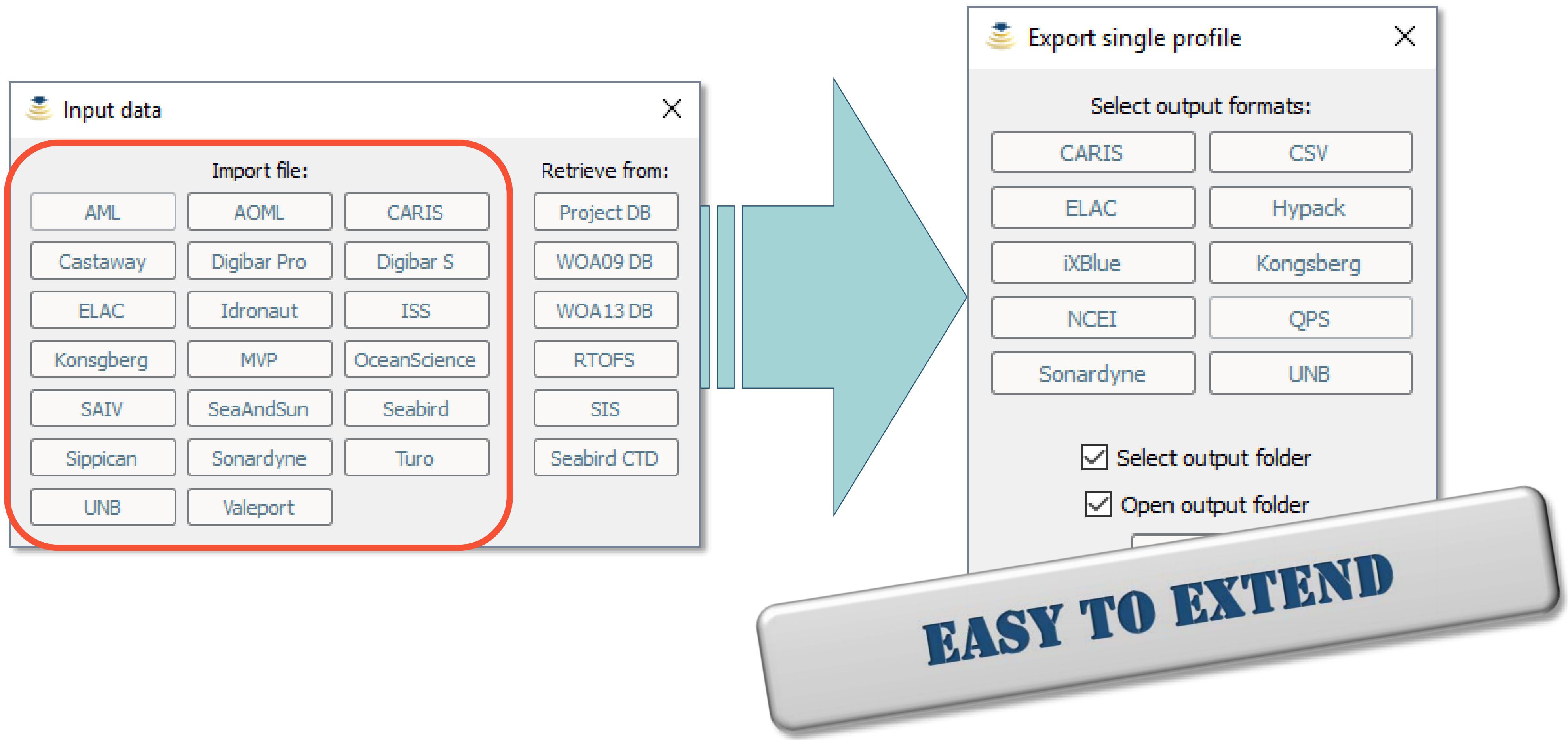
Liberal License

✓Support

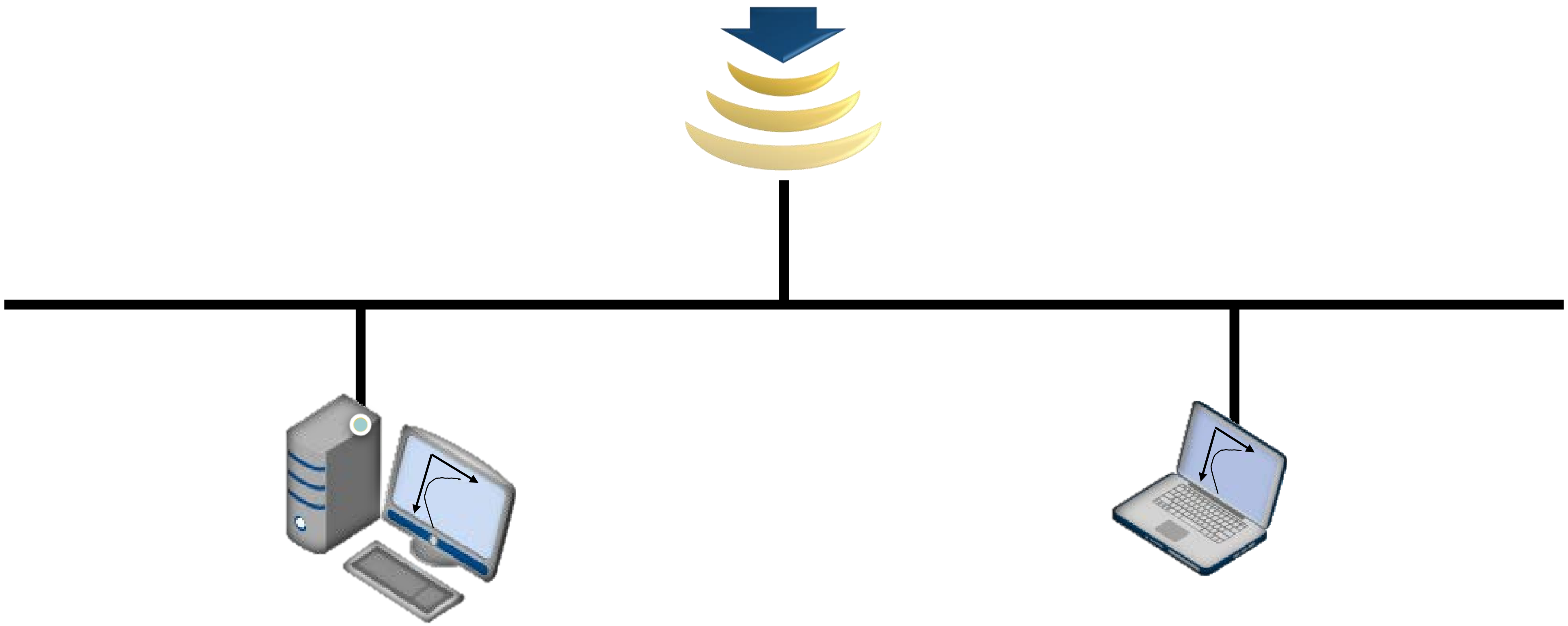
✓Open

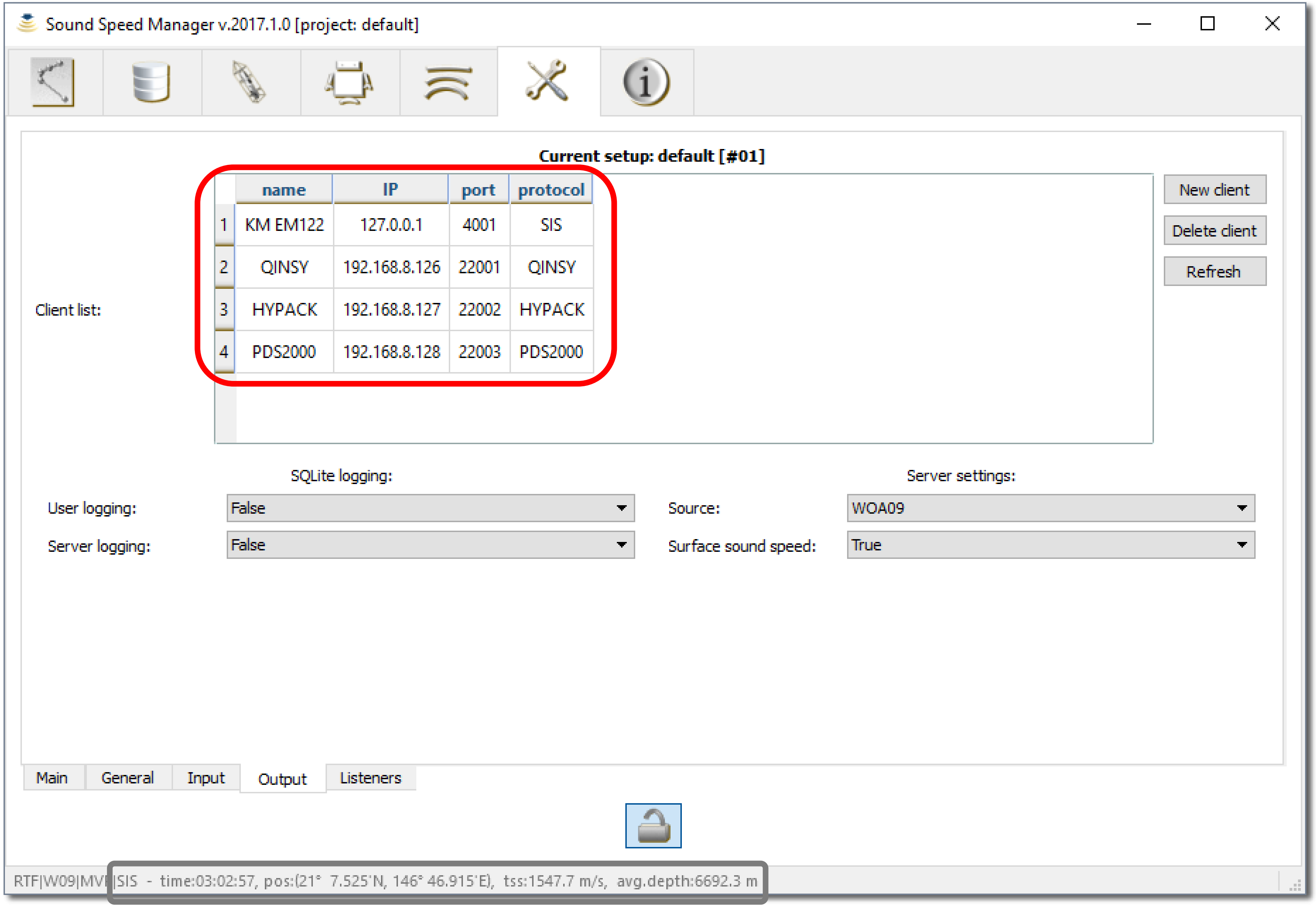
✓Free

FORMAT CONVERTER



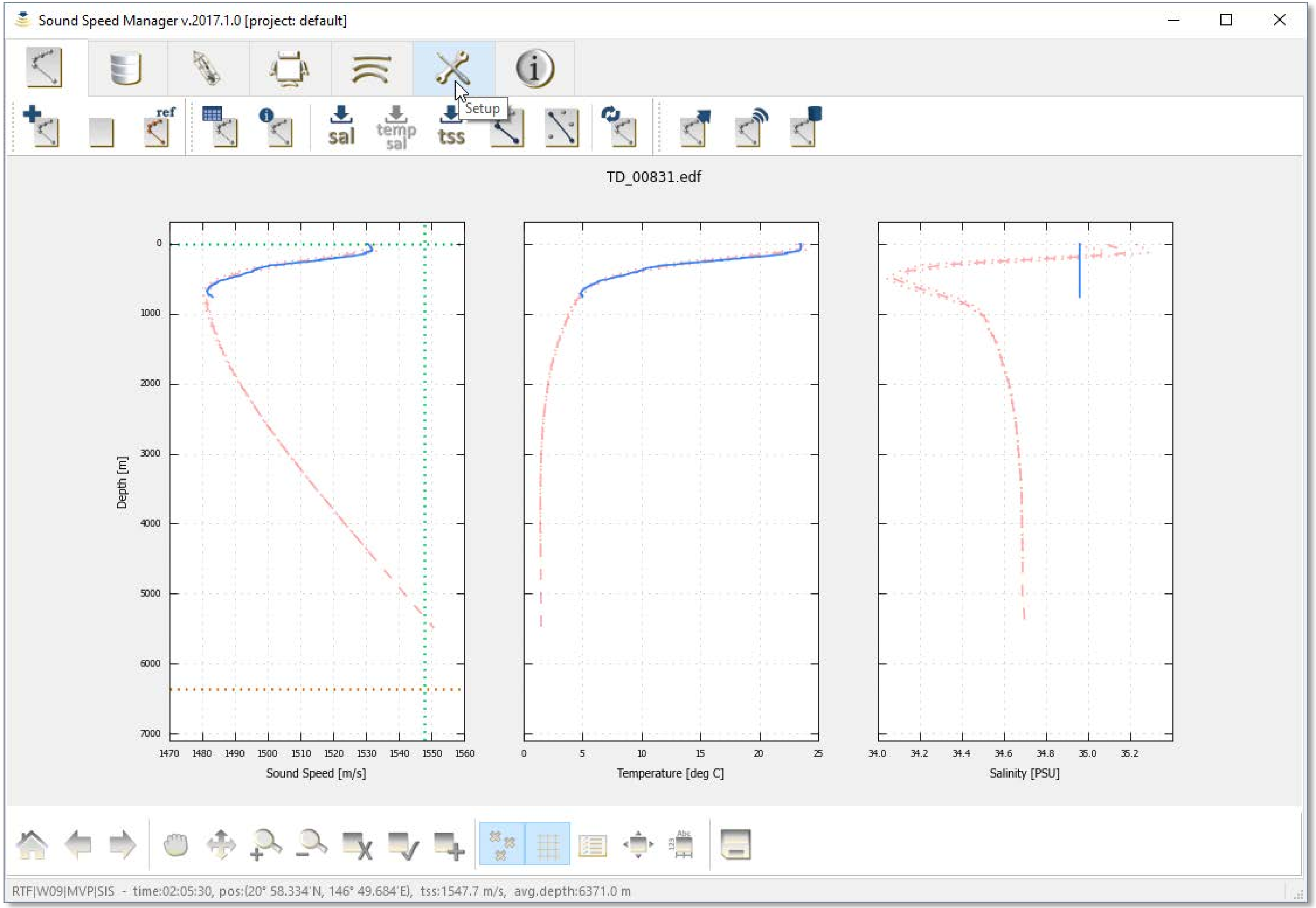
NETWORK IO

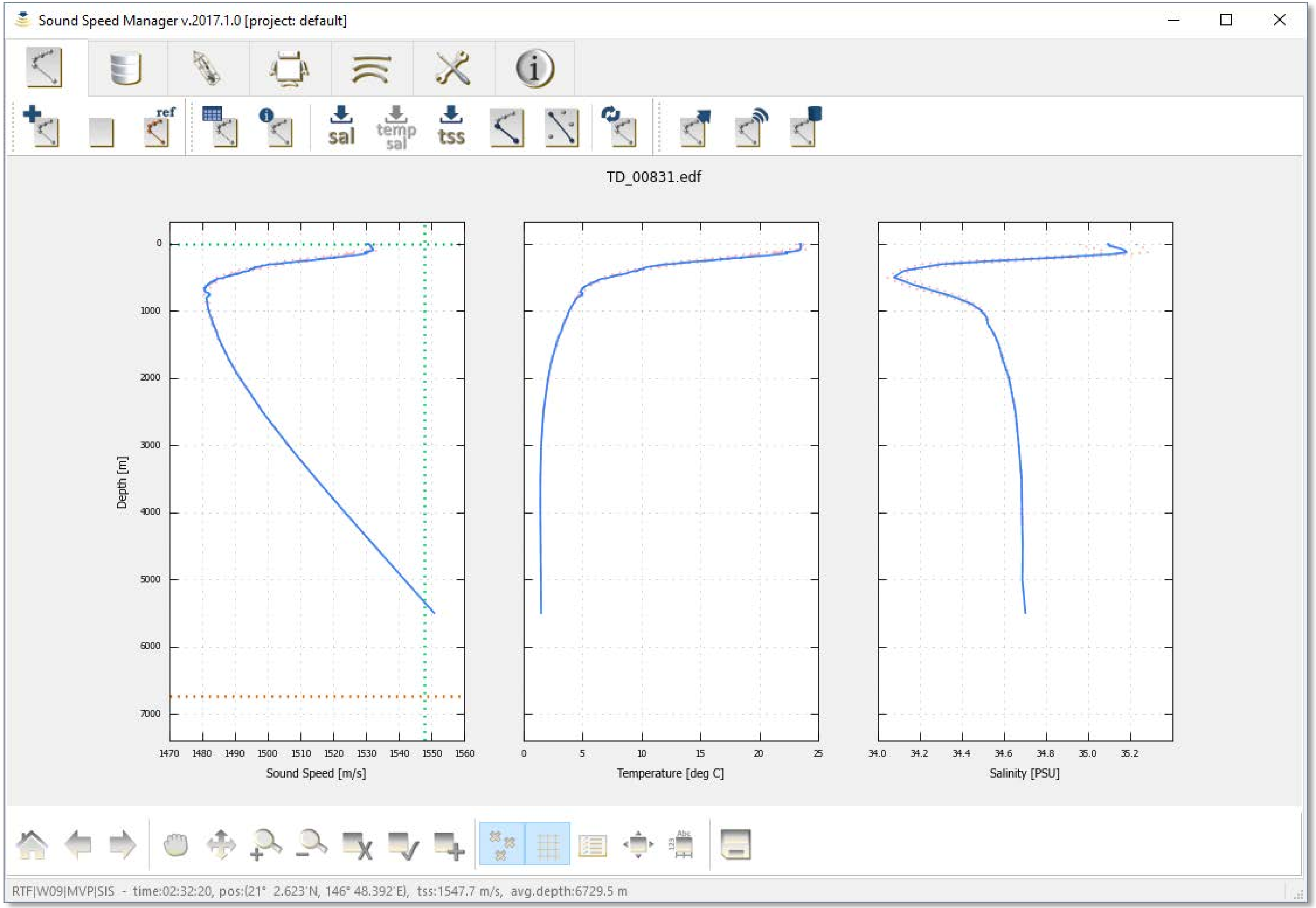


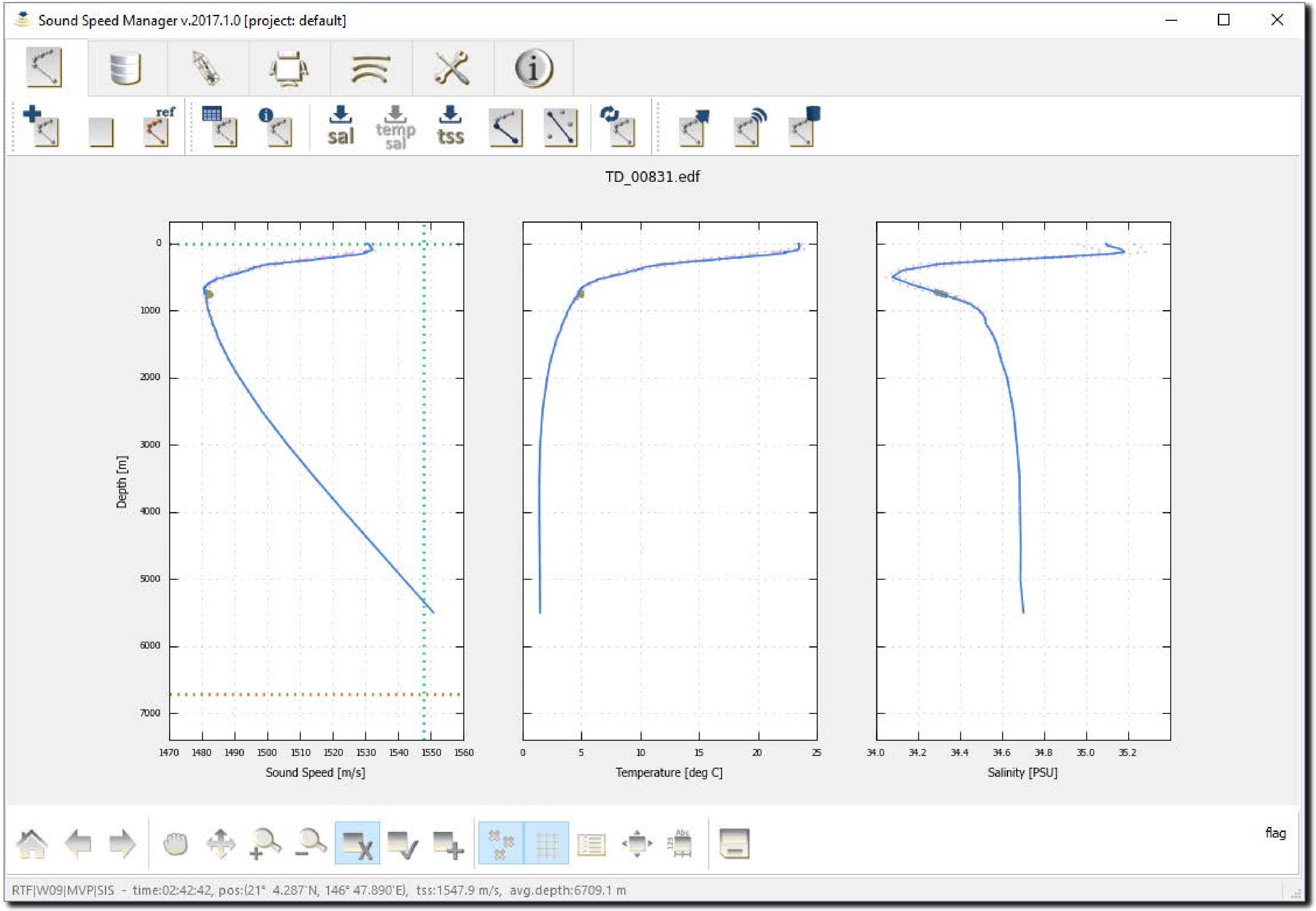


Sound Speed Manager v.2017.1.0 [project: default]
Current setup: default [#01]
Client list:
name
IP
port
protocol
1 KM EM122 127.0.0.1 4001 SIS
2 QINSY 192.168.8.126 22001 QINSY
3 HYPACK 192.168.8.127 22002 HYPACK
4 PDS2000 192.168.8.128 22003 PDS2000
New client
Delete client
Refresh
SQLite logging: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

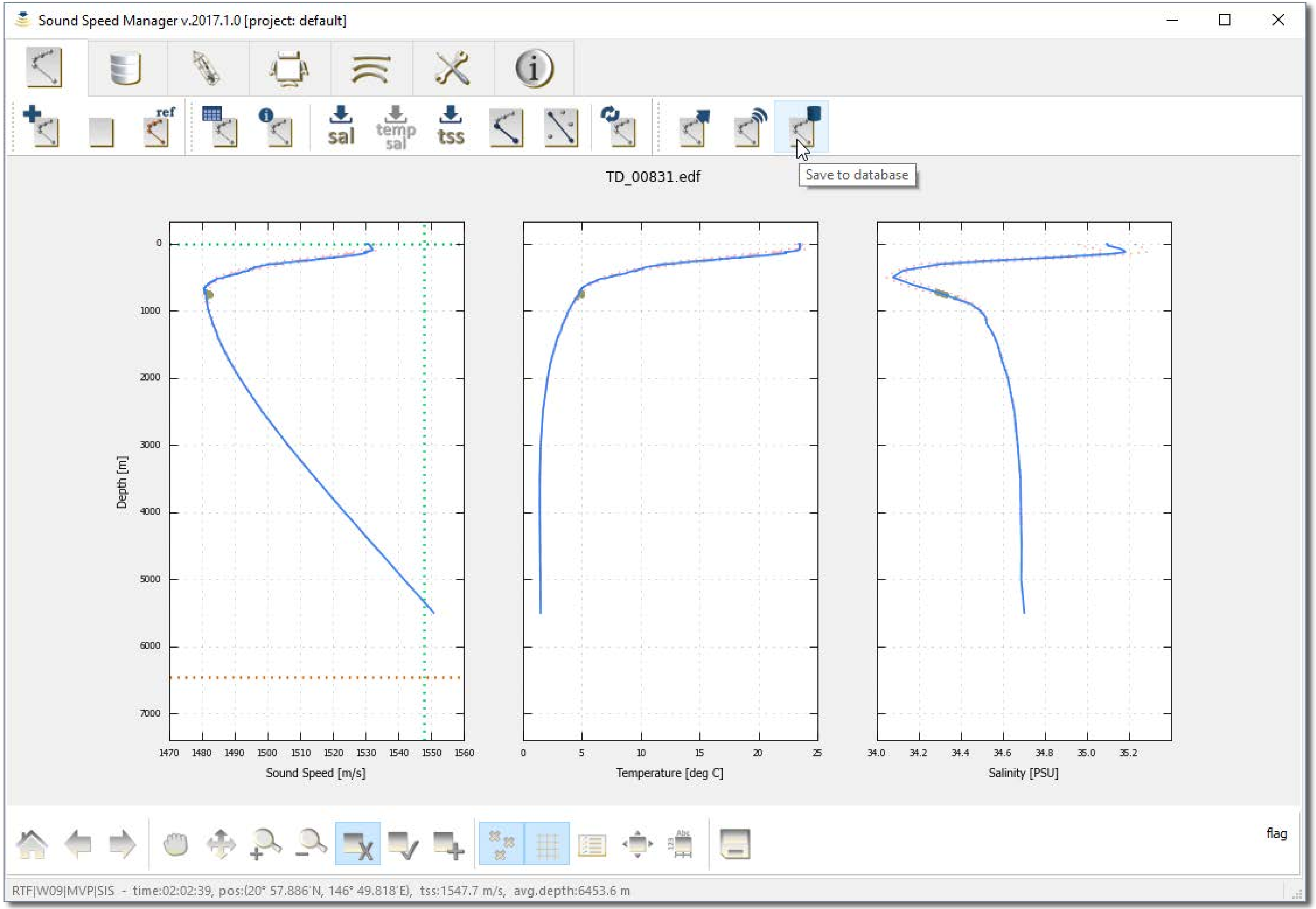

Sound Speed Manager v.2017.1.0 [project: default]
sal
temp sal
tss
ref
TD_00831.edf [45695h 26m since last tx]
Depth [m]
Sound Speed [m/s]
Temperature [deg C]
Salinity [PSU]
Transmitted
Reception confirmed from 'KM EM122'!
OK
RTF|W09|MVP|SIS - time:02:22:05, pos:(21° 0.977'N, 146° 48.889'E), tss:1547.7 m/s, av
STREAMLINE WORKFLOWS
Rolls-Royce MVP Controller
MVP
SIS


Sound Speed Manager v.2017.1.0 [project: default]
Setup
ref
sal
temp sal
tss
TD_00831.edf
Depth [m]
Sound Speed [m/s]
Temperature [deg C]
Salinity [PSU]
RTF|W09|MVP|SIS - time:02:05:30, pos:(20° 58.334'N, 146° 49.684'E), tss:1547.7 m/s, avg.depth:6371.0 m


Sound Speed Manager v.2017.1.0 [project: default]
ref
sal
temp
sal
tss
TD_00831.edf
Depth [m]
Sound Speed [m/s]
Temperature [deg C]
Salinity [PSU]
RTF|W09|MVP|SIS - time:02:32:20, pos:(21° 2.623'N, 146° 48.392'E), tss:1547.7 m/s, avg.depth:6729.5 m

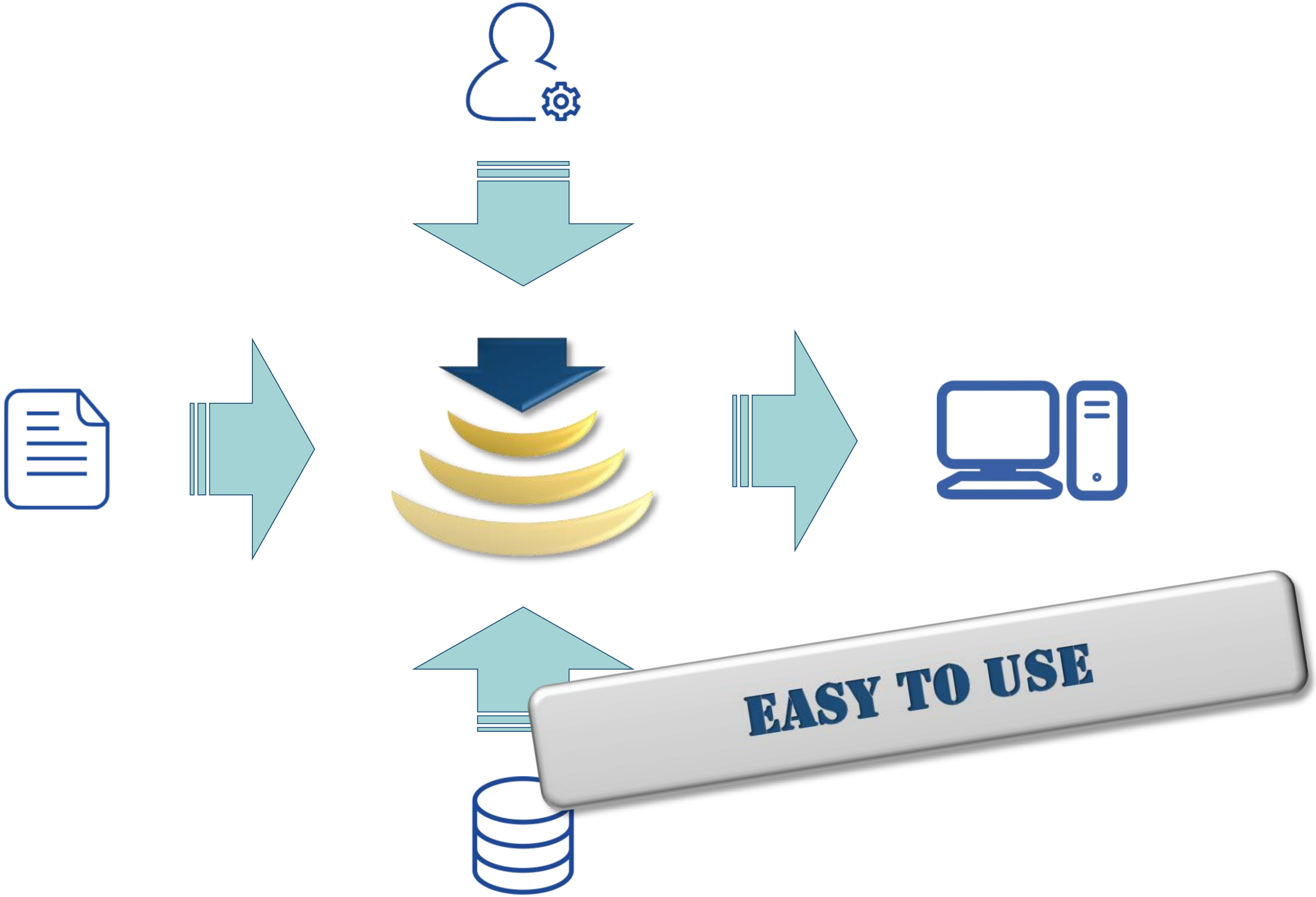


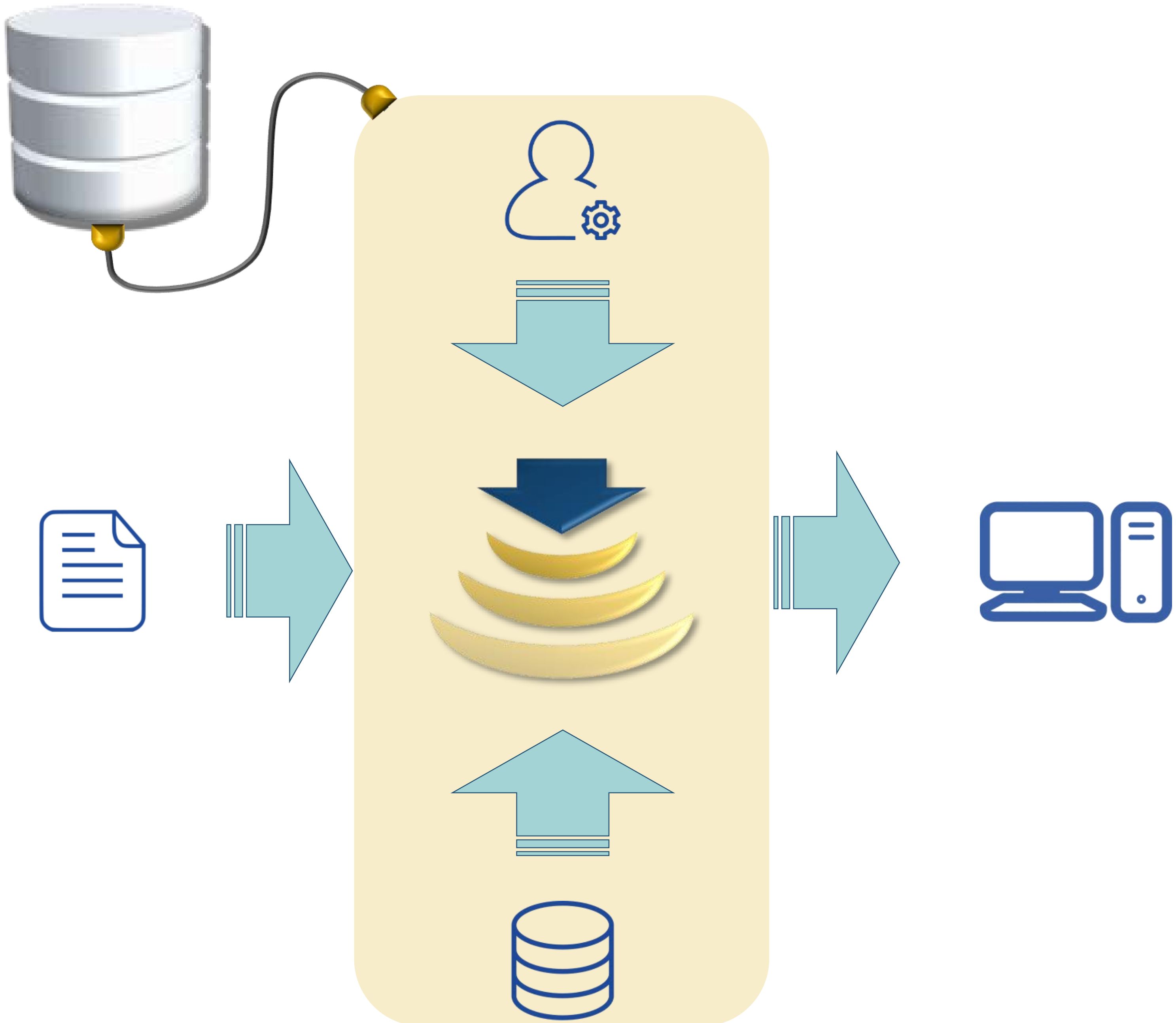
Sound Speed Manager v.2017.1.0 [project: default]
ref
sal
temp sal
tss
TD_00831.edf
Depth [m]
Sound Speed [m/s]
Temperature [deg C]
Salinity [PSU]
flag
RTF|W09|MVP|SIS - time:02:42:42, pos:(21° 4.287'N, 146° 47.890'E), tss:1547.9 m/s, avg.depth:6709.1 m

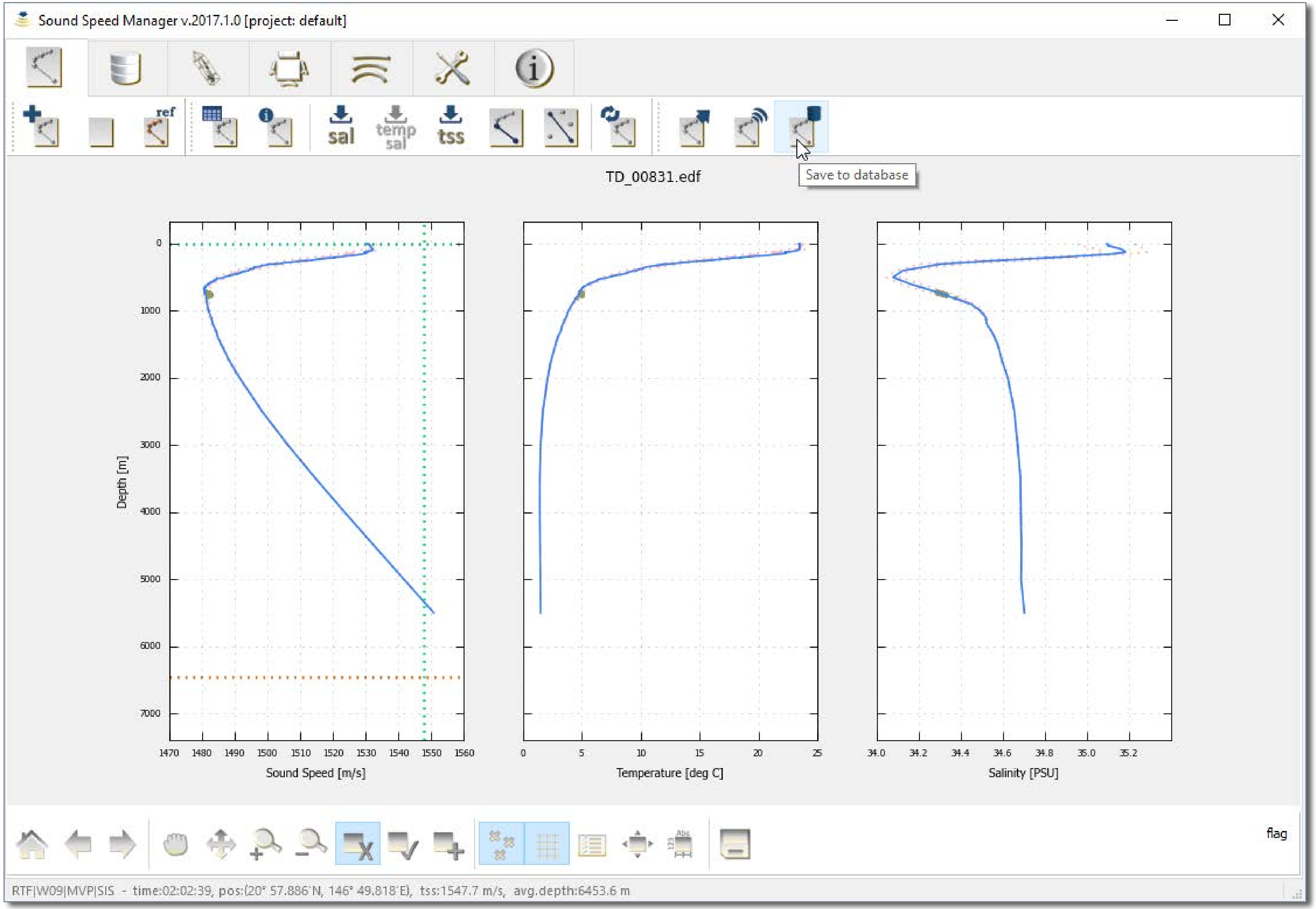


Sound Speed Manager v.2017.1.0 [project: default]
ref
sal
temp
sal
tss
Save to database
TD_00831.edf
Depth [m]
0
1000
2000
3000
4000
5000
6000
7000
1470 1480 1490 1500 1510 1520 1530 1540 1550 1560
Sound Speed [m/s]
0 5 10 15 20 25
Temperature [deg C]
34.0 34.2 34.4 34.6 34.8 35.0 35.2
Salinity [PSU]
flag
RTF|W09|MVP|SIS - time:02:02:39, pos:(20° 57.886'N, 146° 49.818'E), tss:1547.7 m/s, avg.depth:6453.6 m

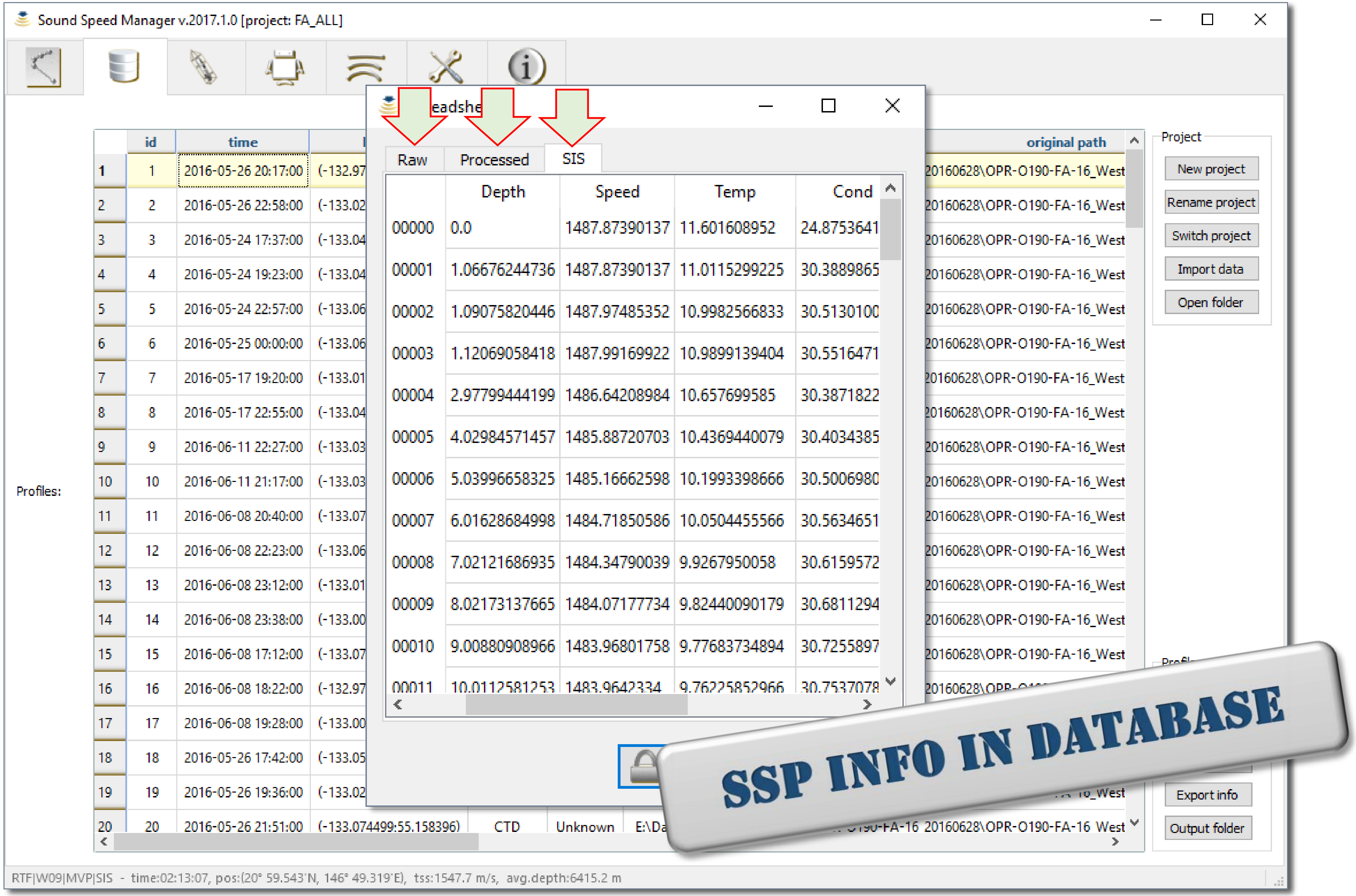
Profile Enhancement

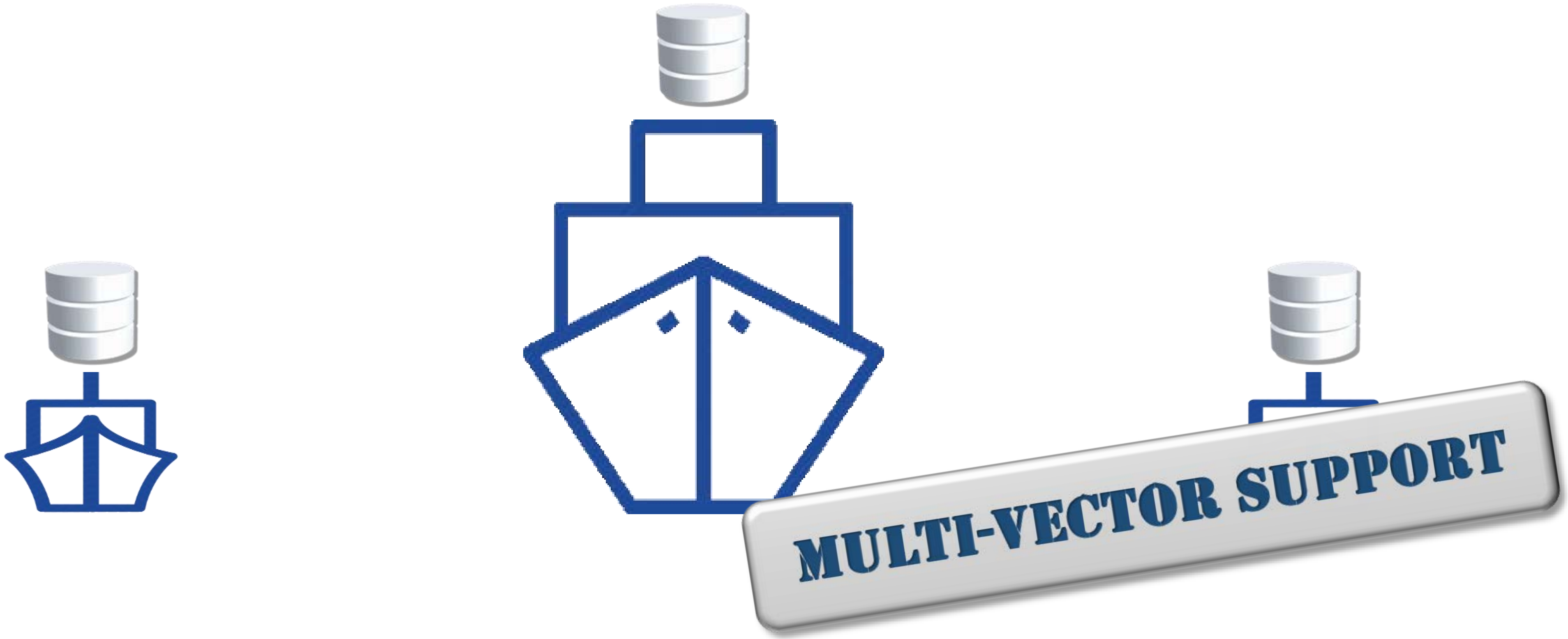


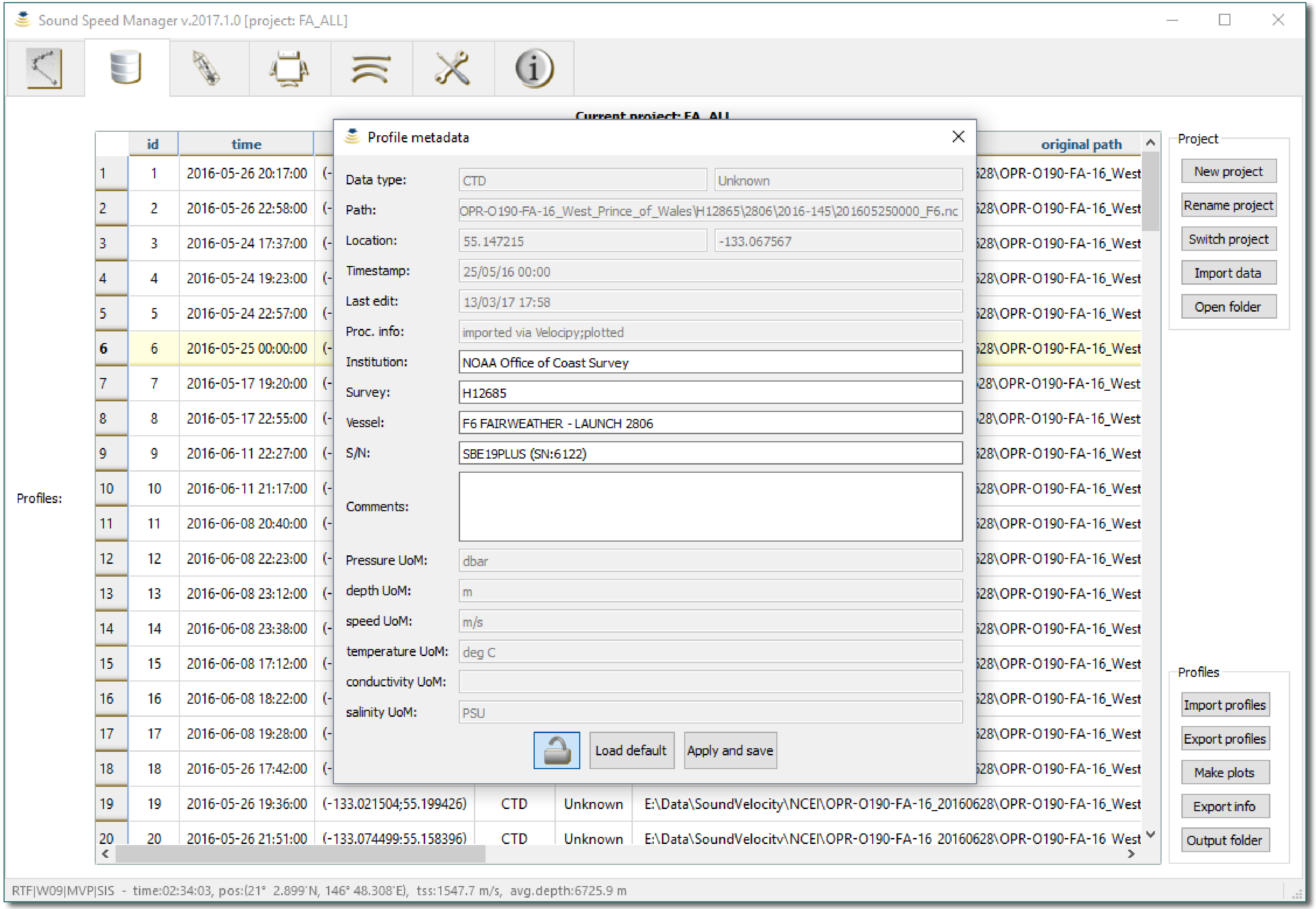


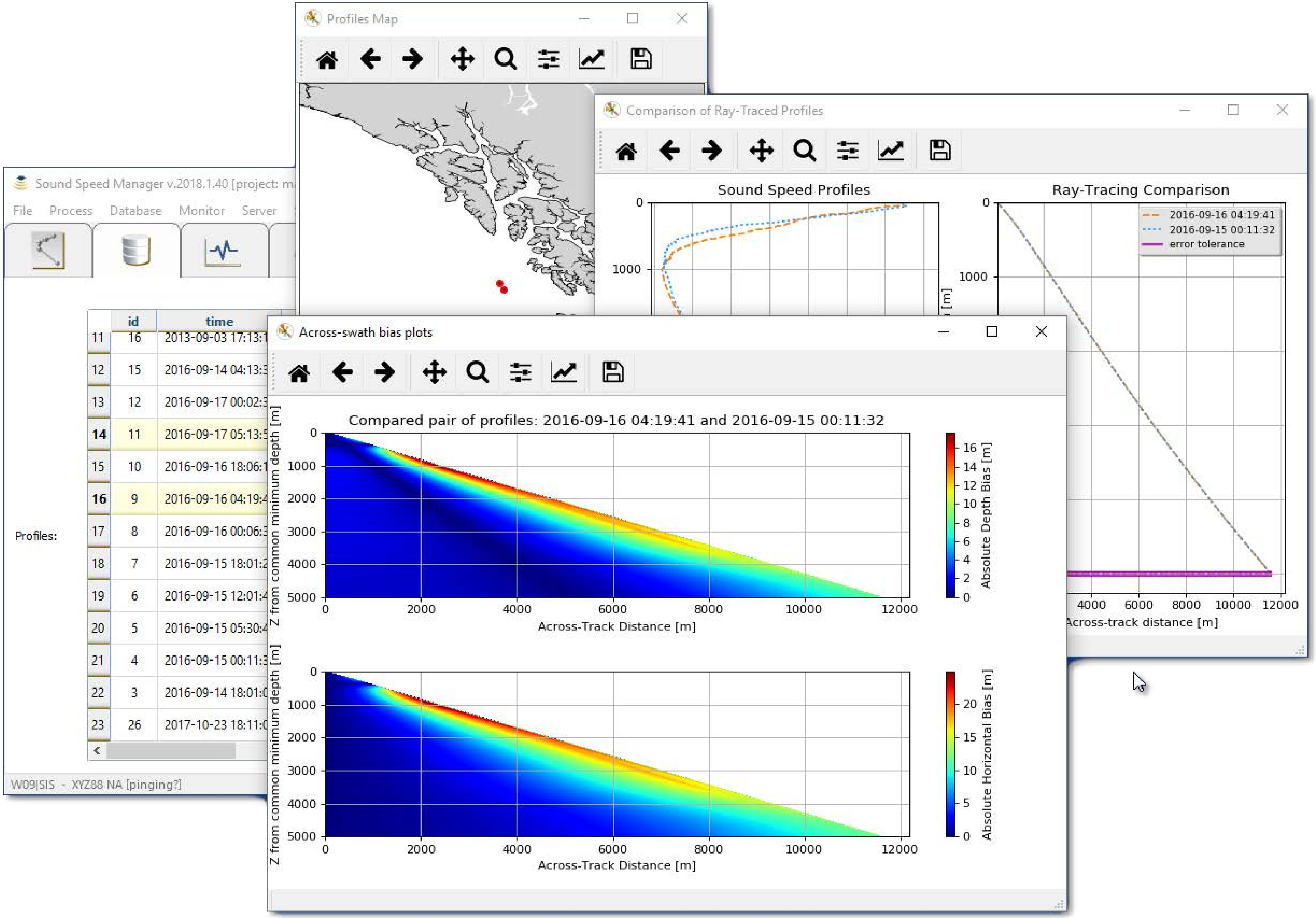


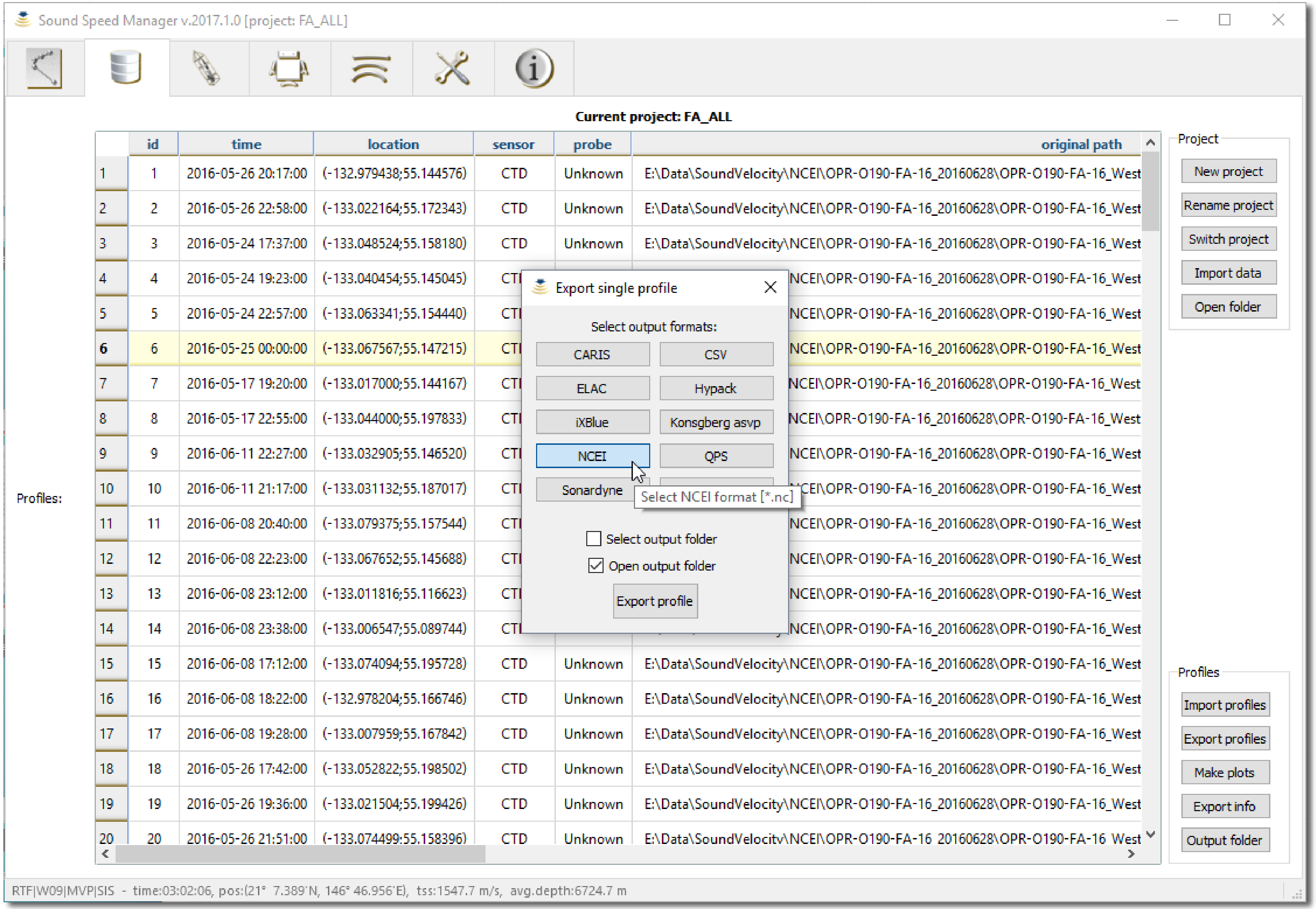
Sound Speed Manager v.2017.1.0 [project: default]
ref
sal
temp sal
tss
Save to database
TD_00831.edf
Depth [m]
Sound Speed [m/s]
Temperature [deg C]
Salinity [PSU]
flag
RTF|W09|MVP|SIS - time:02:02:39, pos:(20° 57.886'N, 146° 49.818'E), tss:1547.7 m/s, avg.depth:6453.6 m


Sound Speed Manager v.2017.1.0 [project: FA_ALL]
Raw
Processed
SIS
Depth
Speed
Temp
Cond
id
time
original path
Project
New project
Rename project
Switch project
Import data
Open folder
Profiles:
Export info
Output folder
SSP INFO IN DATABASE
RTF|W09|MVP|SIS - time:02:13:07, pos:(20° 59.543'N, 146° 49.319'E), tss:1547.7 m/s, avg.depth:6415.2 m


MULTI-VECTOR SUPPORT

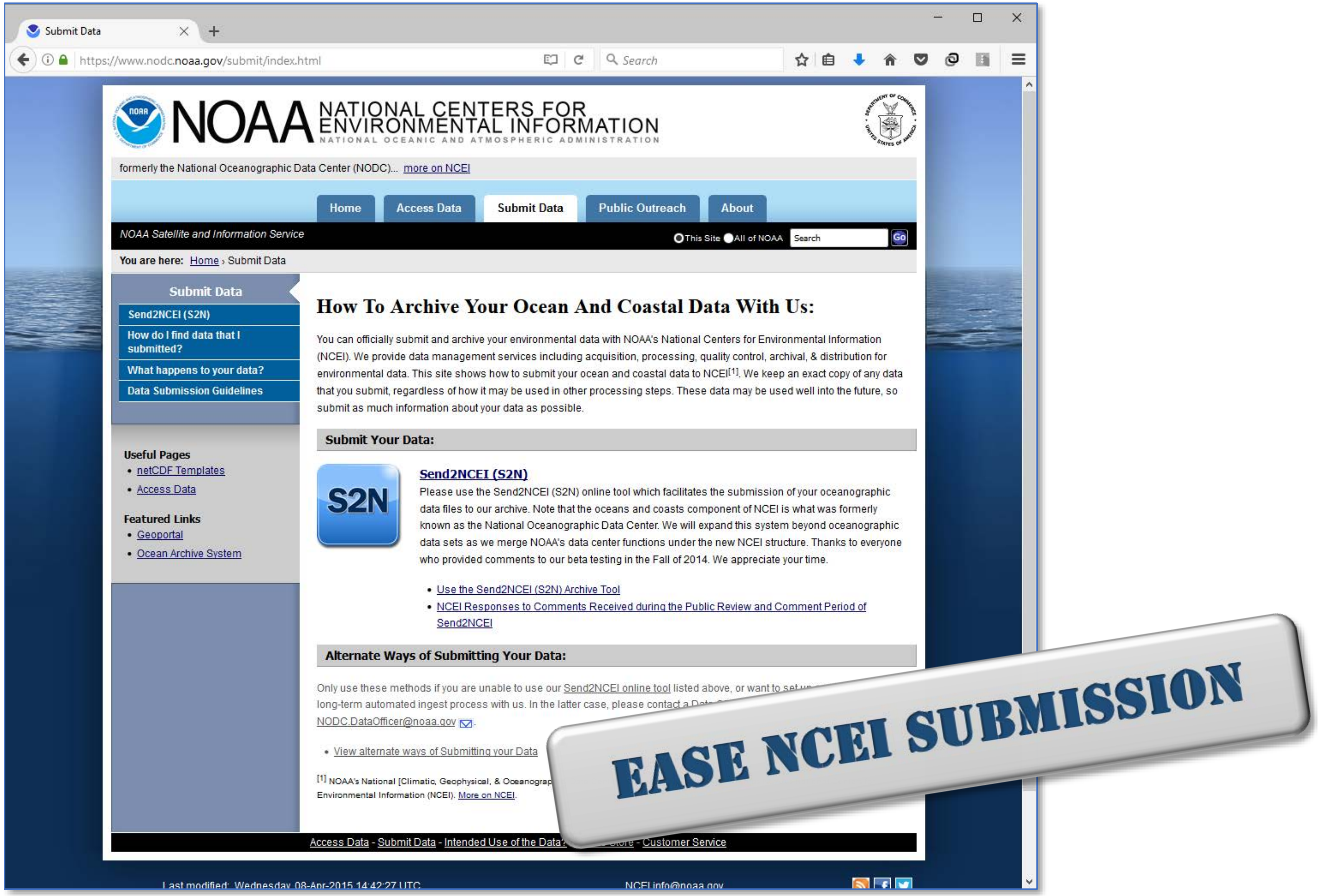

Sound Speed Manager v.2017.1.0 [project: FA_ALL]
Profile metadata
Data type: CTD Unknown
Path: OPR-O190-FA-16_West_Prince_of_Wales\H12865\2806\2016-145\201605250000_F6.nc
Location: 55.147215 -133.067567
Timestamp: 25/05/16 00:00
Last edit: 13/03/17 17:58
Proc. info: imported via Velocipy;plotted
Institution: NOAA Office of Coast Survey
Survey: H12685
Vessel: F6 FAIRWEATHER - LAUNCH 2806
S/N: SBE19PLUS (SN:6122)
Comments:
Pressure UoM: dbar
depth UoM: m
speed UoM: m/s
temperature UoM: deg C
conductivity UoM:
salinity UoM: PSU
Load default
Apply and save
Profiles:
Project
New project
Rename project
Switch project
Import data
Open folder
Profiles
Import profiles
Export profiles
Make plots
Export info
Output folder
RTF|W09|MVP|SIS - time:02:34:03, pos:(21° 2.899'N, 146° 48.308'E), tss:1547.7 m/s, avg.depth:6725.9 m

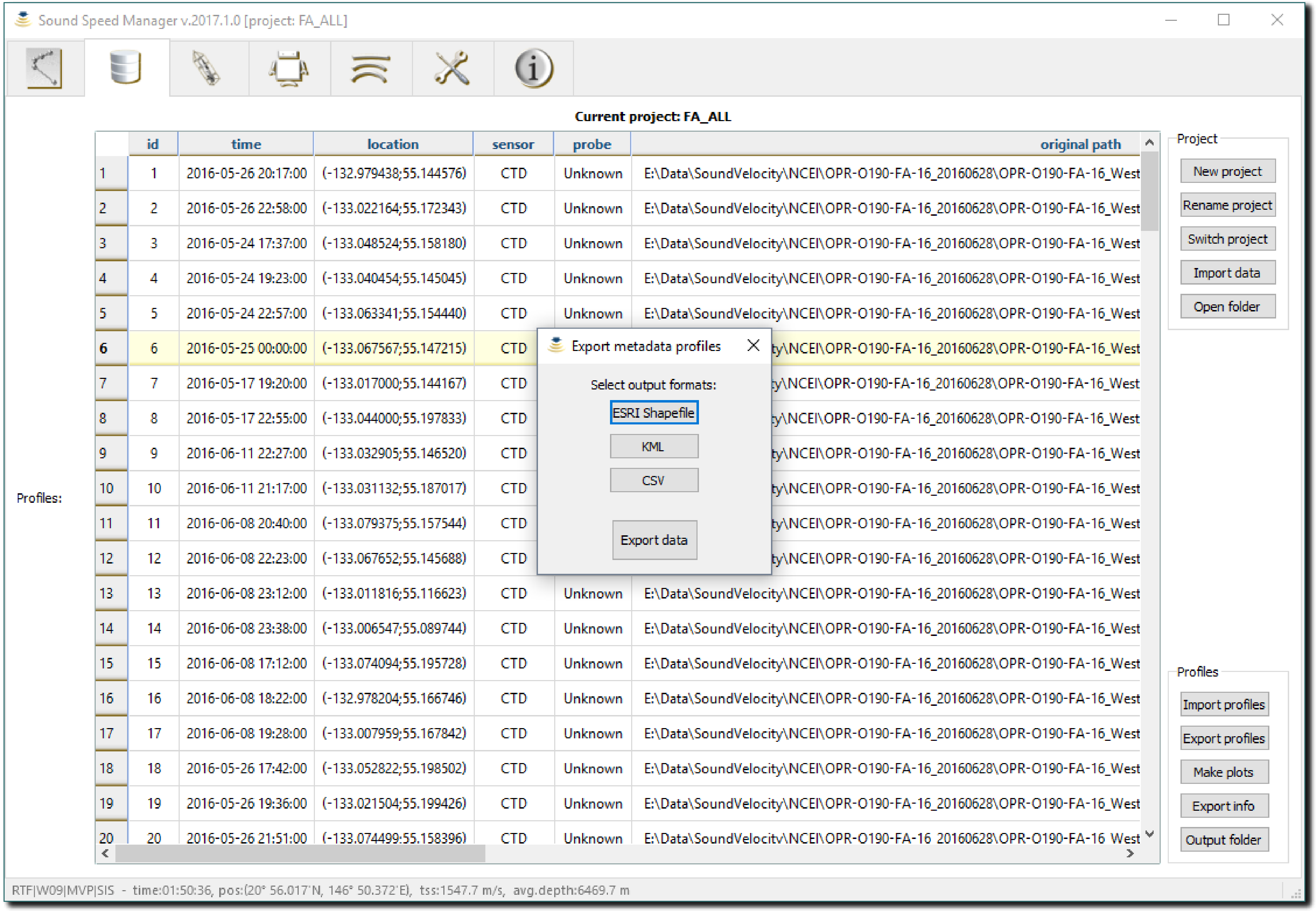

Profiles Map
Comparison of Ray-Traced Profiles
Sound Speed Profiles
Ray-Tracing Comparison
2016-09-16 04:19:41
2016-09-15 00:11:32
error tolerance
Across-track distance [m]
Sound Speed Manager v.2018.1.40 [project: m
File Process Database Monitor Server
Profiles:
id time
11 16 2013-09-03 17:13:1
12 15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

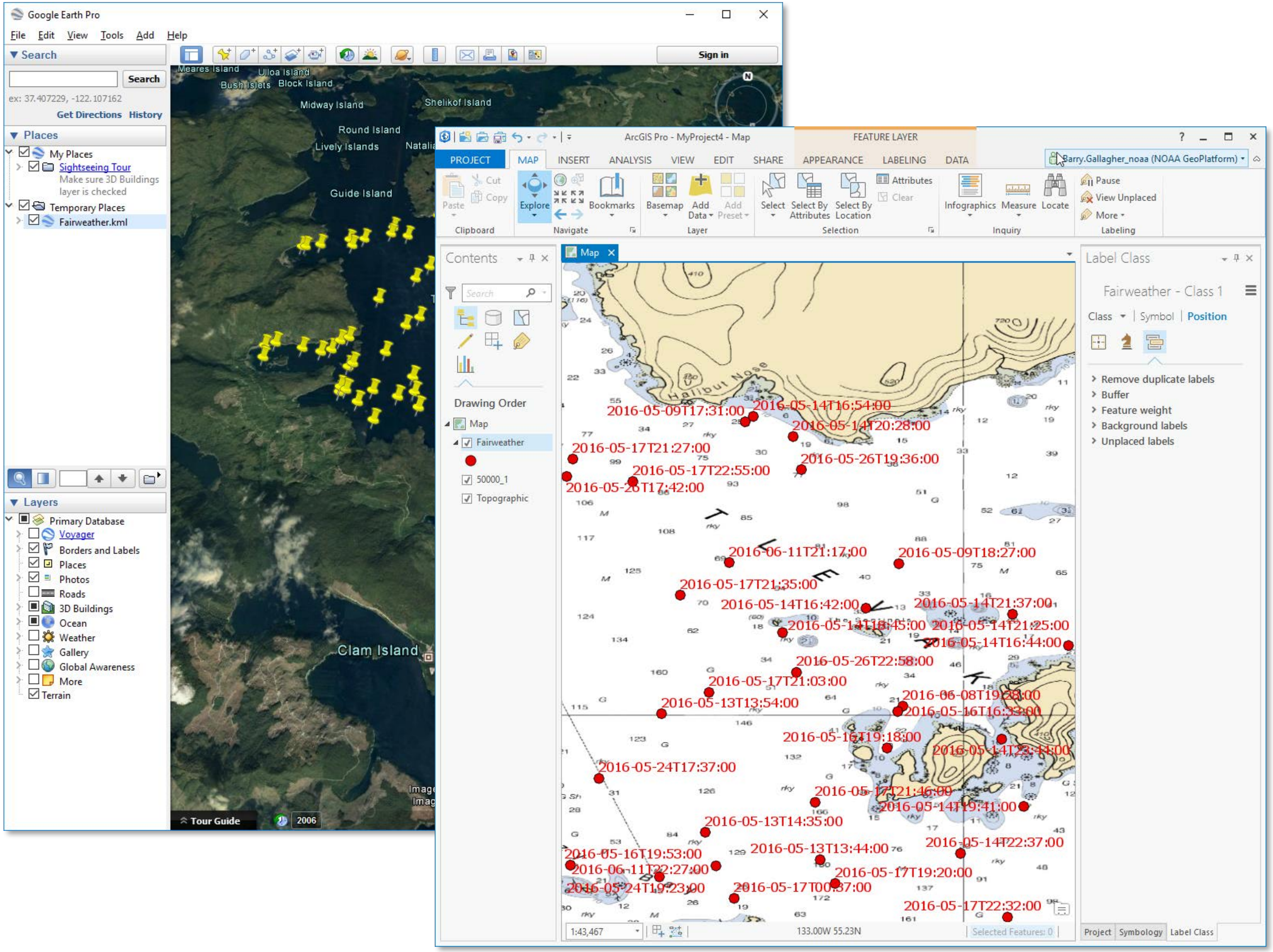


Sound Speed Manager v.2017.1.0 [project: FA_ALL]
Current project: FA_ALL
id time location sensor probe original path
1 1 2016-05-26 20:17:00 (-132.979438;55.144576) CTD Unknown E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
2 2 2016-05-26 22:58:00 (-133.022164;55.172343) CTD Unknown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

DATA DISSEMINATION

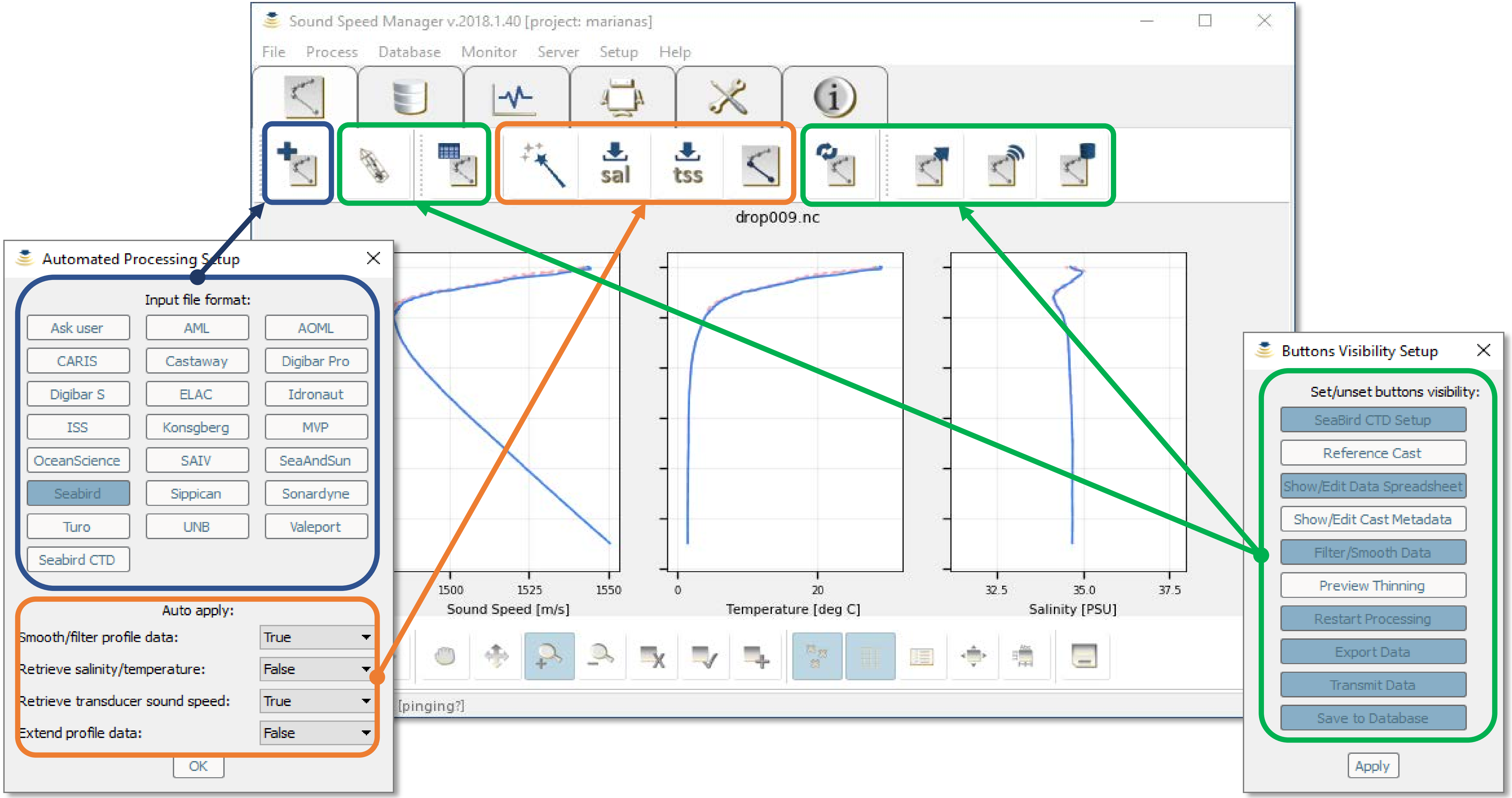



Sound Speed Manager v.2017.1.0 [project: FA_ALL]
Current project: FA_ALL
Profiles:
id | time | location | sensor | probe | original path
1 | 1 | 2016-05-26 20:17:00 | (-132.979438;55.144576) | CTD | Unknown | E:\Data\SoundVelocity\NCEI\OPR-O190-FA-16_20160628\OPR-O190-FA-16_West
2 | 2 | 2016-05-26 22:58:00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

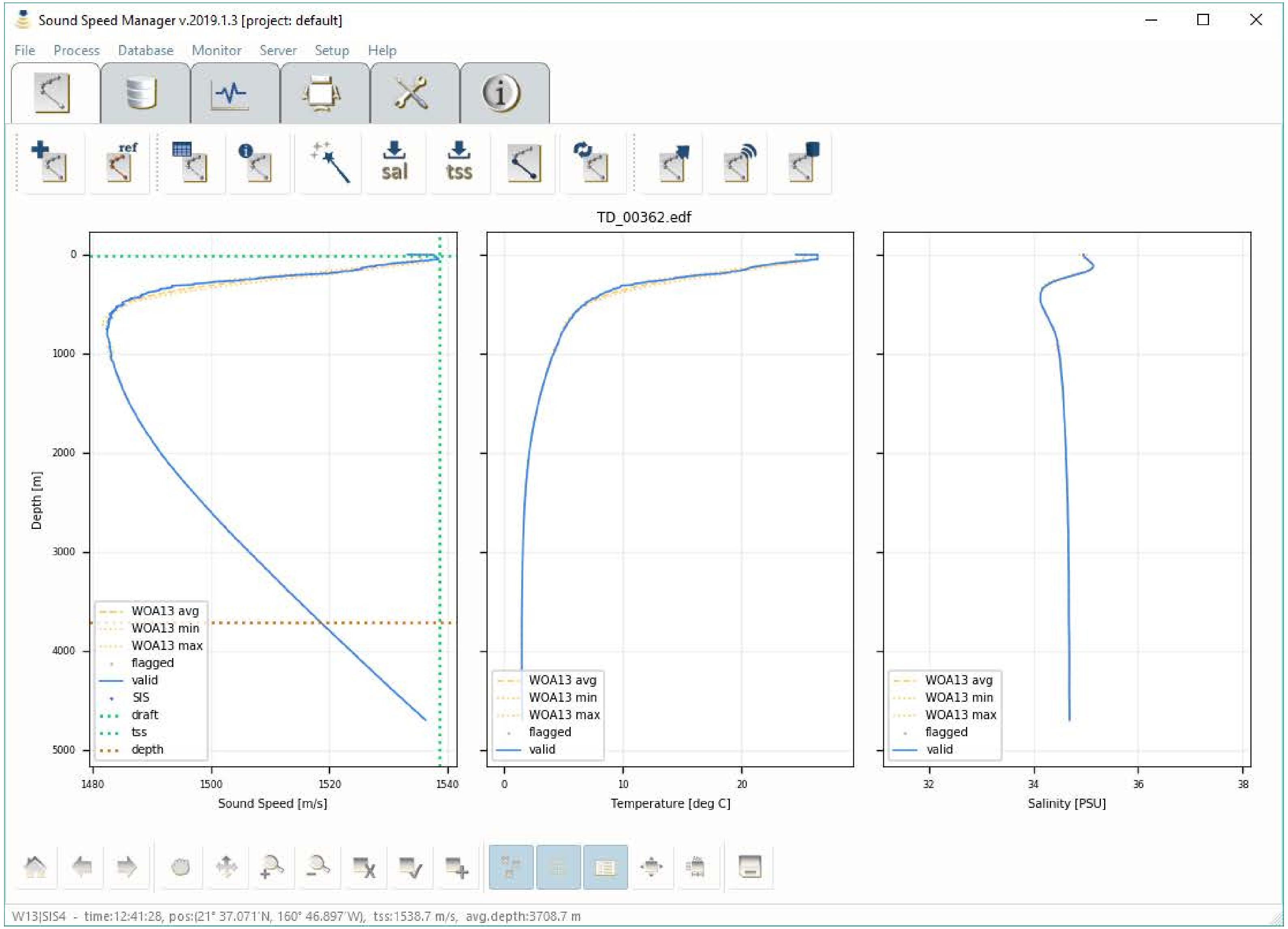


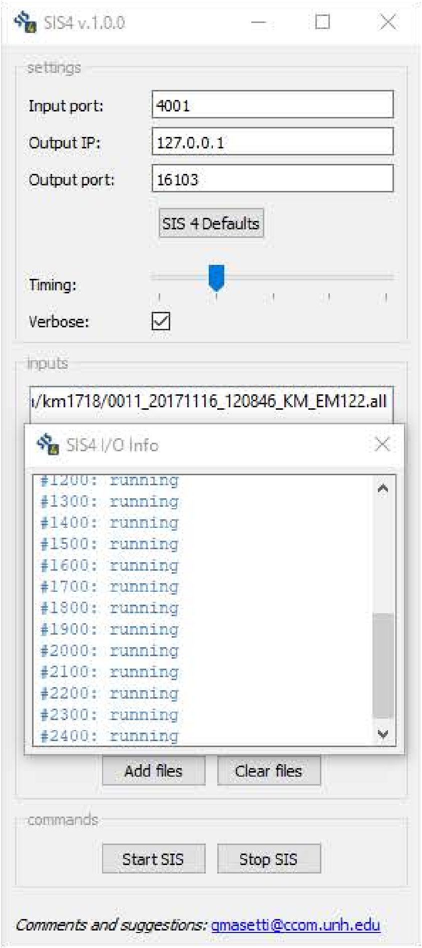
Google Earth Pro
File Edit View Tools Add Help
Search
Search
ex: 37.407229, -122.107162
Get Directions History
Places
My Places
Sightseeing Tour
Make sure 3D Buildings layer is checked
Temporary Places
Fairweather.kml
Layers
Primary Database
Voyager
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
Terrain
Sign in
Meares Island
Ulloa Island
Bush Islets
Block Island
Midway Island
Shelikof Island
Round Island
Lively Islands
Guide Island
Clam Island
Tour Guide
2006
ArcGIS Pro - MyProject4 - Map
FEATURE LAYER
PROJECT MAP INSERT ANALYSIS VIEW EDIT SHARE APPEARANCE LABELING DATA
Barry.Gallagher_noaa (NOAA GeoPlatform)
Paste Cut Copy
Clipboard
Explore
Bookmarks
Navigate
Basemap
Add Data
Add Preset
Layer
Select
Select By Attributes
Select By Location
Attributes
Clear
Selection
Infographics
Measure
Locate
Inquiry
Pause
View Unplaced
More
Labeling
Contents
Drawing Order
Map
Fairweather
50000_1
Topographic
Map
Label Class
Fairweather - Class 1
Class Symbol Position
Remove duplicate labels
Buffer
Feature weight
Background labels
Unplaced labels
Halibut Nose
2016-05-09T17:31:00
2016-05-14T16:54:00
2016-05-14T20:28:00
2016-05-17T21:27:00
2016-05-26T19:36:00
2016-05-17T22:55:00
2016-05-26T17:42:00
2016-06-11T21:17:00
2016-05-09T18:27:00
2016-05-17T21:35:00
2016-05-14T16:42:00
2016-05-14T21:37:00
2016-05-14T21:25:00
2016-05-14T16:44:00
2016-05-26T22:58:00
2016-05-17T21:03:00
2016-06-08T19:28:00
2016-05-13T13:54:00
2016-05-16T16:33:00
2016-05-16T19:18:00
2016-05-24T17:37:00
2016-05-17T21:46:00
2016-05-14T19:41:00
2016-05-13T14:35:00
2016-05-14T22:37:00
2016-05-16T19:53:00
2016-05-13T13:44:00
2016-06-11T22:27:00
2016-05-17T19:20:00
2016-05-24T19:23:00
2016-05-17T00:37:00
2016-05-17T22:32:00
1:43,467
133.00W 55.23N
Selected Features: 0
Project Symbology Label Class

Recent Improvements

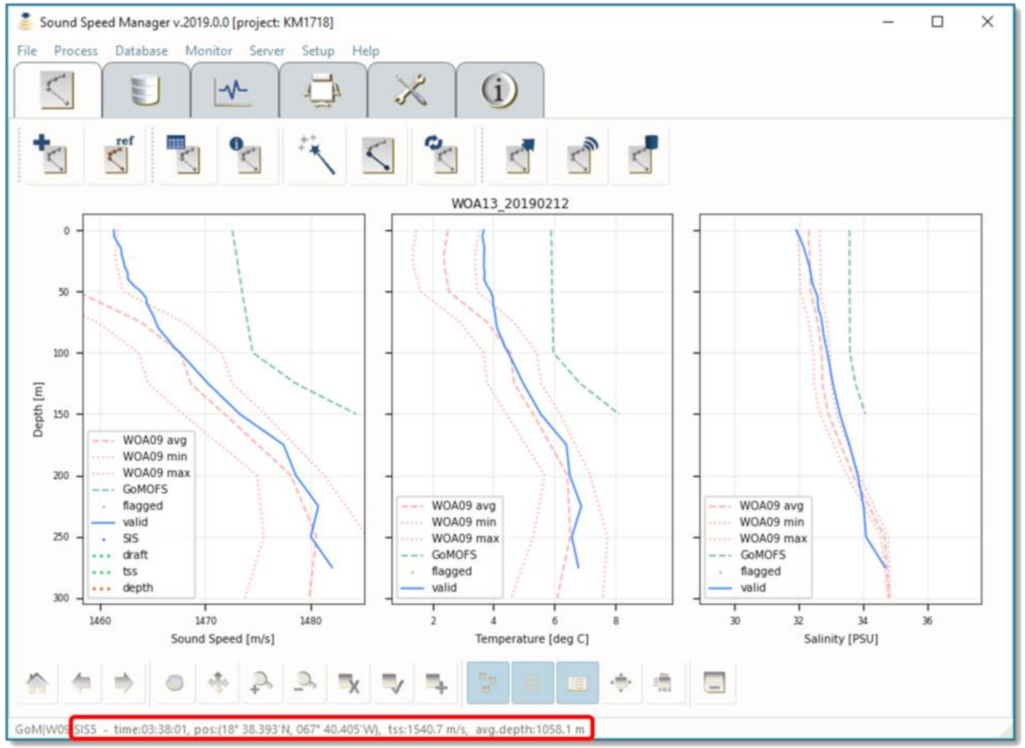


SSM → Simulators and Testing

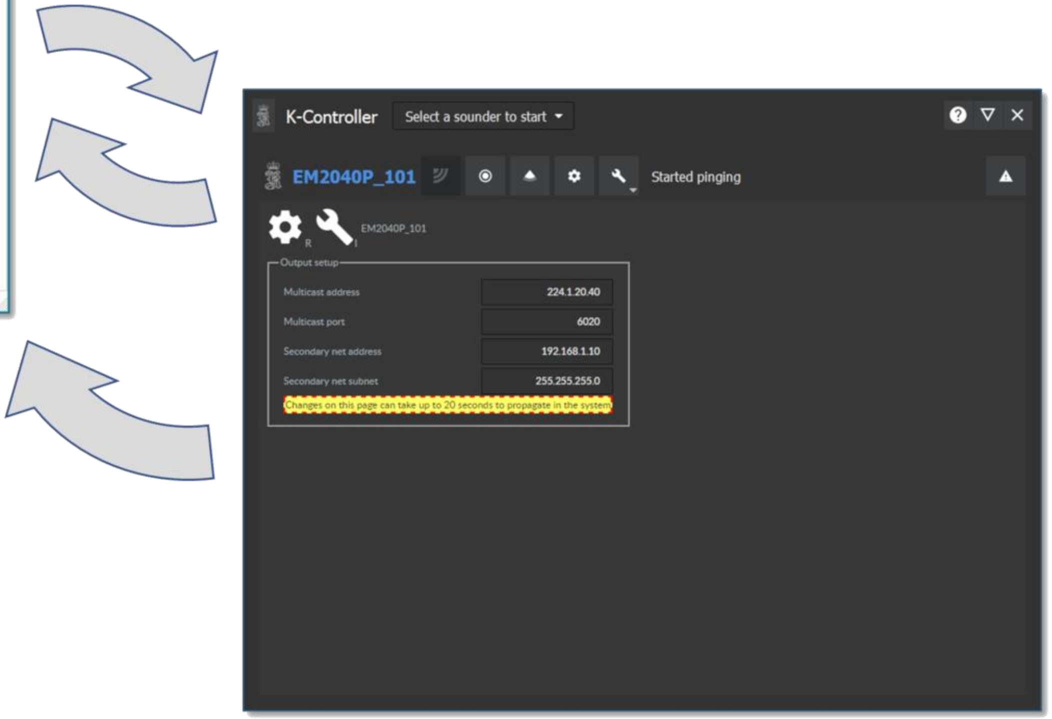




SSM → KMALL AND K-CONTROLLER



- Tx SSP (S01) for immediate use
- Ack of Rx SSP (#SVP)



- Request Current SSP (#KSSIS,454)
- .kmall parsing
  - #SPO
  - #MRZ
  - #SVP

DATA MONITOR

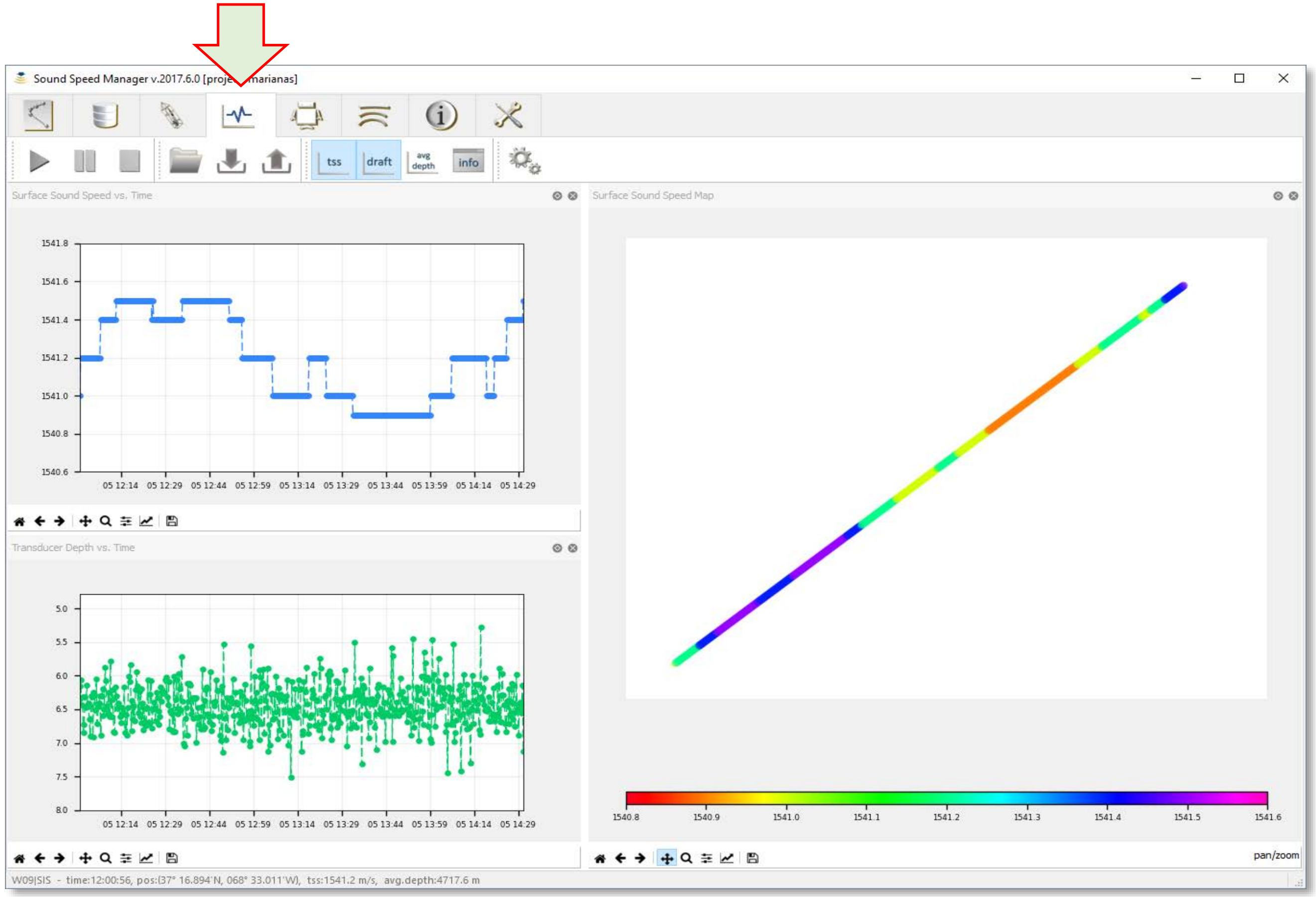
DATA MONITOR

An extension of Sound Speed Manager to:

Monitor survey data

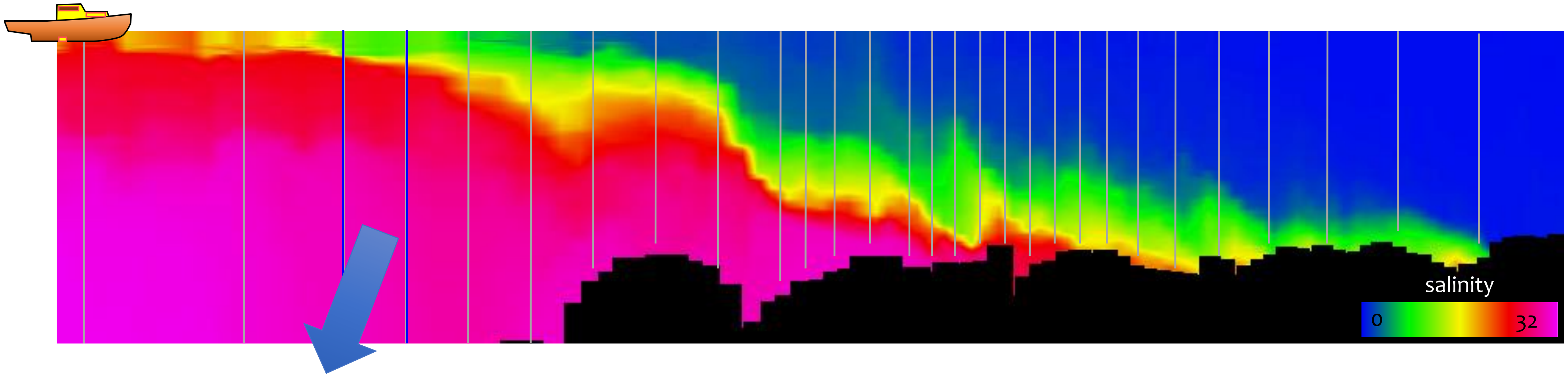
Predict cast time

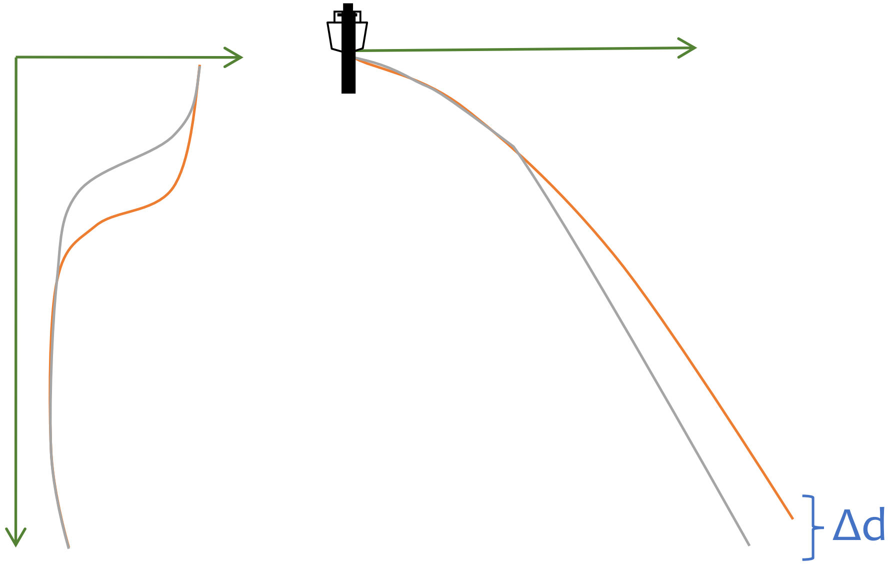
DATA MONITOR



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

CastTime

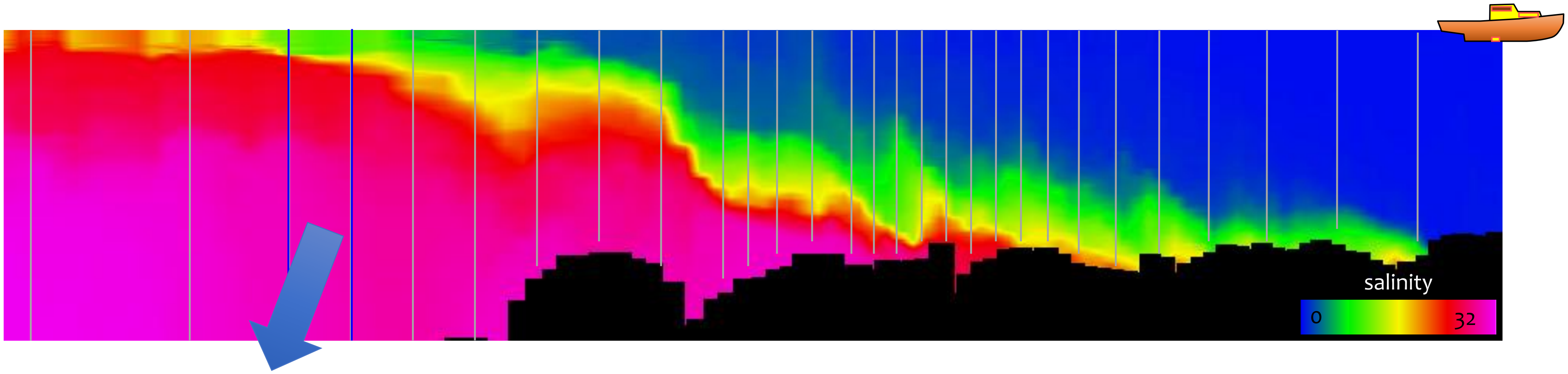


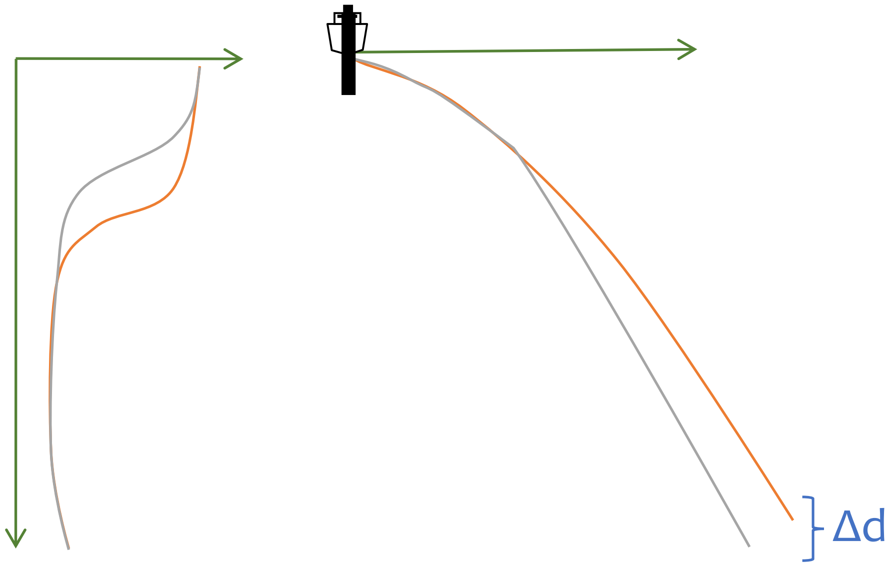


In a nutshell:

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

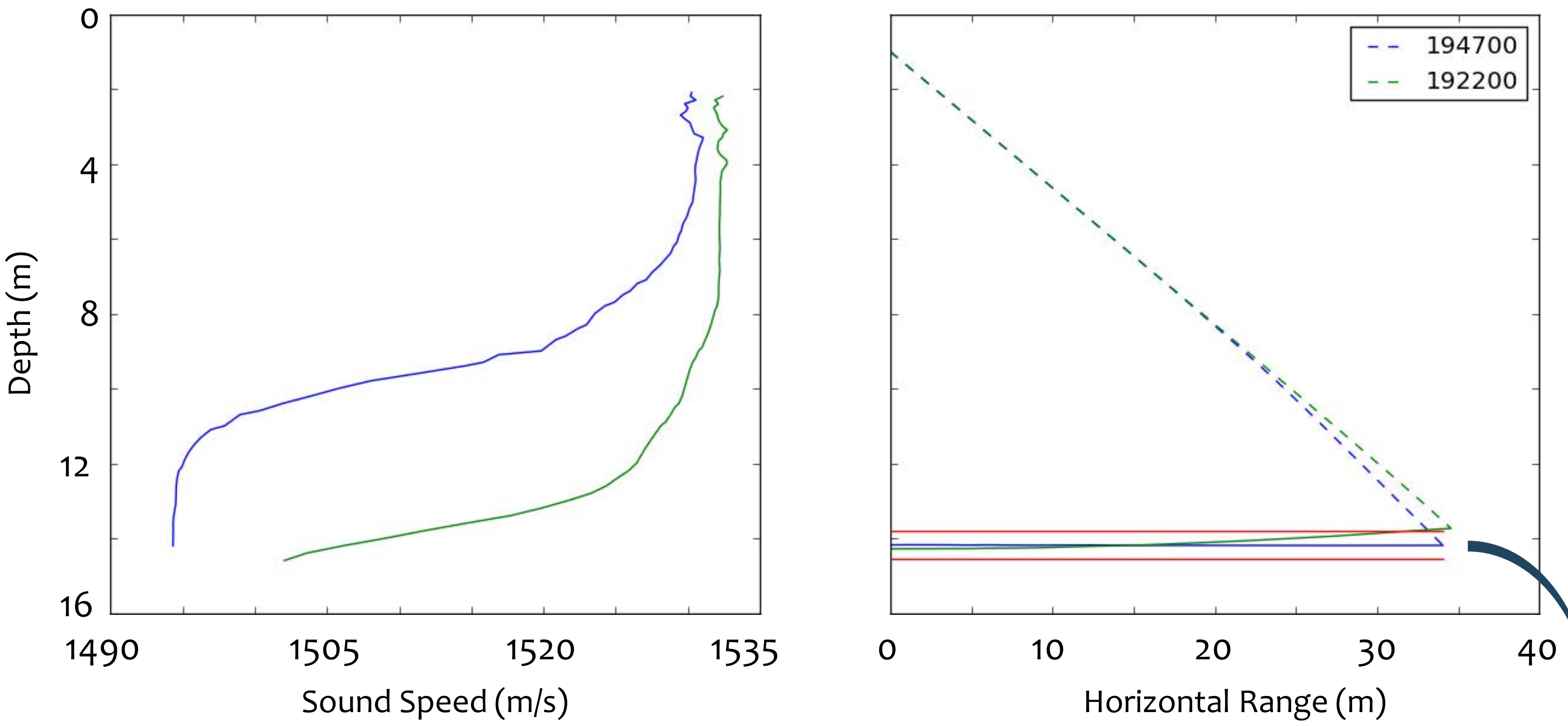
CastTime





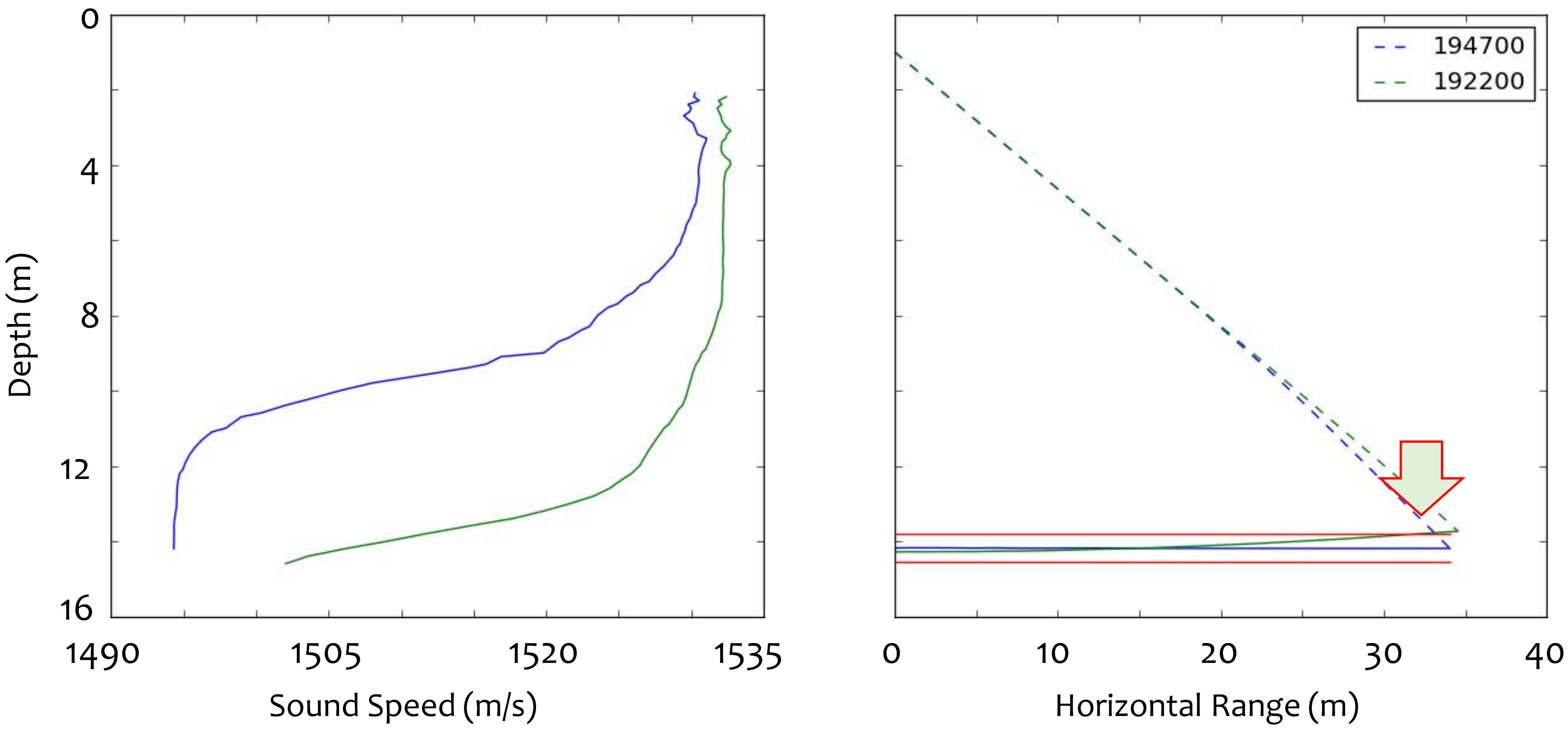
So how do we get **Δd**?

Survey Data Monitor & Cast Timing

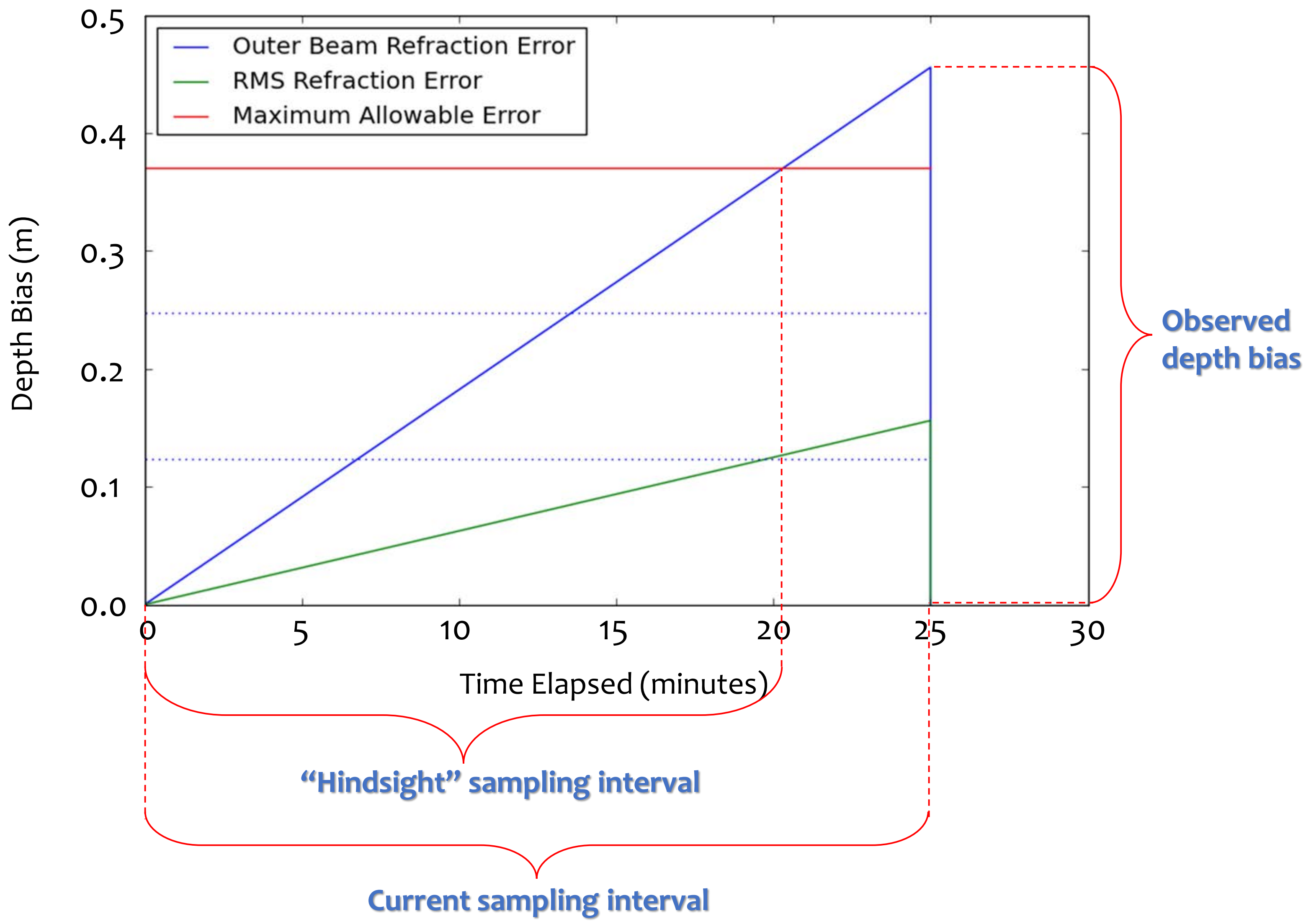


Estimate sounding depth bias using **simulated flat seafloors**

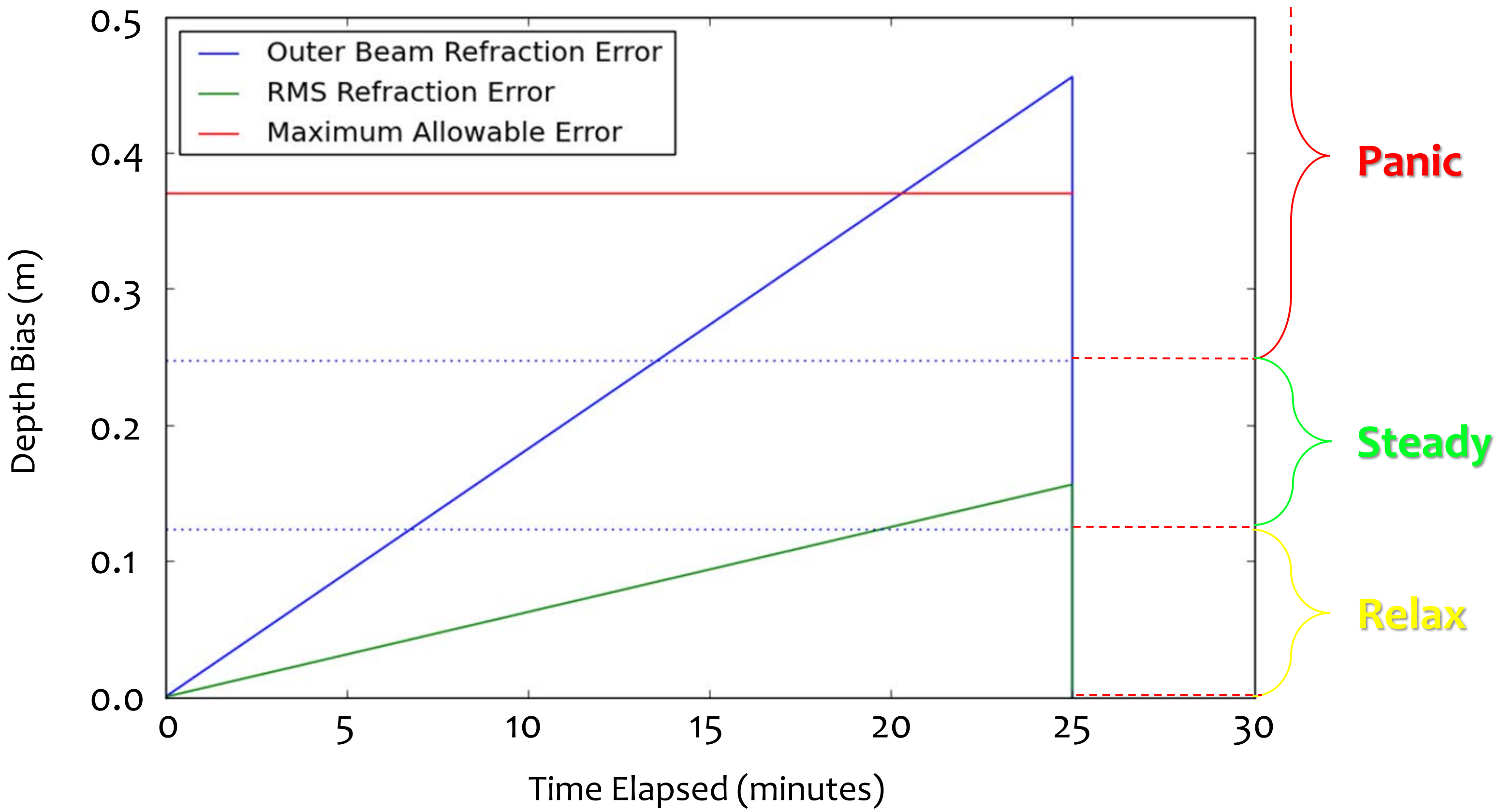
SURVEY DATA MONITOR & CAST TIMING



- Red lines represent maximum allowable error per NOAA specifications
- In the example, outer beam depth bias (of 0.46 m) exceeds NOAA specs

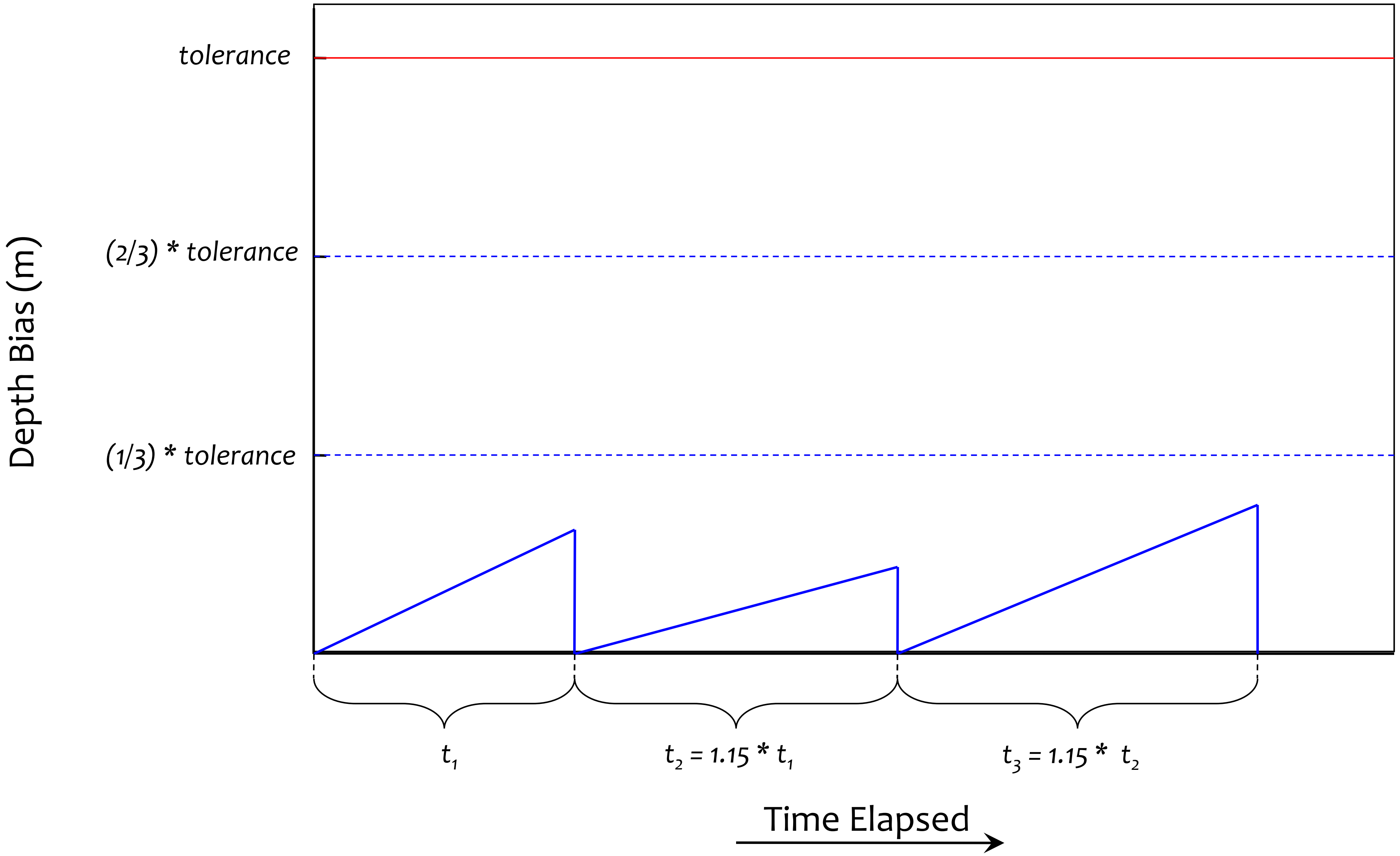


Outer Beam Refraction Error
RMS Refraction Error
Maximum Allowable Error
0.5
0.4
0.3
0.2
0.1
0.0
Depth Bias (m)
0
5
10
15
20
25
30
Time Elapsed (minutes)
Observed depth bias
"Hindsight" sampling interval
Current sampling interval



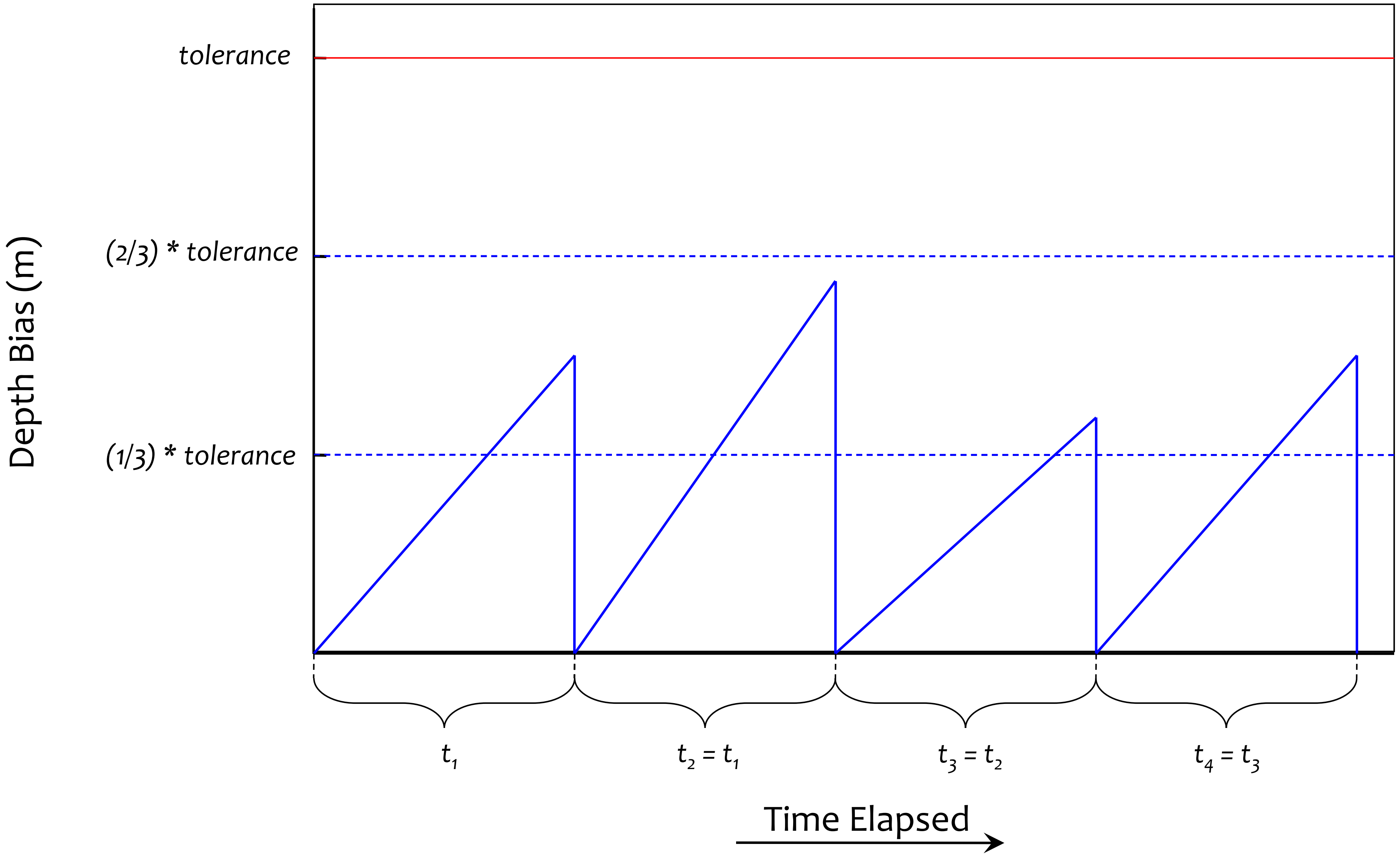
Outer Beam Refraction Error
RMS Refraction Error
Maximum Allowable Error
0.5
0.4
0.3
0.2
0.1
0.0
Depth Bias (m)
0
5
10
15
20
25
30
Time Elapsed (minutes)
Panic
Steady
Relax

Algorithm Logic Example: RELAX



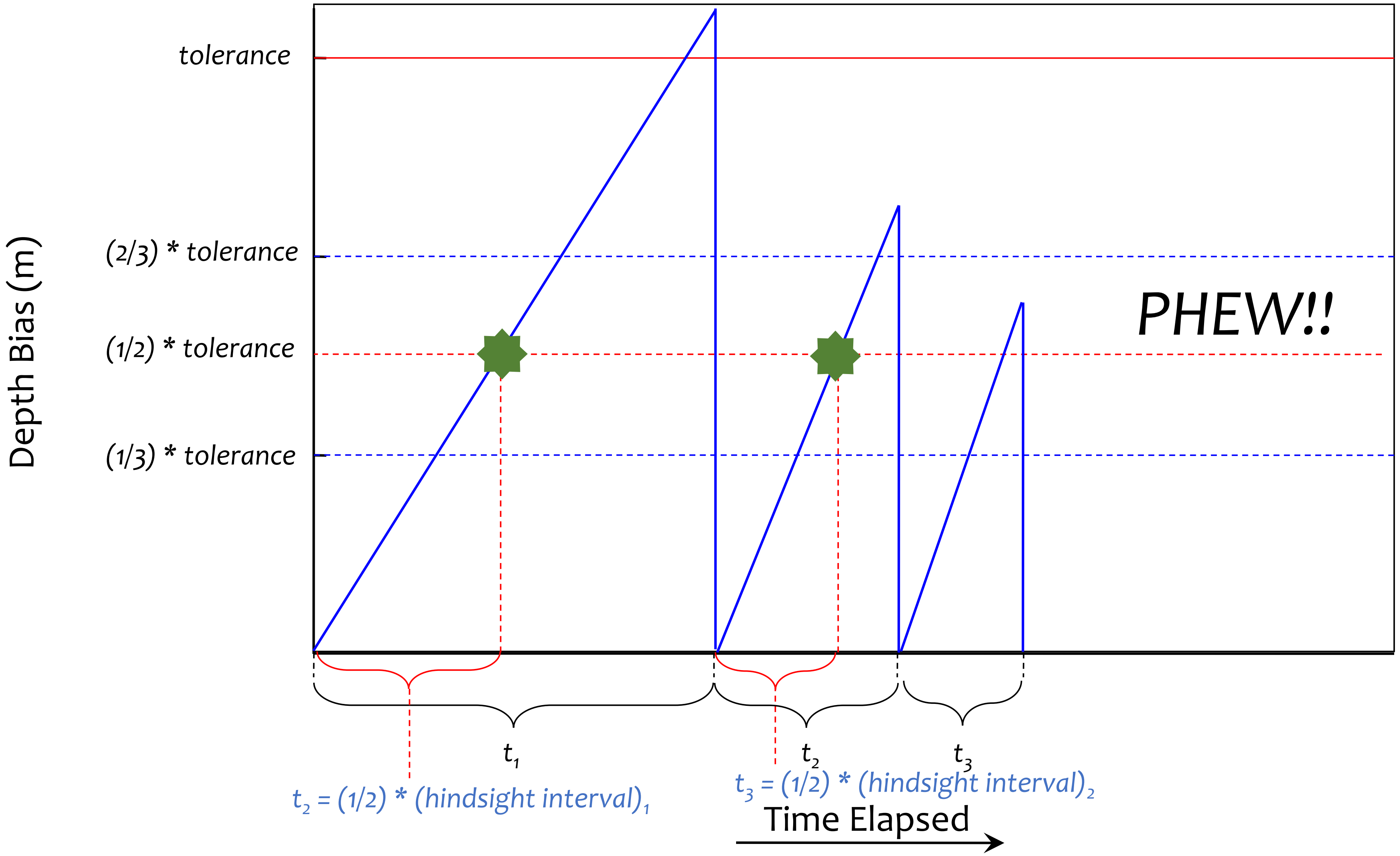
t_1 = initial sampling interval

Algorithm Logic Example: **STEADY**



t_1 = initial sampling interval

Algorithm Logic Example: **PANIC!!**



t_1 = *initial sampling interval*

Other Features Available in

- Scriptable Library
- Synthetic Profile Server tool
- SeaCAT plugin (serial communication port)
- DQA functions
- Surface sound speed sensor
- Data decimation and other settings
- Data other than salinity, temp, and sound speed
- Interaction with acquisition/processing software

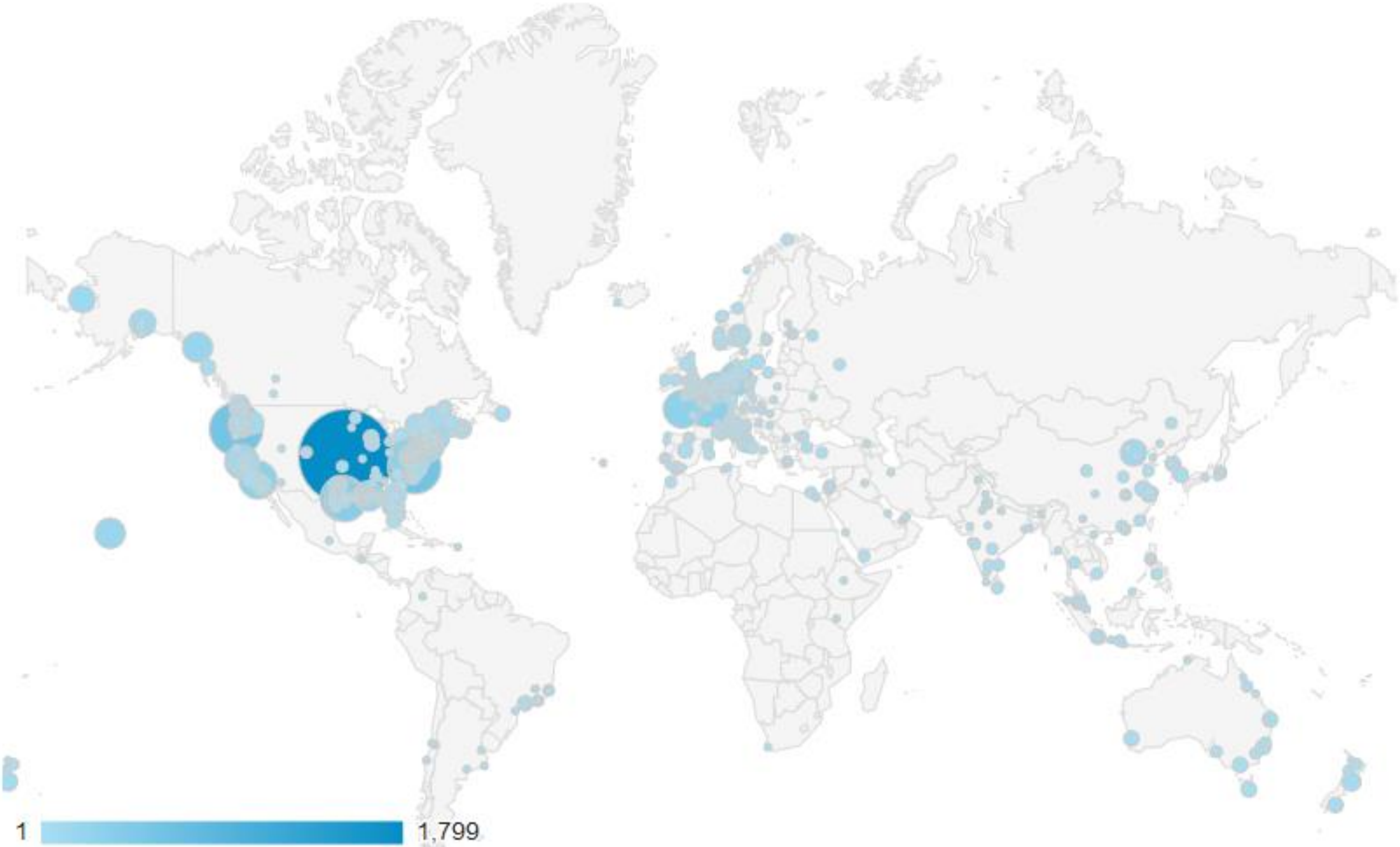
- **… BUT we have online and offline documentation!**

Manuals

https://www.hydroffice.org/manuals/soundspeed/index.html

Adoption

- NOAA OCS Vessels (through Pydro distribution)
- UNOLS Vessels (frozen, stand-alone app)
- An increasing number of hydrographic agencies and professional surveyors based on:
  - Contacts by email
  - Workshops & conferences feedback
  - Data from Google Analytics



(*) GOOGLE ANALYTICS, NUMBER OF SESSIONS, JANUARY 2018, LOCATION FILTERED: DURHAM, SILVER SPRING, SEATTLE, UNSET.

Sound Speed Manager DEMO

www.hydroffice.org/soundspeed

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

v0

SmartMap

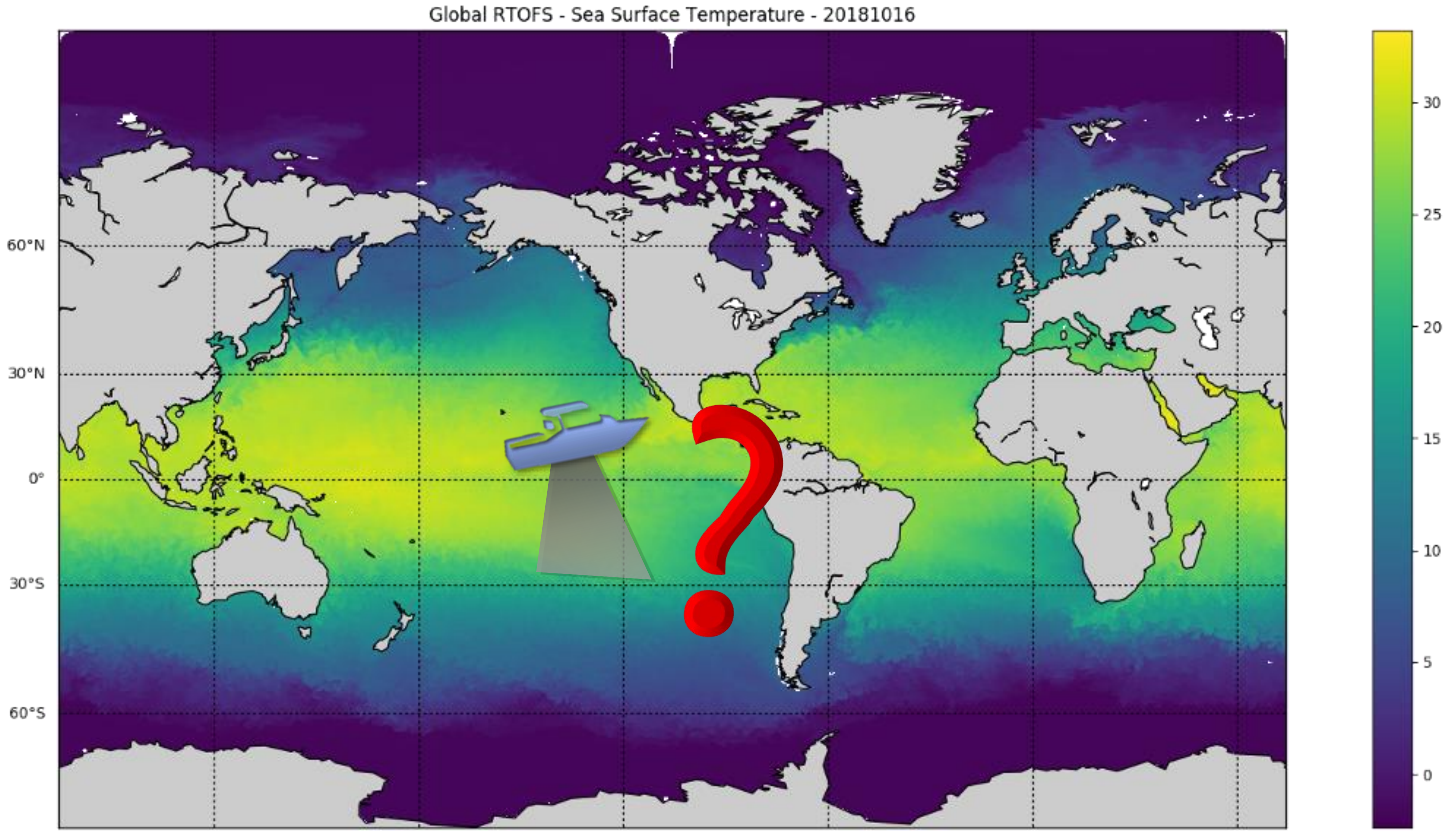
G. Masetti & T. Faulkes

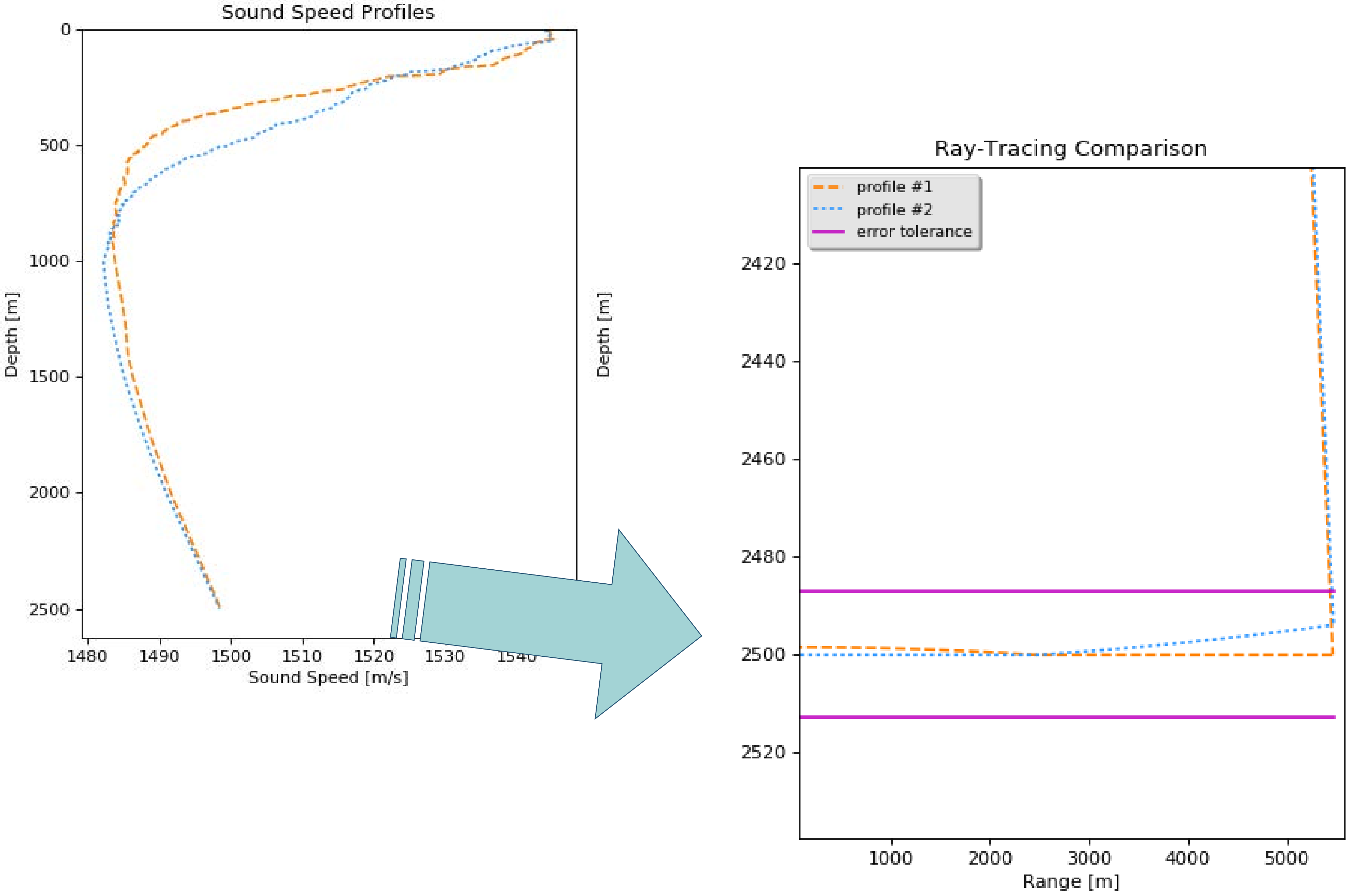
Canberra, June 18-20 2019

SmartMap

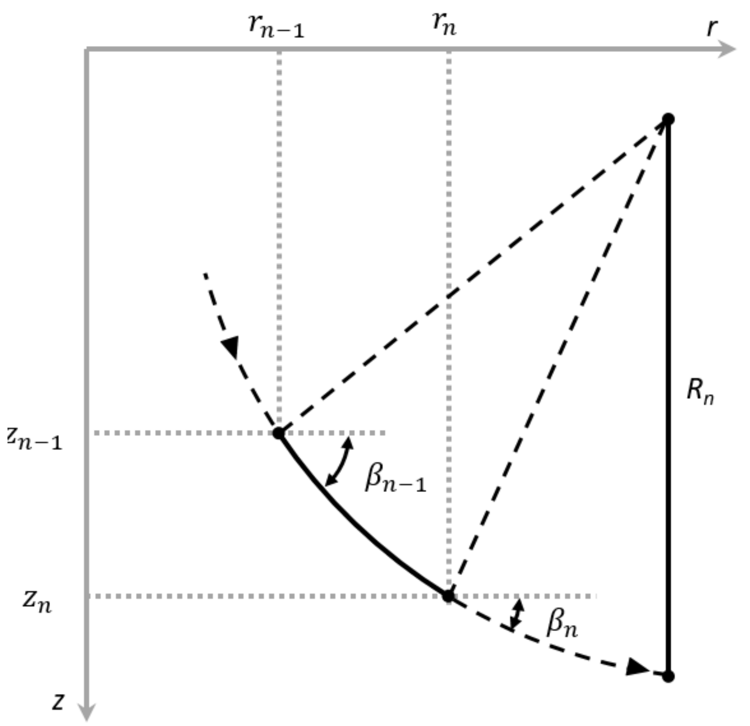
A tool to evaluate the **effects** of **oceanographic variability on mapping surveys**

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


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


Sound Speed Profiles
0
500
1000
1500
2000
2500
Depth [m]
1480
1490
1500
1510
1520
1530
1540
Sound Speed [m/s]
Depth [m]
Ray-Tracing Comparison
profile #1
profile #2
error tolerance
2420
2440
2460
2480
2500
2520
1000
2000
3000
4000
5000
Range [m]

SmartMap Algorithm

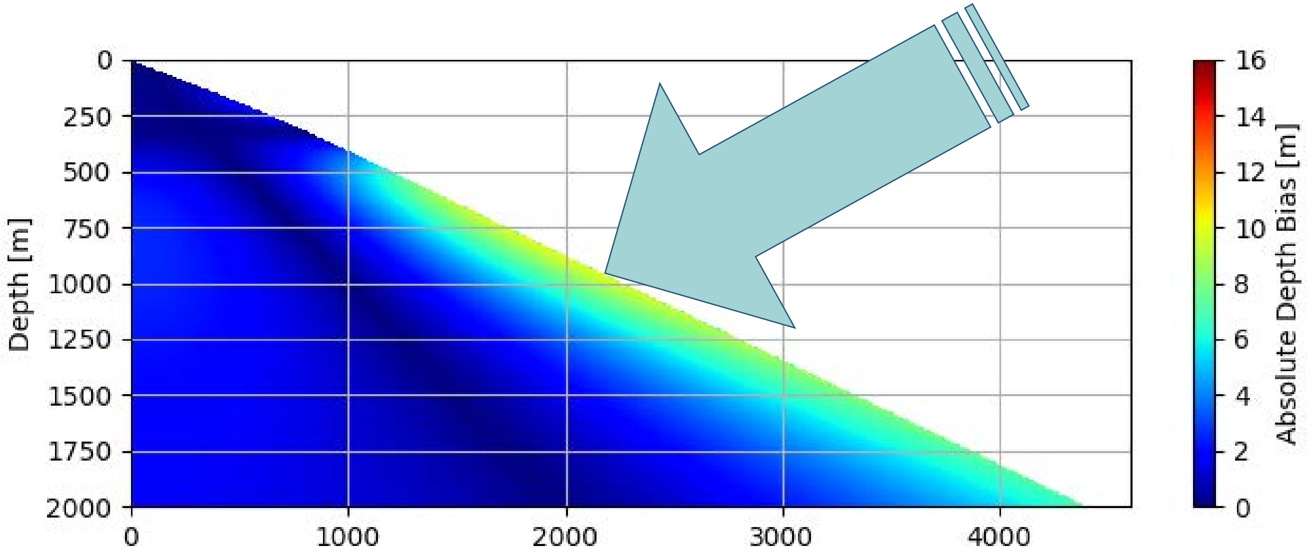


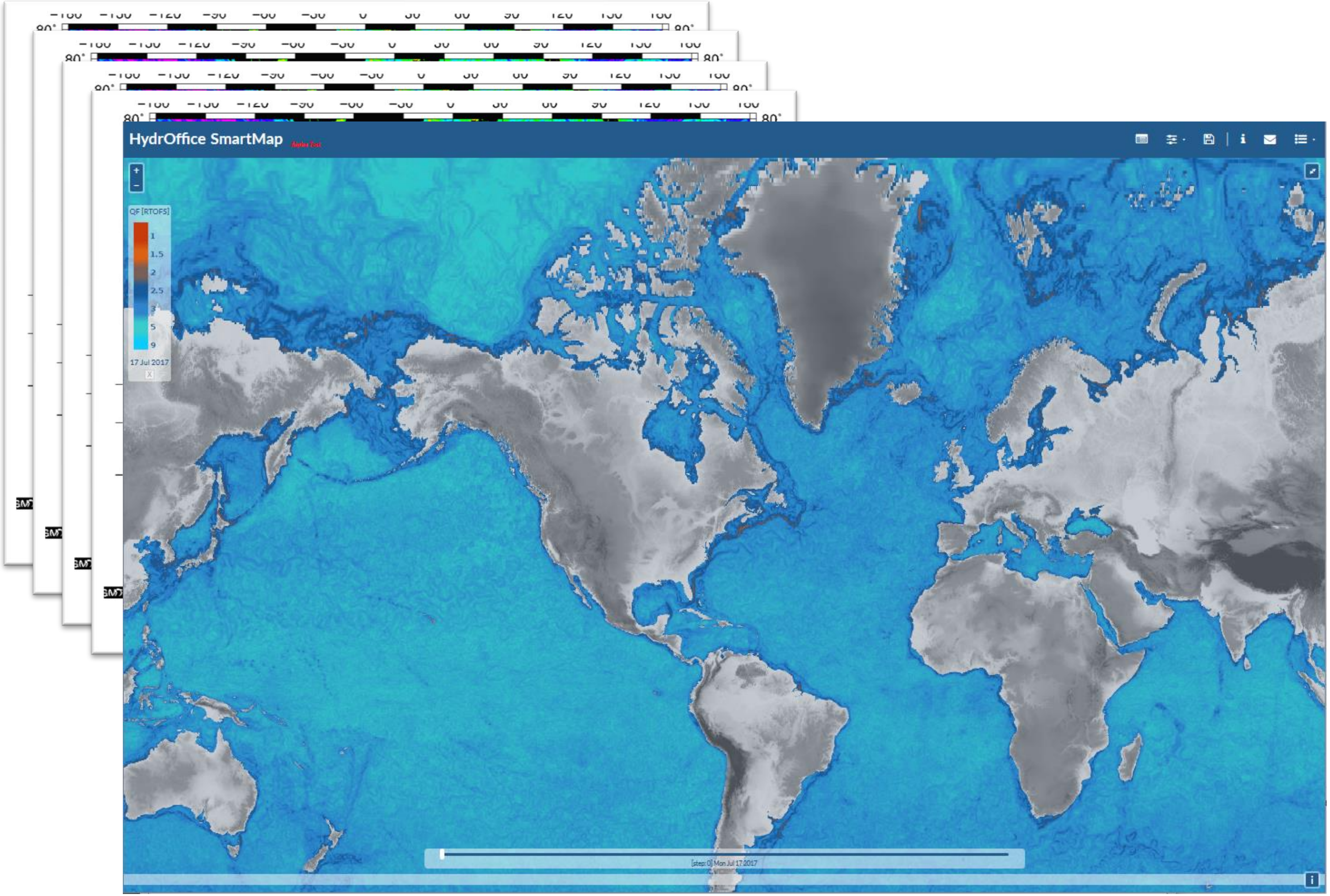
- Constant Gradient:

$$g_n = \frac{c_n - c_{n-1}}{z_n - z_{n-1}}$$

- Snell Law:

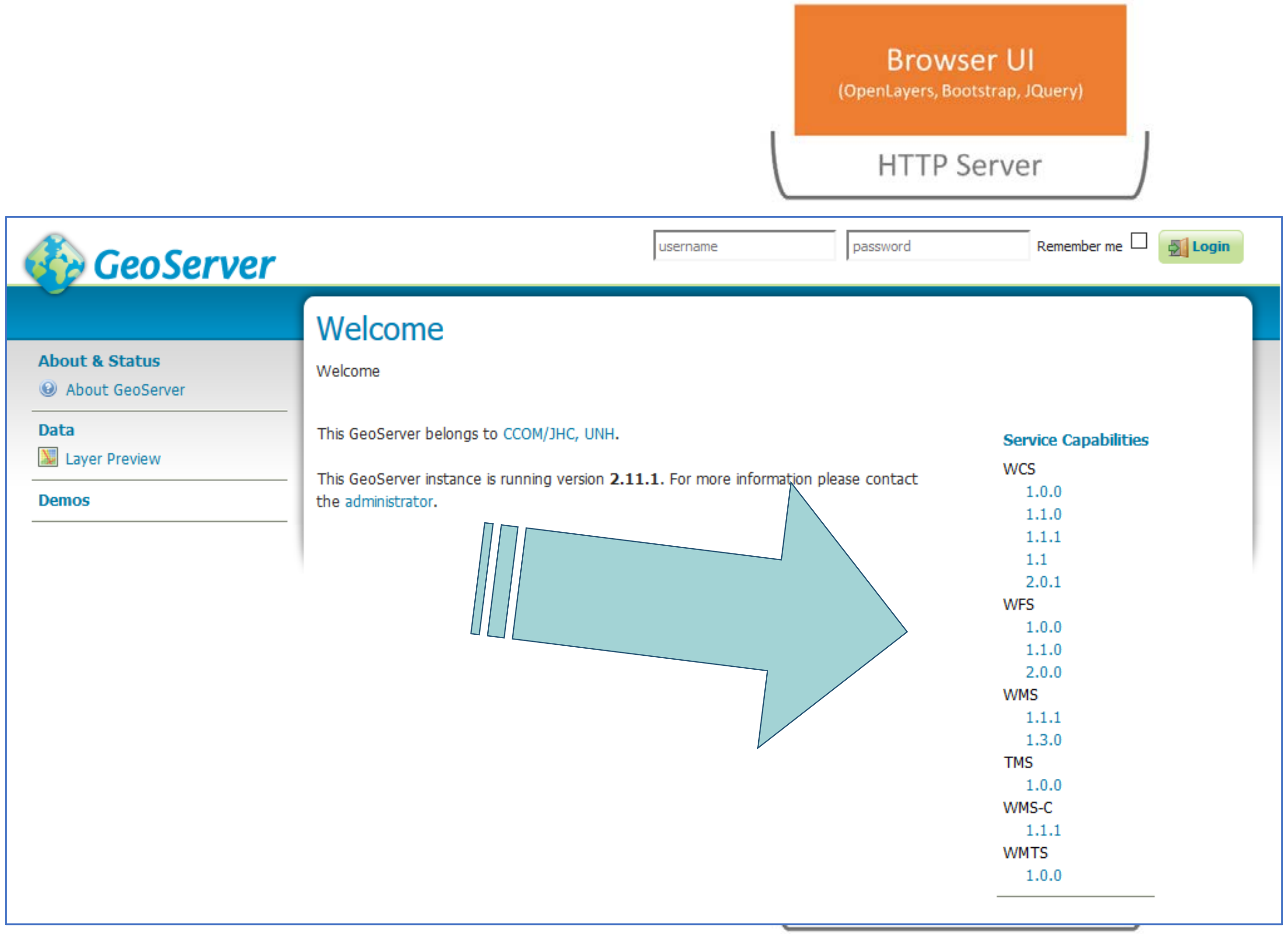
$$\frac{\cos \beta_n}{c_n} = \frac{\cos \beta_{n-1}}{c_{n-1}} = a$$




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

SmartMap components

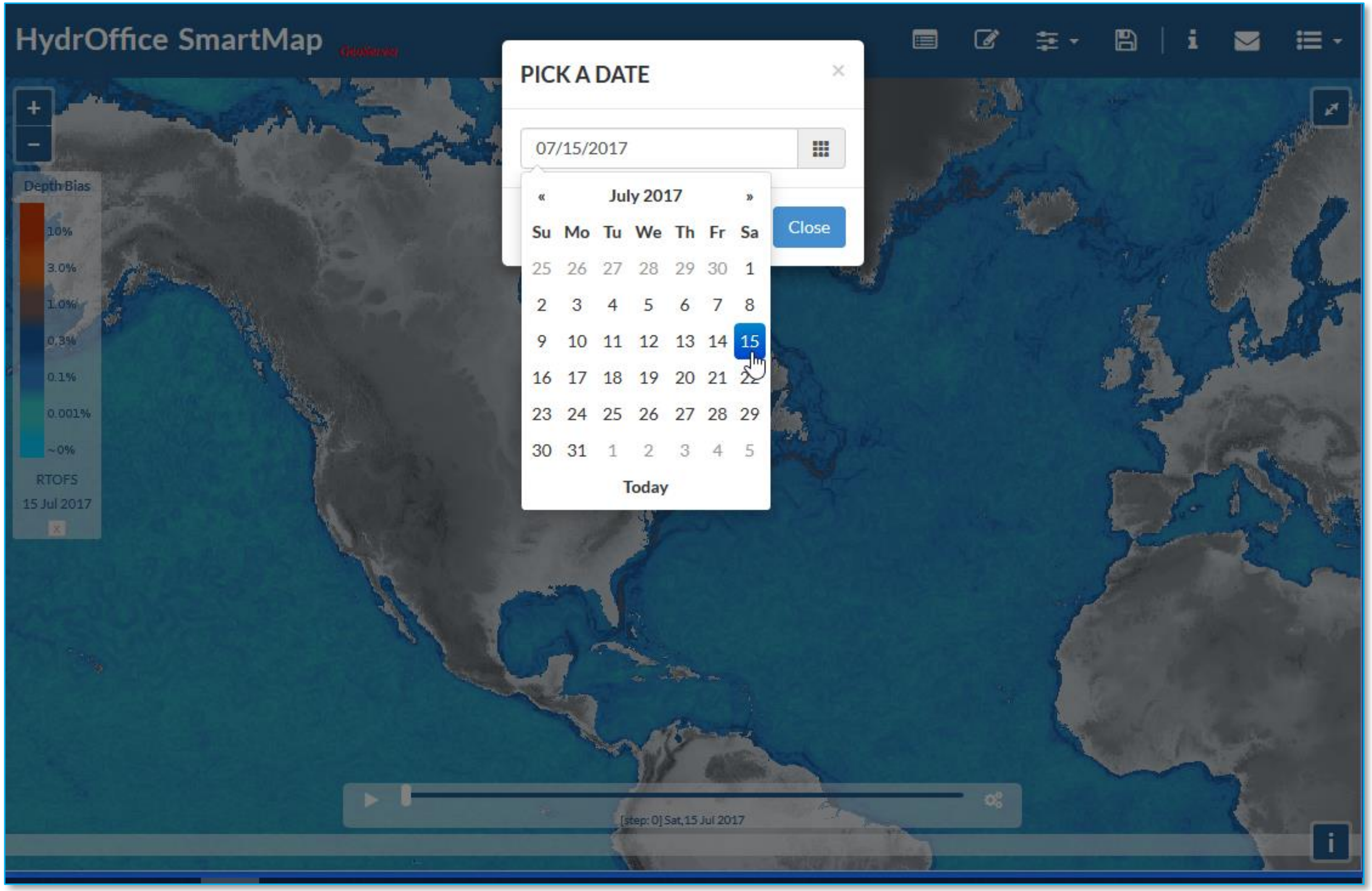
- Backend
  - C++
  - Python
- Frontend
  - GeoServer
  - OGC services
- WebGIS
  - *hydroffice.org/smartmap/*



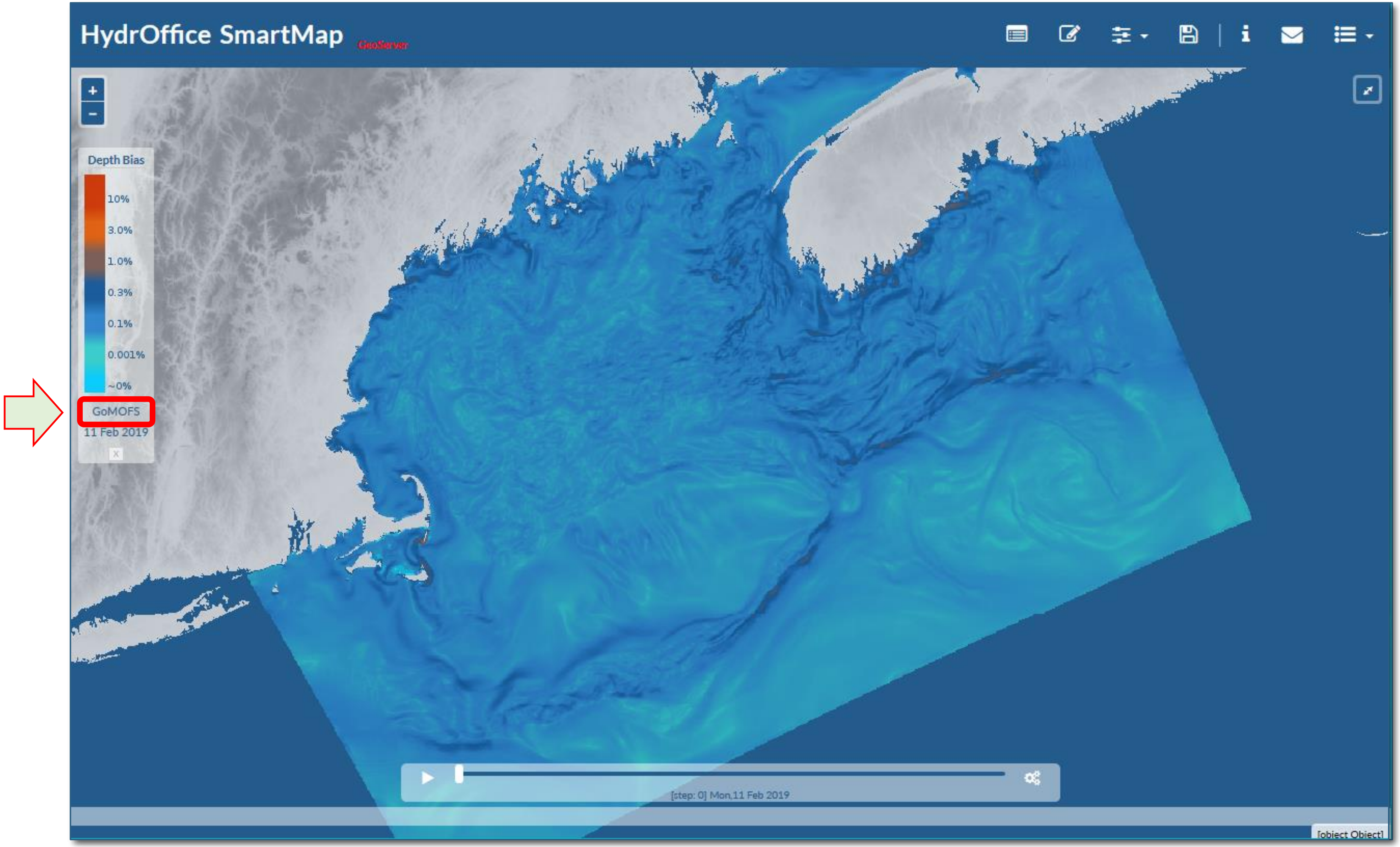
SmartMap WebGIS

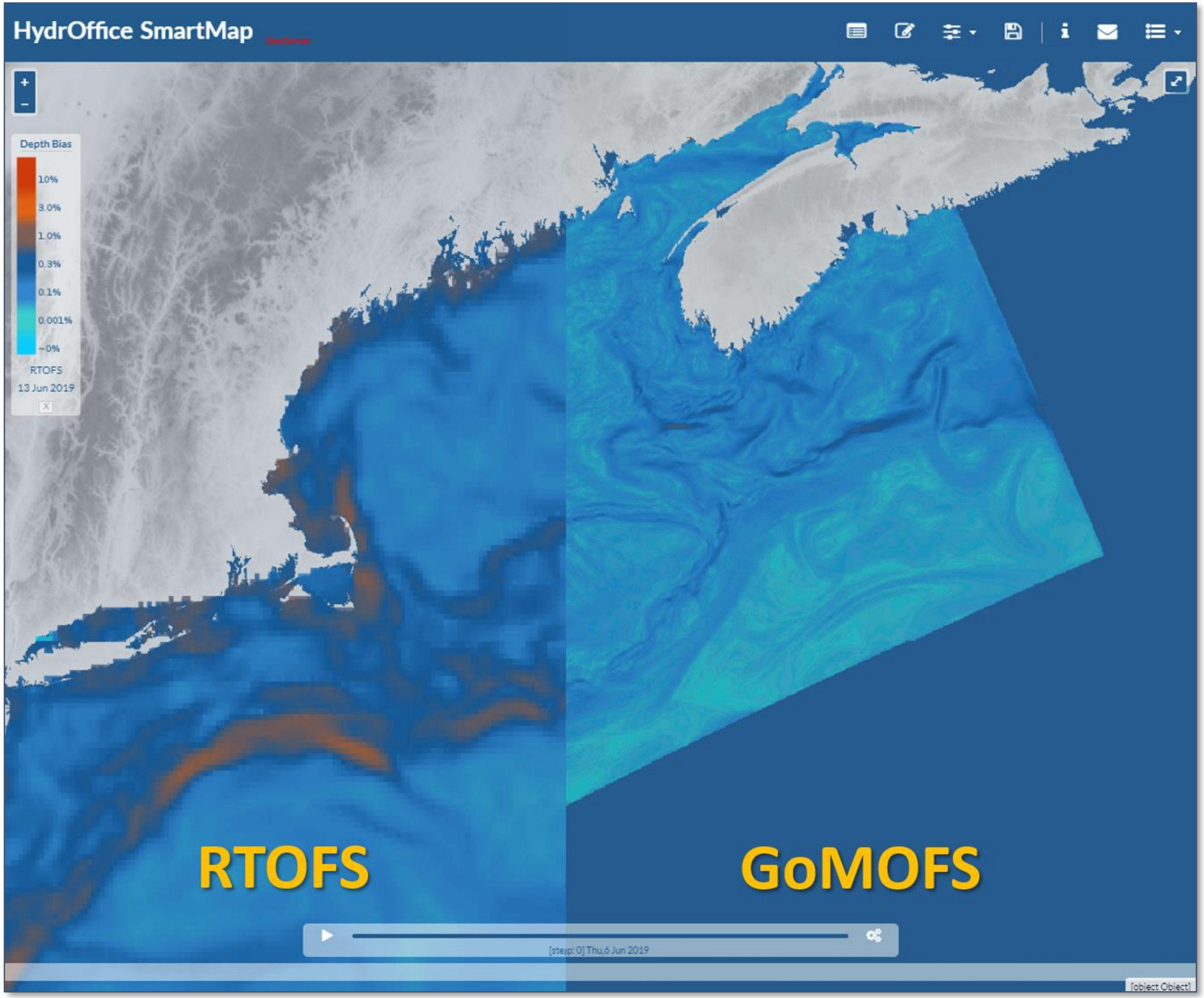
- RTOFS + WOA13 + GoMOFS
- Nowcasts + Forecasts

Past Analyses

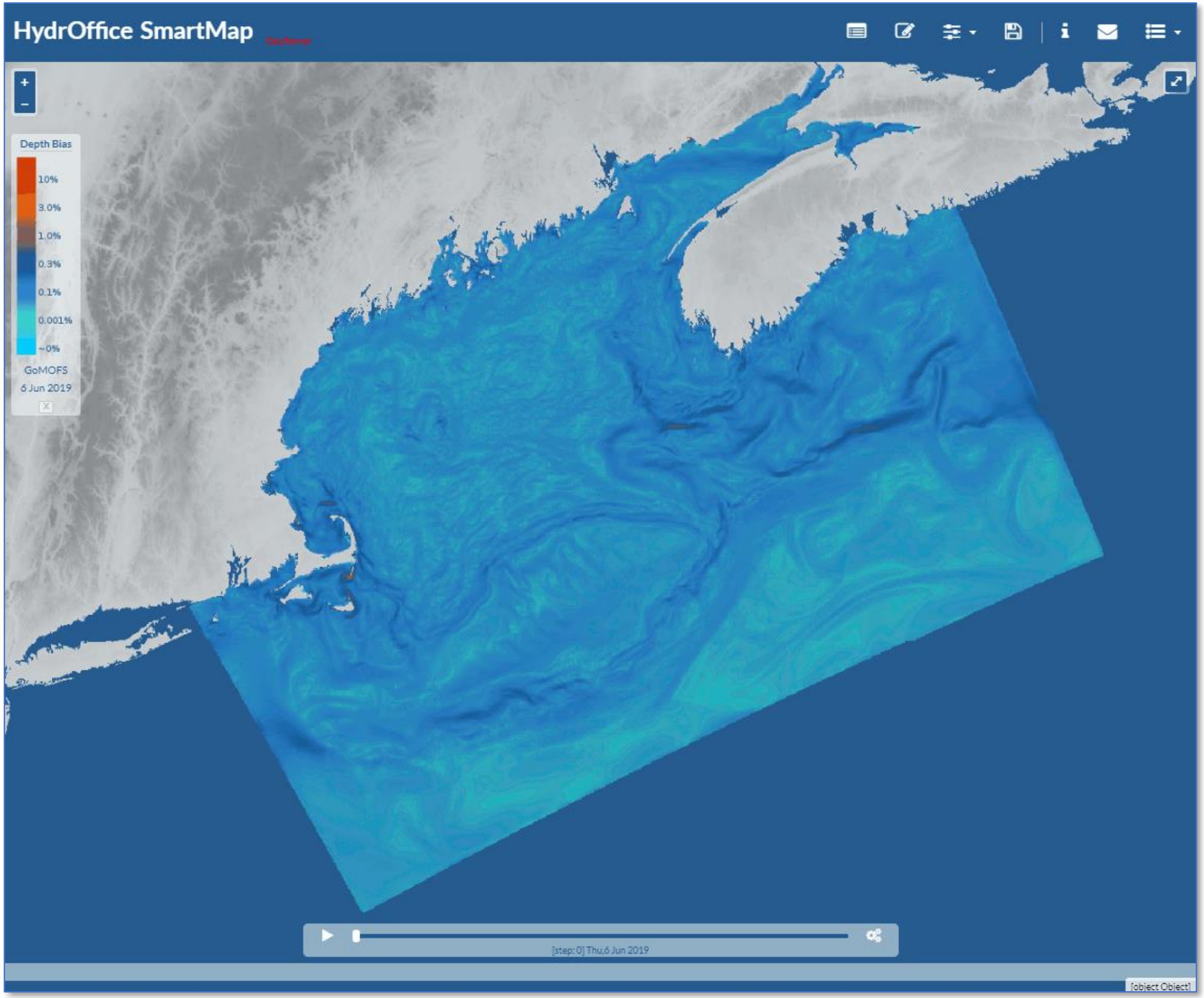


GULF OF MAINE OFS ⟶ BETA





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


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

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

v0

BRESS

G. MASETTI & T. FAULKES

CANBERRA, JUNE 18-20 2019

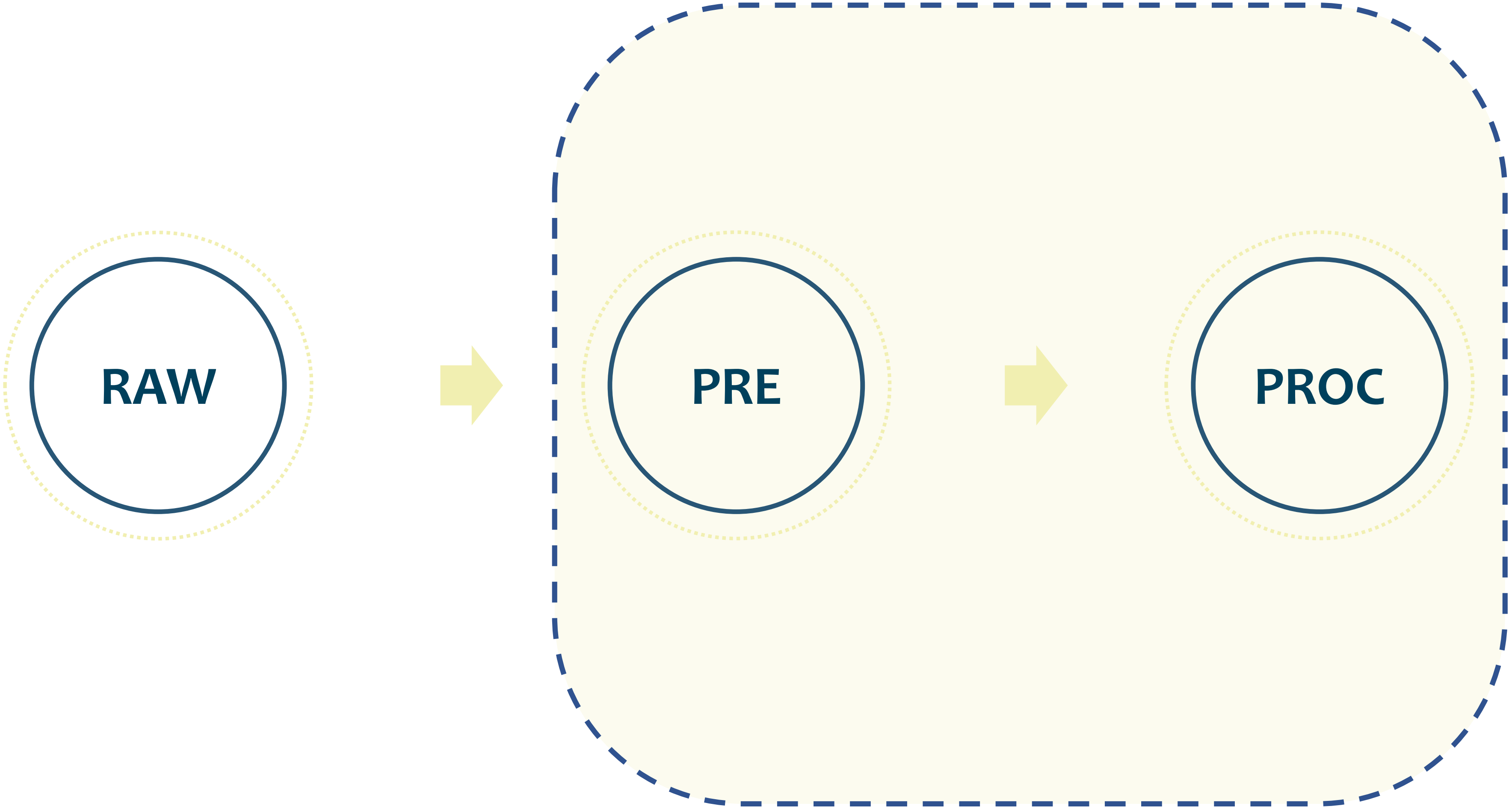
GENERAL WORKFLOW

- Data
- Acquisition

- Filtering and
- Pre-Processing

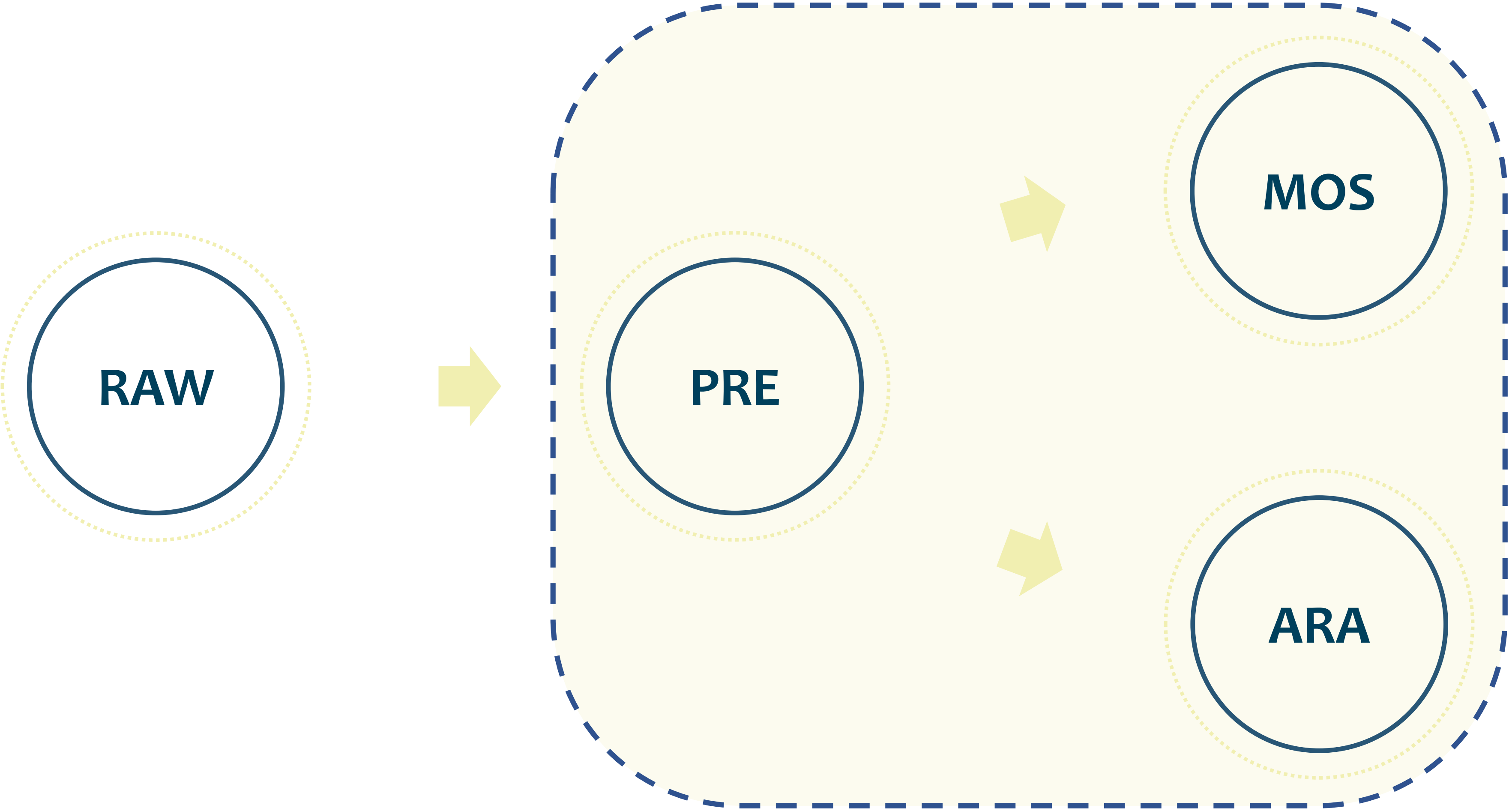
- Analysis and
- Output

GEOCODER



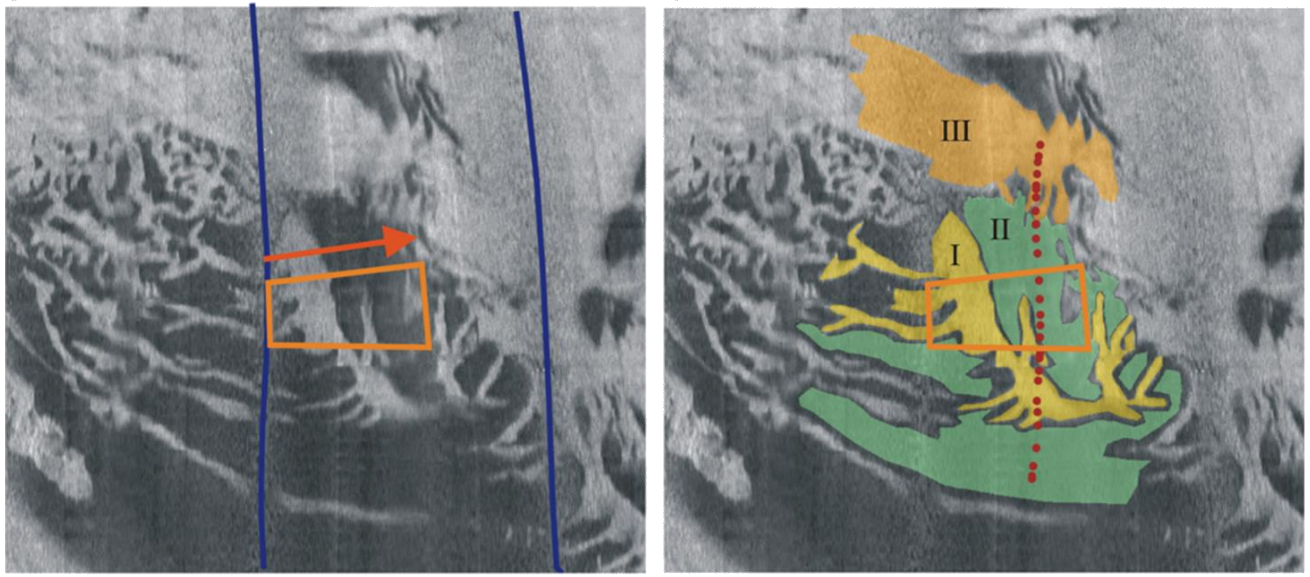
Ref.: Fonseca, L., and Mayer, L.A., *Remote estimation of surficial seafloor properties through the application of Angular Range Analysis to multibeam sonar data*, Mar. Geophysical Res., 28 (2), p. 119-126, 2007.

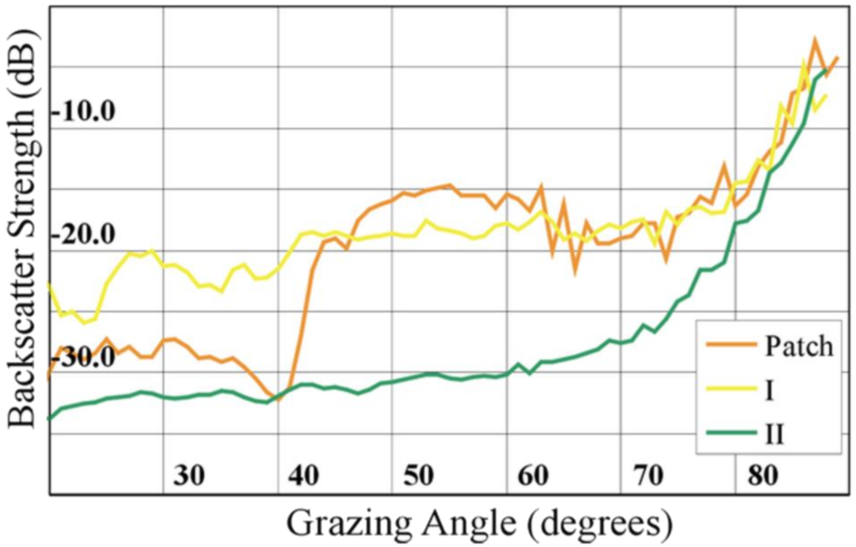
GEOCODER



Ref.: Fonseca, L., and Mayer, L.A., *Remote estimation of surficial seafloor properties through the application of Angular Range Analysis to multibeam sonar data*, Mar. Geophysical Res., 28 (2), p. 119-126, 2007.

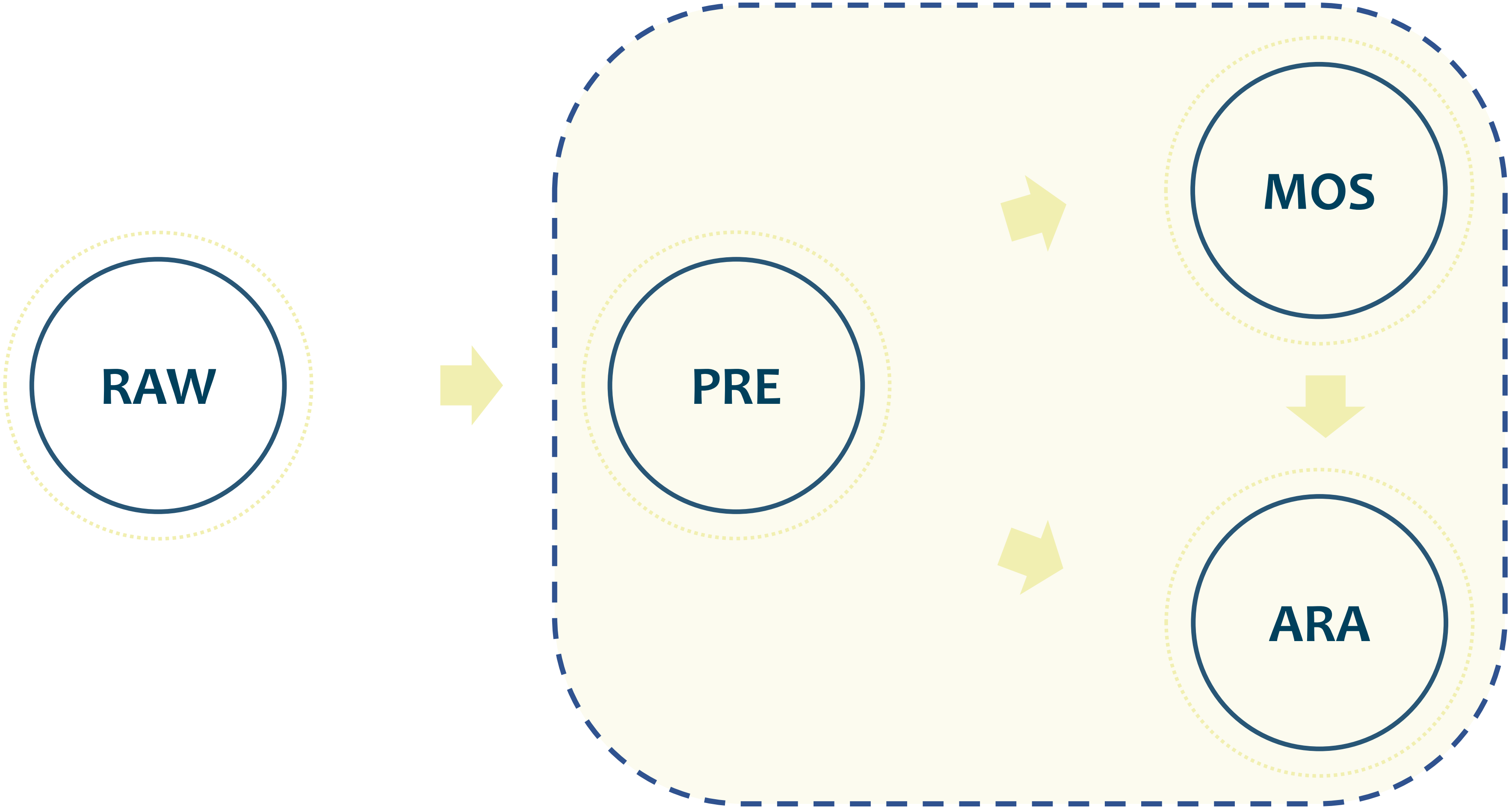
PATCH-BASED VS. THEME-BASED ARA





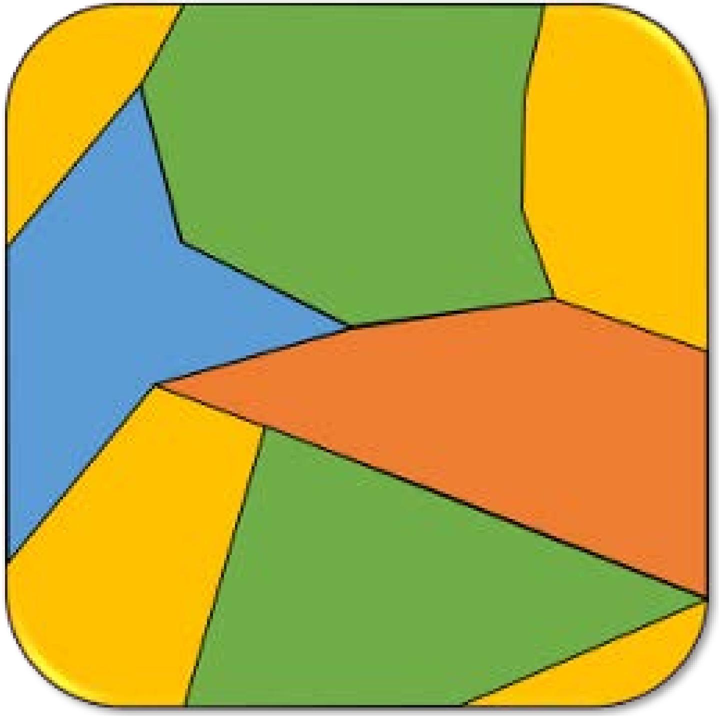
Ref.: Fonseca, L. et al., *Angular range analysis of acoustic themes from Stanton Banks Ireland*, Applied Acoustics, vol. 70. pp. 1298-1304, 2009.

GEOCODER



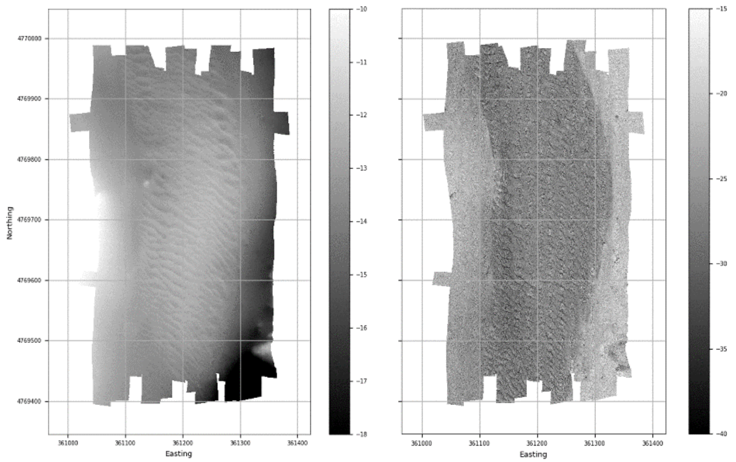
Ref.: Fonseca, L., and Mayer, L.A., *Remote estimation of surficial seafloor properties through the application of Angular Range Analysis to multibeam sonar data*, Mar. Geophysical Res., 28 (2), p. 119-126, 2007.

BRESS



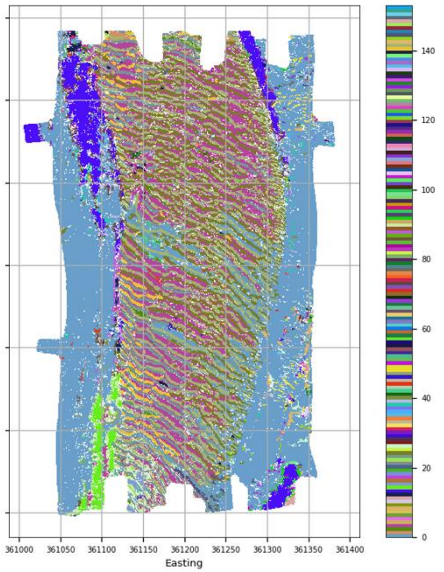
Preliminary segmentation from co-located DEMs and backscatter mosaics

Based on principles of:
Topographic openness
Pattern recognition
Texture classification



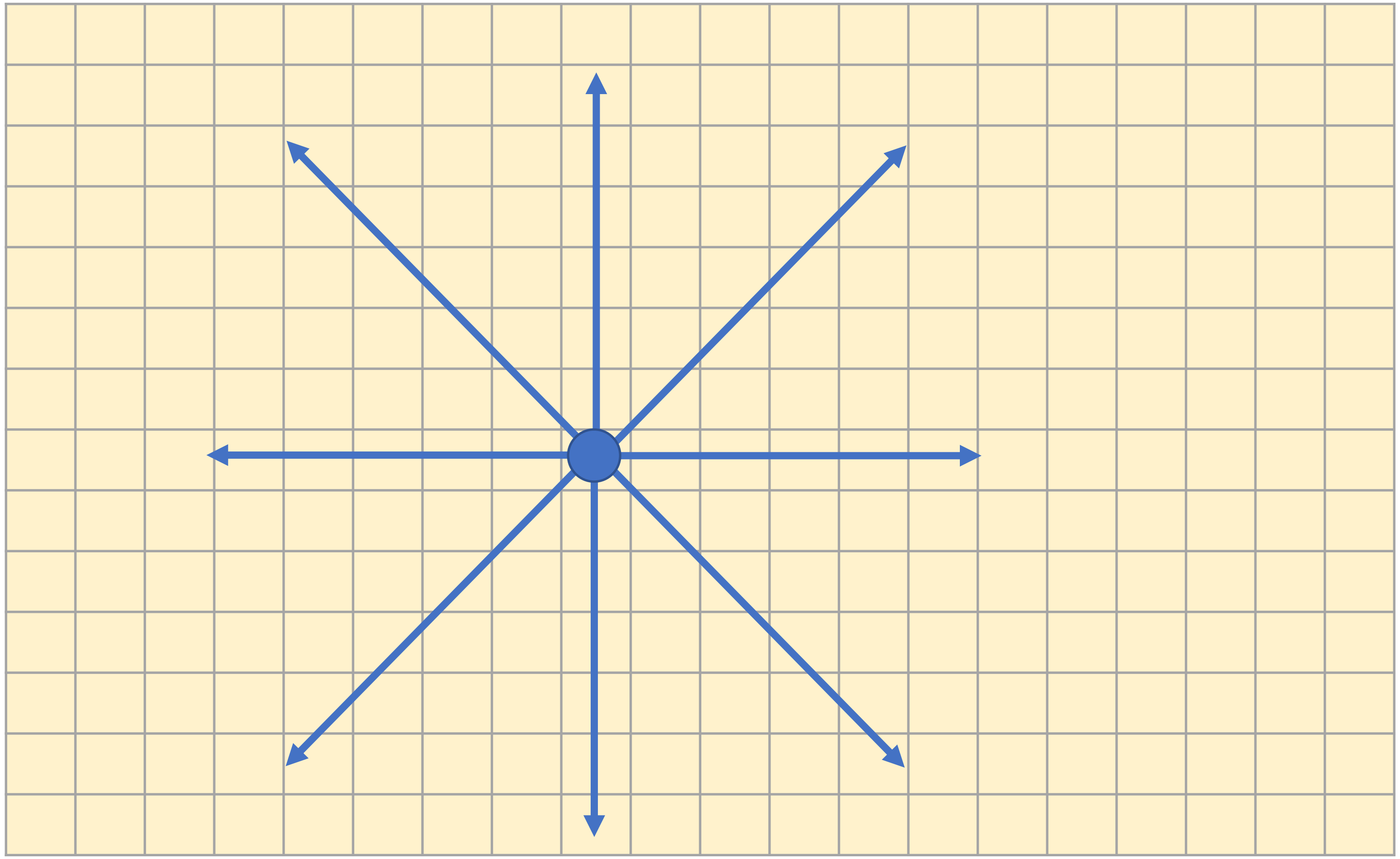
Inputs: DTM and mosaic

Five steps

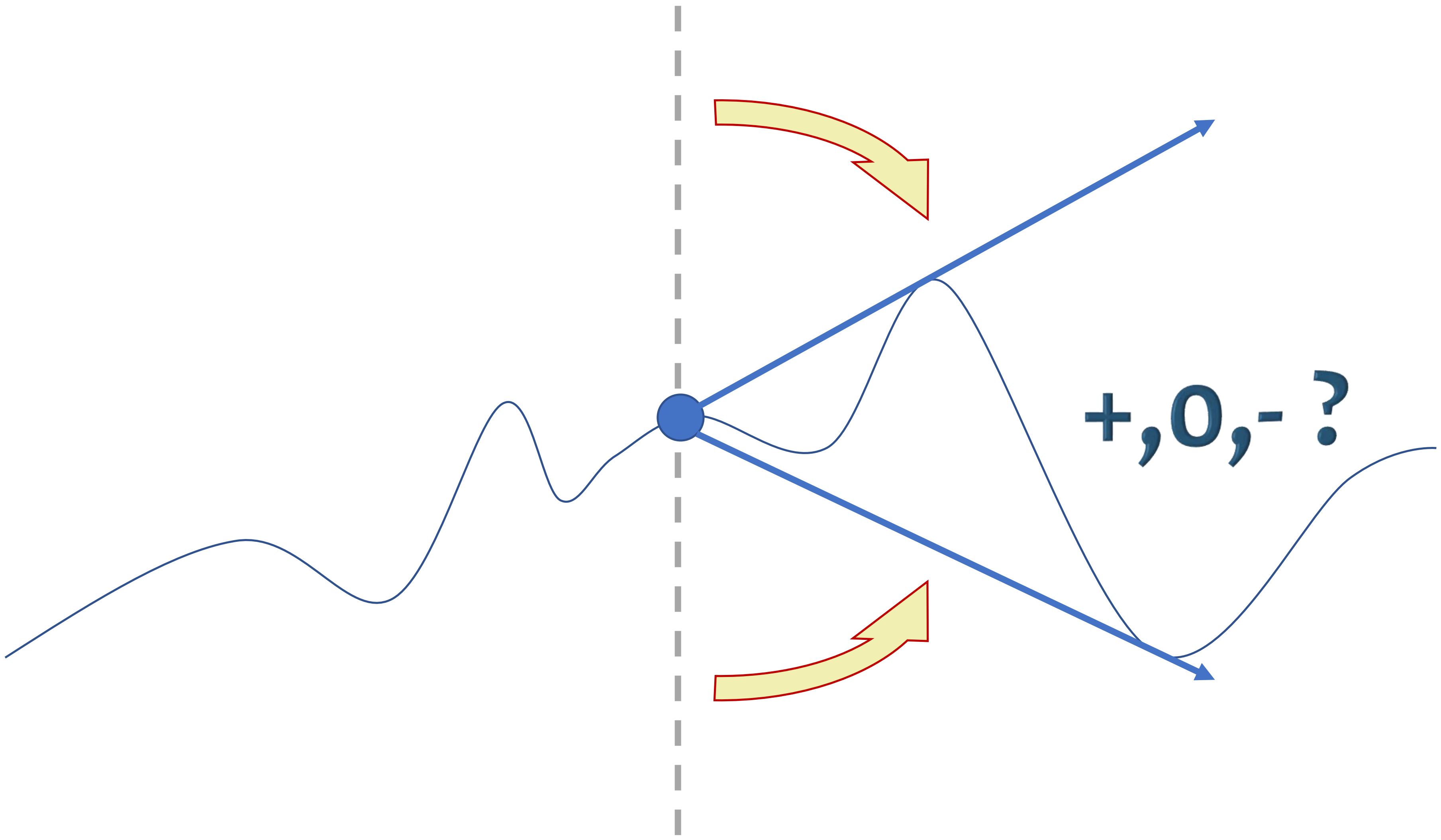


Outputs: segments (same landform, similar texture)

#1 Local Ternary Patterns

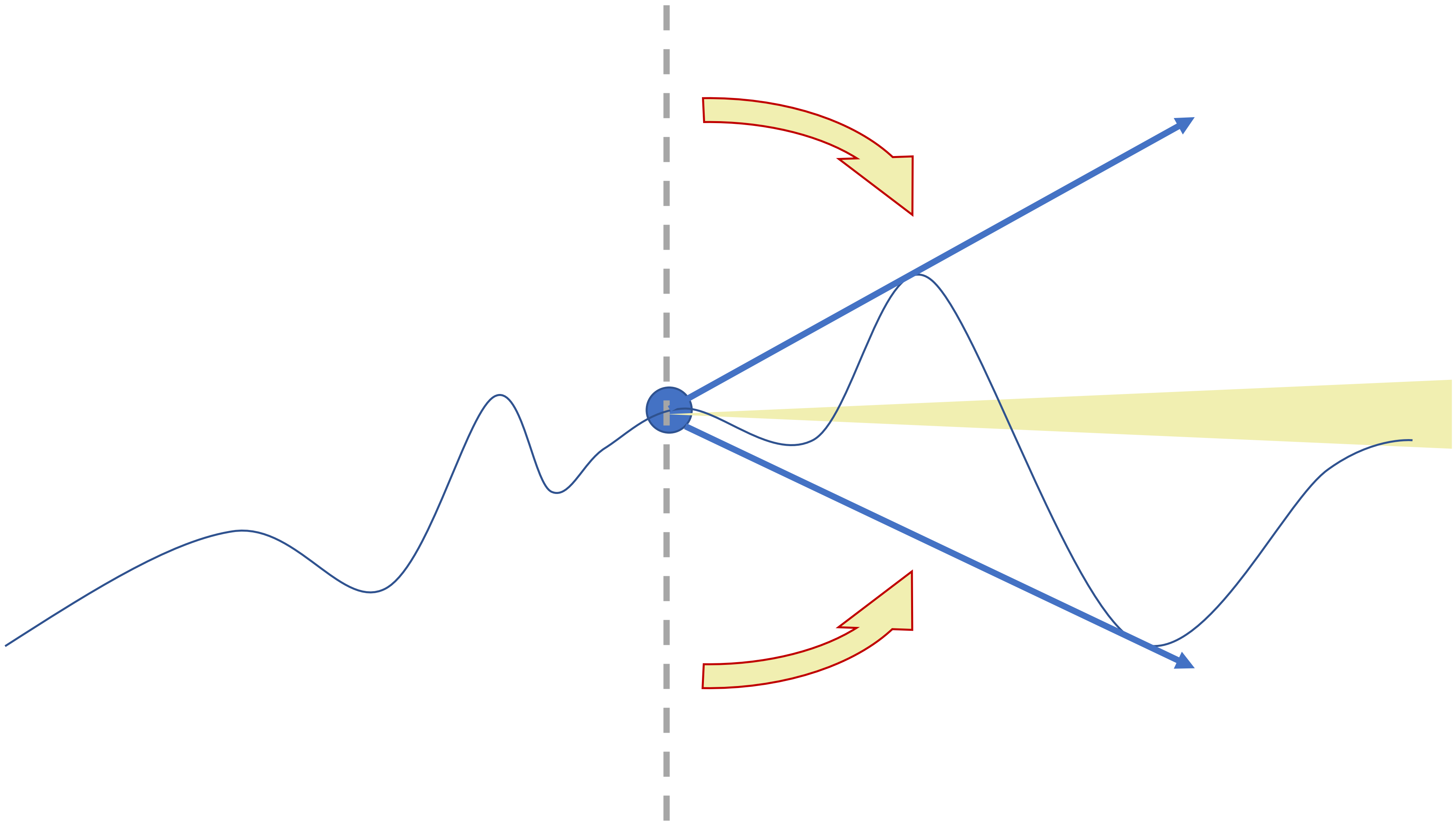


#1 Local Ternary Patterns

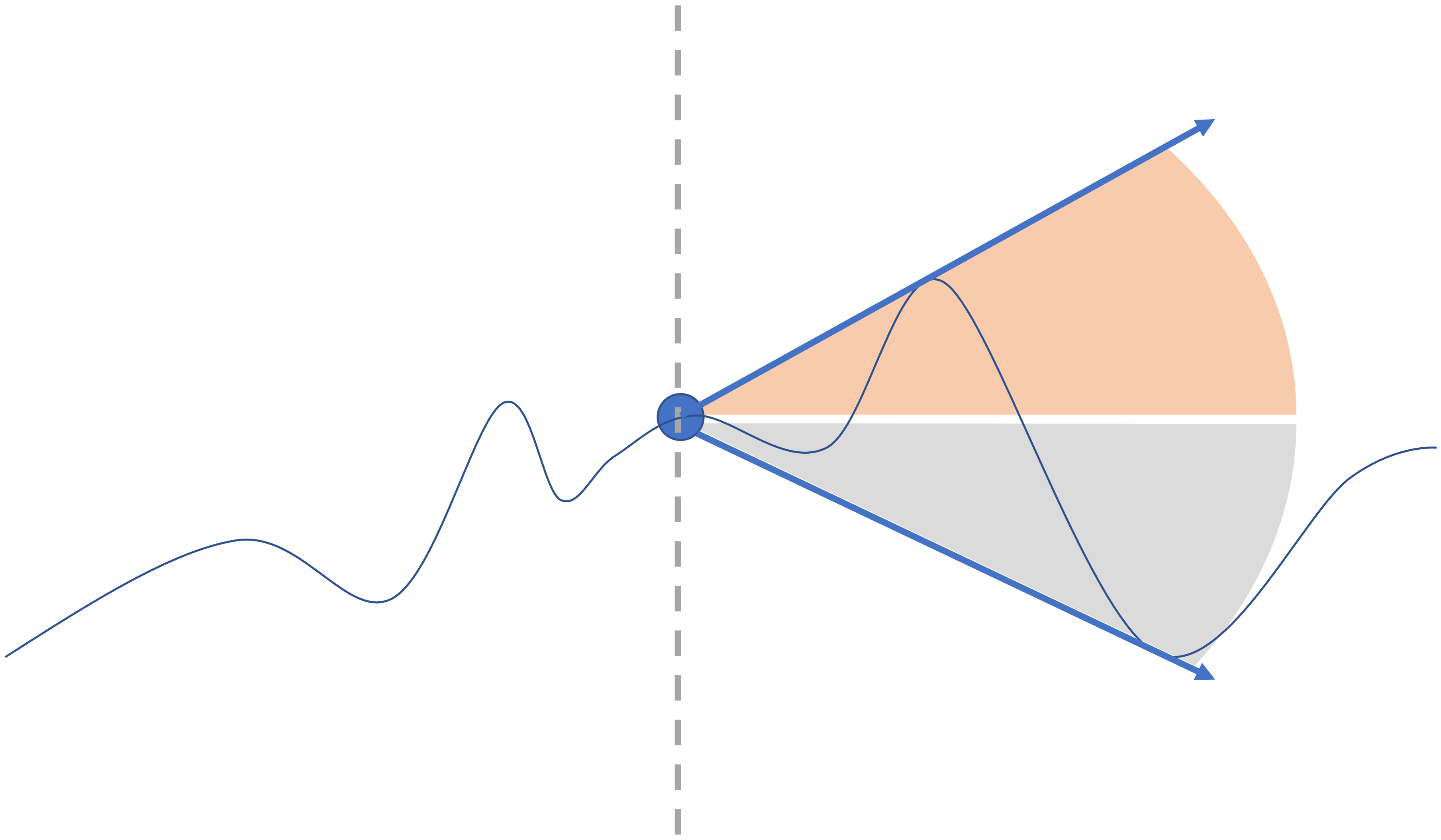


Example of a profile looking at just one of the eight directions

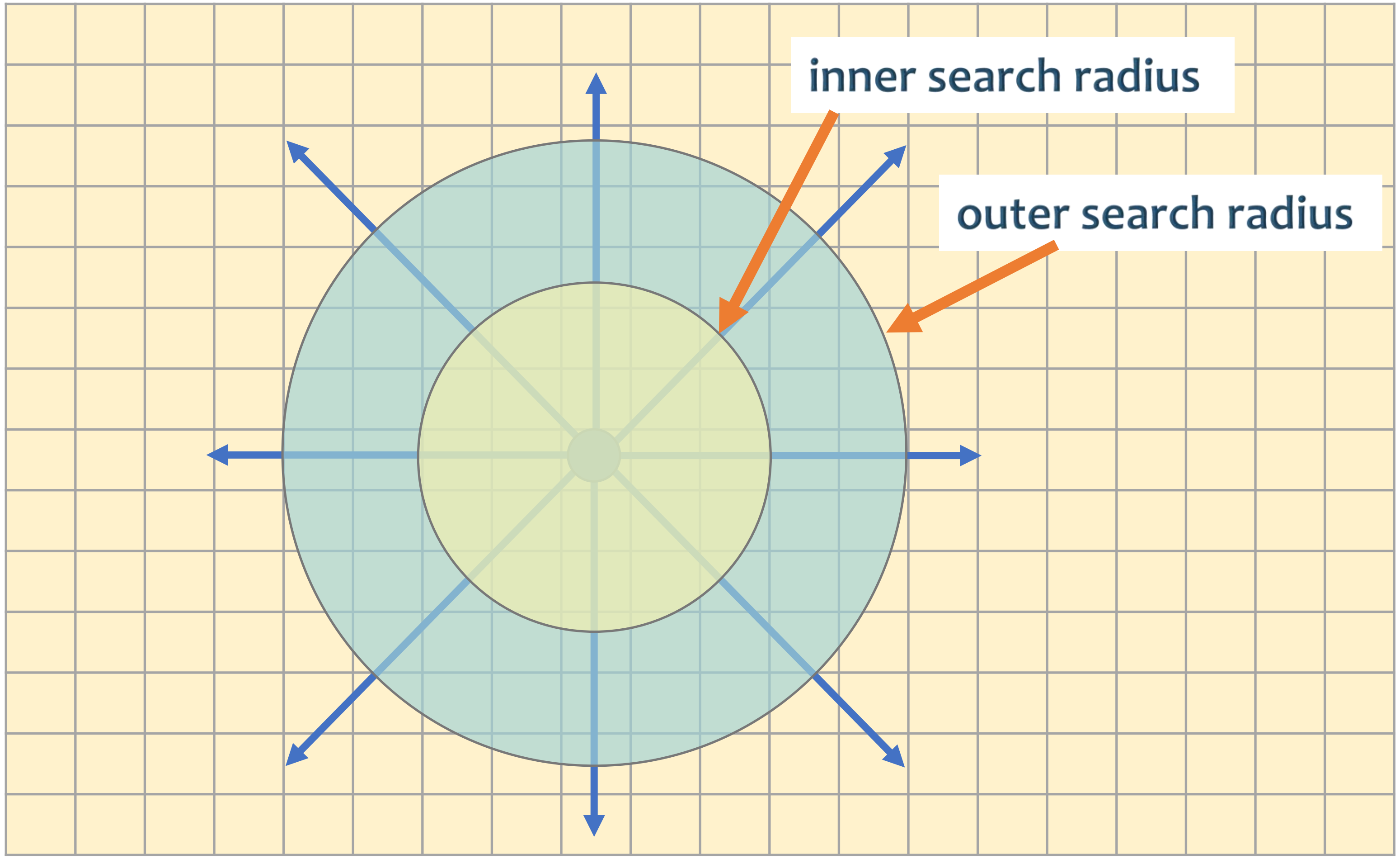
Delta Angle for Openness



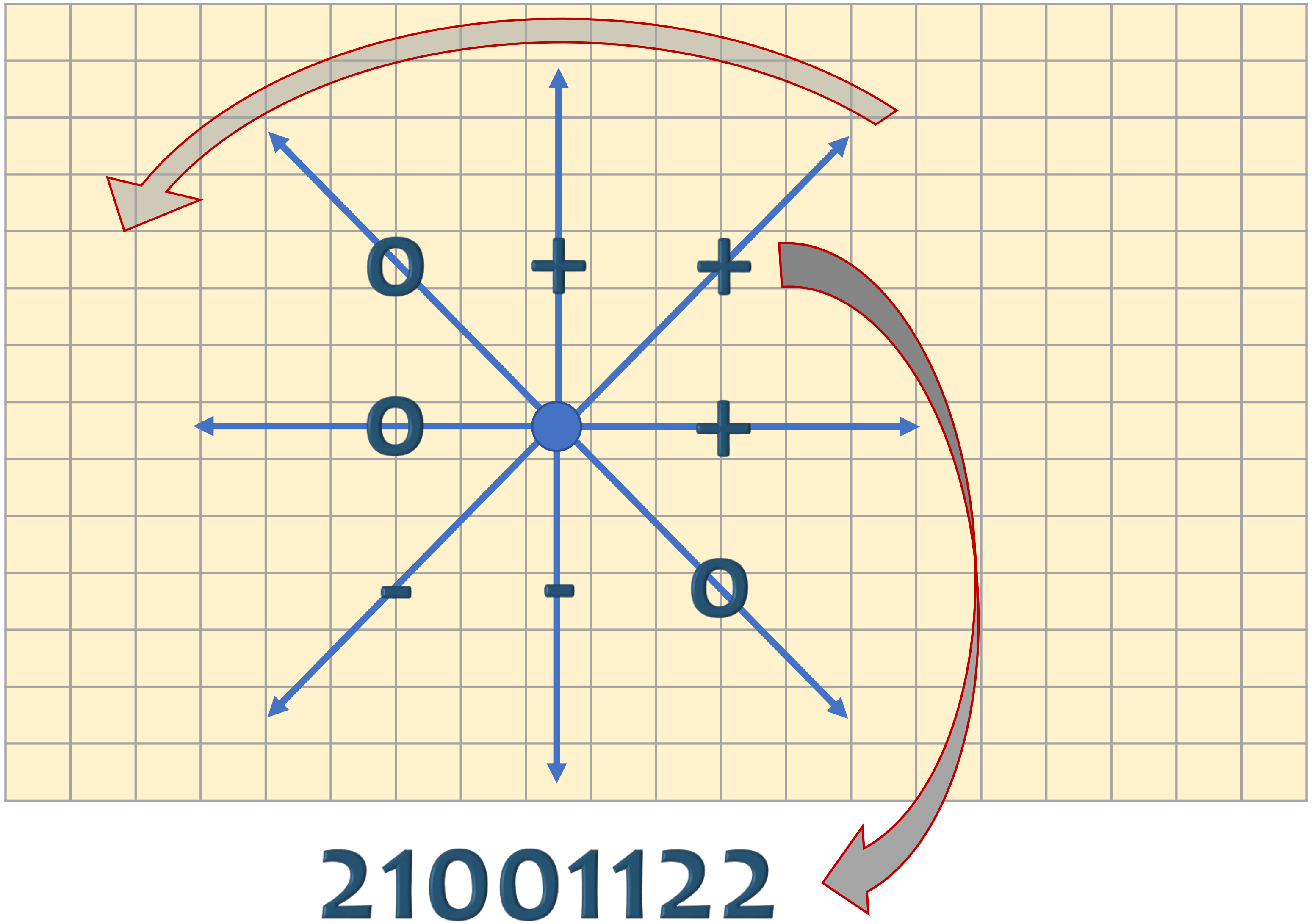
Largest Angle for Openness



Search Annulus

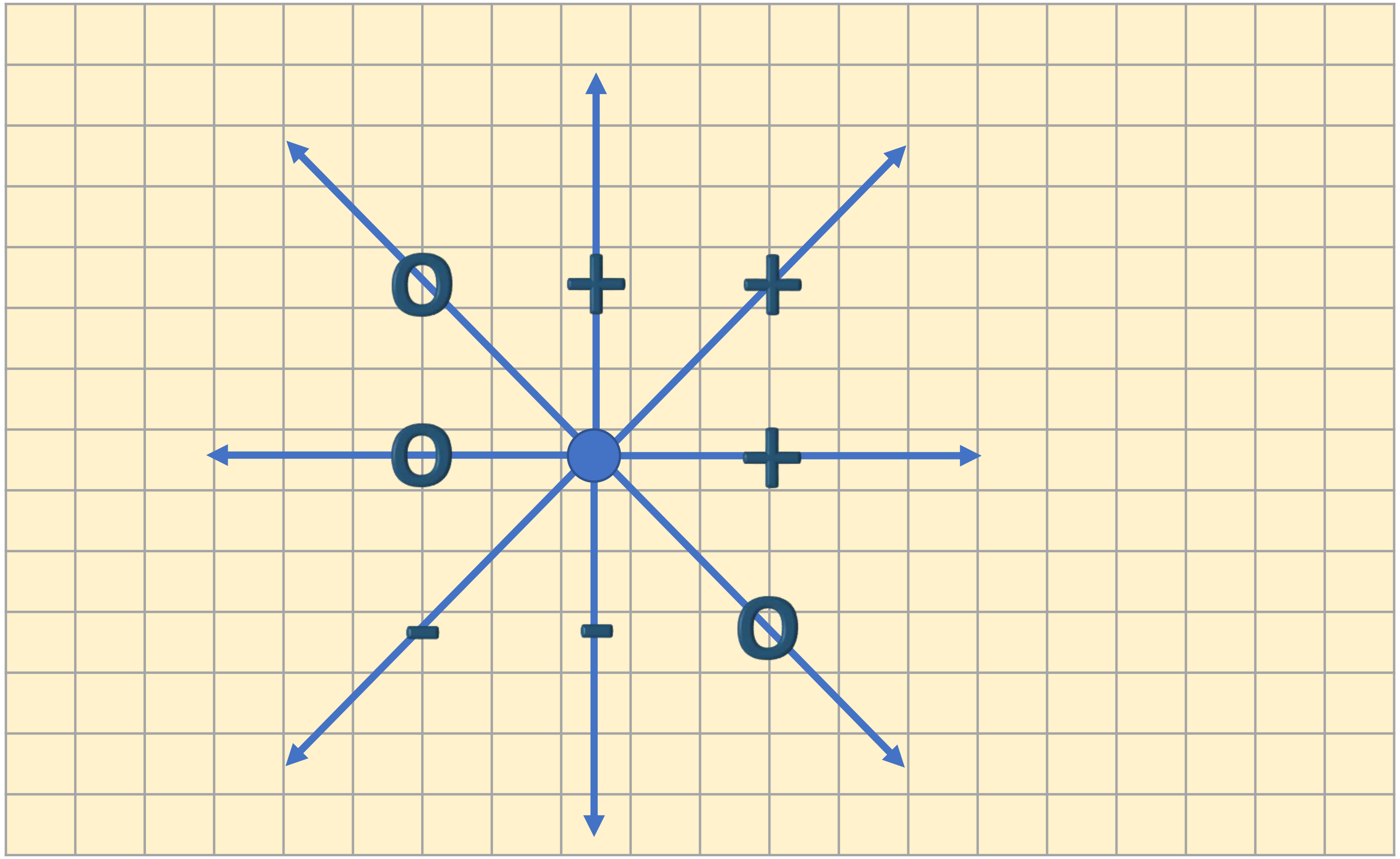


#1 Local Ternary Patterns



21001122

#2 Morphons

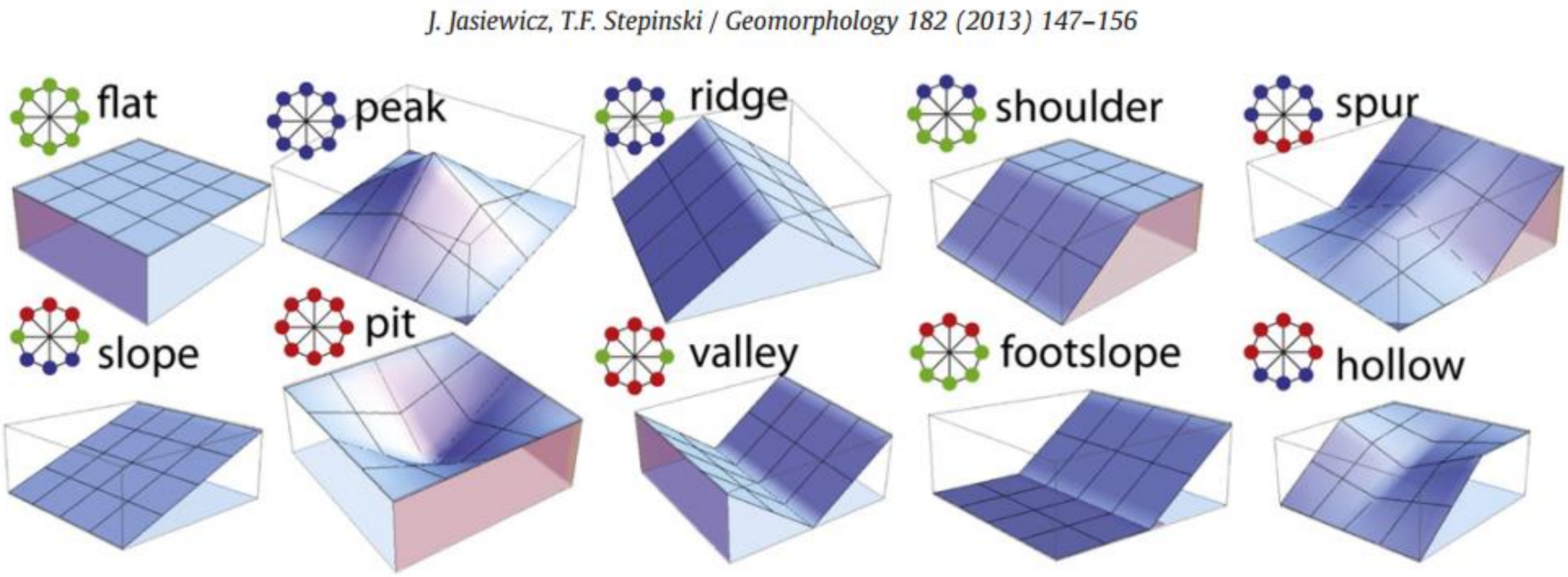


#2 Morphons

$3^8 = 6{,}561 \Rightarrow 498$

After rotation and mirroring

#3 Landforms



Ref.: Jasiewicz, J., Stepinski, T.F., *Geomorphons - a pattern recognition approach to classification and mapping of landforms*, Geomorphology, 182, 147-156, 2013.

#3 Landforms

10-type Classification Table

FL: Flat
PK: Peak
RI: Ridge
SH: Shoulder
CV: Convex Slope/Spur
SL: Slope
CN: Concave Slope/Hollow
FS: Footslope
VL: Valley
PT: Pit

-\+	0	1	2	3	4	5	6	7	8
0	FL	FL	FL	FS	FS	VL	VL	VL	PT
1	FL	FL	FS	FS	FS	VL	VL	VL	
2	FL	SH	SL	SL	CN	CN	VL		
3	SH	SH	SL	SL	SL	CN			
4	SH	SH	CV	SL	SL				
5	RI	RI	CV	CV					
6	RI	RI	RI						
7	RI	RI							
8	PK								

#3 Landforms

6-type Classification Table

FL: Flat
~~PK: Peak~~
RI: Ridge
SH: Shoulder
~~CV: Convex Slope/Spur~~
SL: Slope
~~CN: Concave Slope/Hollow~~
FS: Footslope
VL: Valley
~~PT: Pit~~

-\\+	0	1	2	3	4	5	6	7	8
0	FL	FL	FL	FS	FS	VL	VL	VL	VL
1	FL	FL	FS	FS	FS	VL	VL	VL	
2	FL	SH	SL	SL	SL	VL	VL		
3	SH	SH	SL	SL	SL	SL			
4	SH	SH	SL	SL	SL				
5	RI	RI	RI	SL					
6	RI	RI	RI						
7	RI	RI							
8	RI								

#3 Landforms

6-type Classification Table

FL: Flat

RI: Ridge
SH: Shoulder

SL: Slope

FS: Footslope
VL: Valley

-\+	0	1	2	3	4	5	6	7	8
0	FL	FL	FL	FS	FS	VL	VL	VL	VL
1	FL	FL	FS	FS	FS	VL	VL	VL	
2	FL	SH	SL	SL	SL	VL	VL		
3	SH	SH	SL	SL	SL	SL			
4	SH	SH	SL	SL	SL				
5	RI	RI	RI	SL					
6	RI	RI	RI						
7	RI	RI							
8	RI								

#3 Landforms

4-type Classification Table

FL: Flat

RI: Ridge
~~SH: Shoulder~~

SL: Slope

~~FS: Footslope~~
VL: Valley

-\+	0	1	2	3	4	5	6	7	8
0	FL	FL	FL	SL	VL	VL	VL	VL	VL
1	FL	FL	SL	SL	VL	VL	VL	VL	
2	FL	SL	SL	SL	SL	VL	VL		
3	SL	SL	SL	SL	SL	SL			
4	RI	RI	SL	SL	SL				
5	RI	RI	RI	SL					
6	RI	RI	RI						
7	RI	RI							
8	RI								

#3 Landforms

4-type Classification Table

FL: Flat

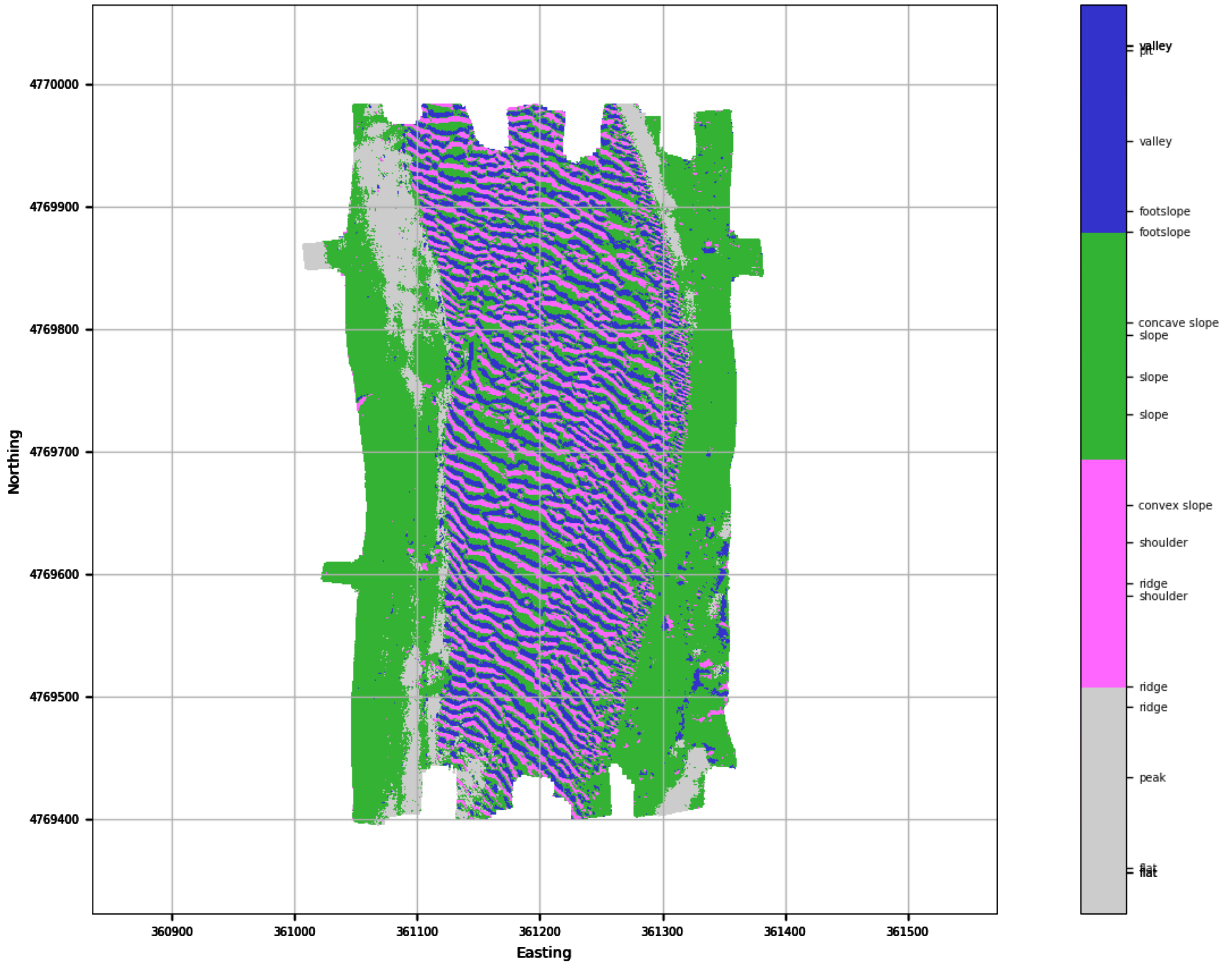
RI: Ridge

SL: Slope

VL: Valley

-\+	0	1	2	3	4	5	6	7	8
0	FL	FL	FL	SL	VL	VL	VL	VL	VL
1	FL	FL	SL	SL	VL	VL	VL	VL	
2	FL	SL	SL	SL	SL	VL	VL		
3	SL	SL	SL	SL	SL	SL			
4	RI	RI	SL	SL	SL				
5	RI	RI	RI	SL					
6	RI	RI	RI						
7	RI	RI							
8	RI								

#3 Landforms

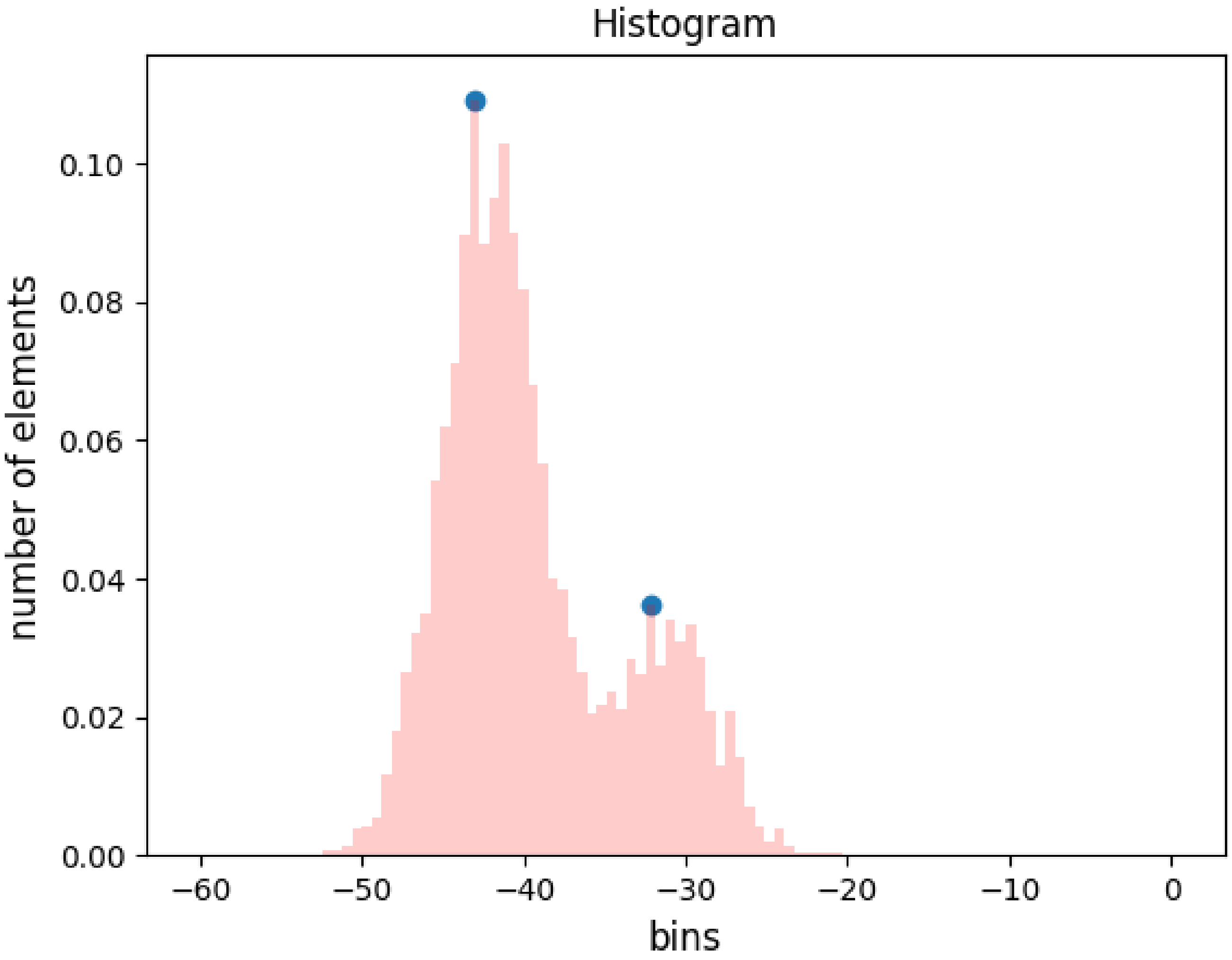


4770000
4769900
4769800
4769700
4769600
4769500
4769400
Northing
360900
361000
361100
361200
361300
361400
361500
Easting
valley
pit
valley
footslope
footslope
concave slope
slope
slope
slope
convex slope
shoulder
ridge
shoulder
ridge
ridge
peak
flat
flat

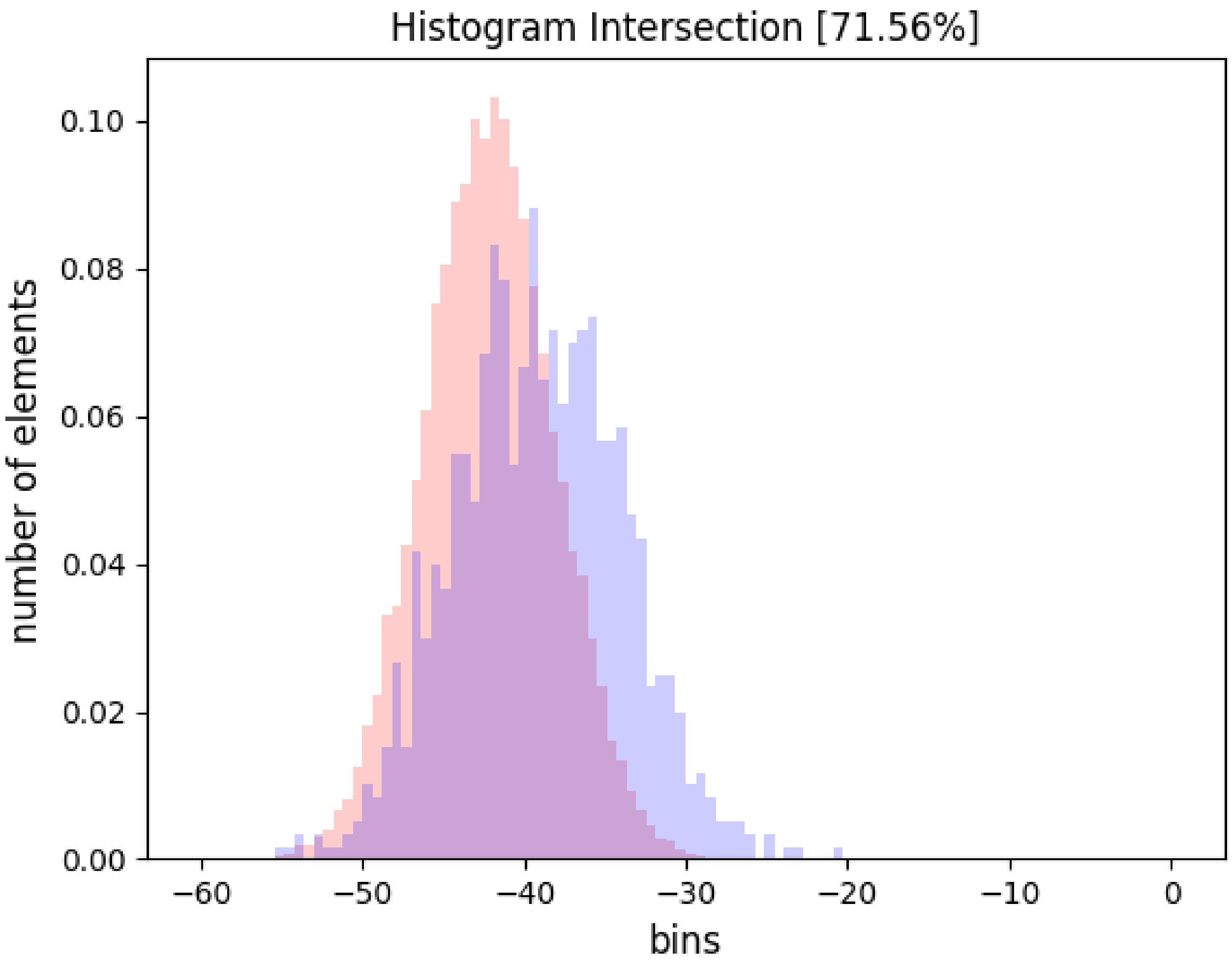
#4 Area Kernels

FL	FL	FL	FL	FL	FL	FL	FL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL
FS	FS	FL	FL	FL	FL	FL	SL	SL	SL	SL	SL	SL	SL	SL	SL	SL	FS	FS	FS
FS	FS	FS	FL	FL	FL	FL	SL	SL	SL	SL	SL	SL	SL	SL	FS	FS	FS	FS	FS
FS	FS	FS	FL	FL	FL	FL	SL	SL	SL	SL	SL	SL	SL	SL	FS	FS	FS	FS	FS
FS	FS	FS	FL	FL	FL	FL	SL	SL	SL	SL	SL	SL	SL	SL	FS	FS	FS	FS	FS
FS	FS	FS	FS	FS	FS	FS	SL	SL	SL	SL	SL	SL	SL	FS	FS	FS	FS	FS	FS
FS	FS	FS	FS	FS	FS	FS	SL	SL	SL	SL	SL	SL	SL	FS	FS	FS	FS	FS	FS
FS	FS	FS	FS	FS	FS	FS	SL	SL	SL	SL	SL	SL	SL	FS	FS	FS	FS	FS	FS
FS	FS	FS	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	FS	FS	FS	FS	FS
FS	FS	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	FS	FS	FS	FS	FS
FS	FS	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	FS	FS	FS	FS	FS
VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	FS	FS	FS	FS	FS
VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	FS	FS	FS	FS	FS
VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	VL	FS	FS	FS	FS	FS	FS	FS

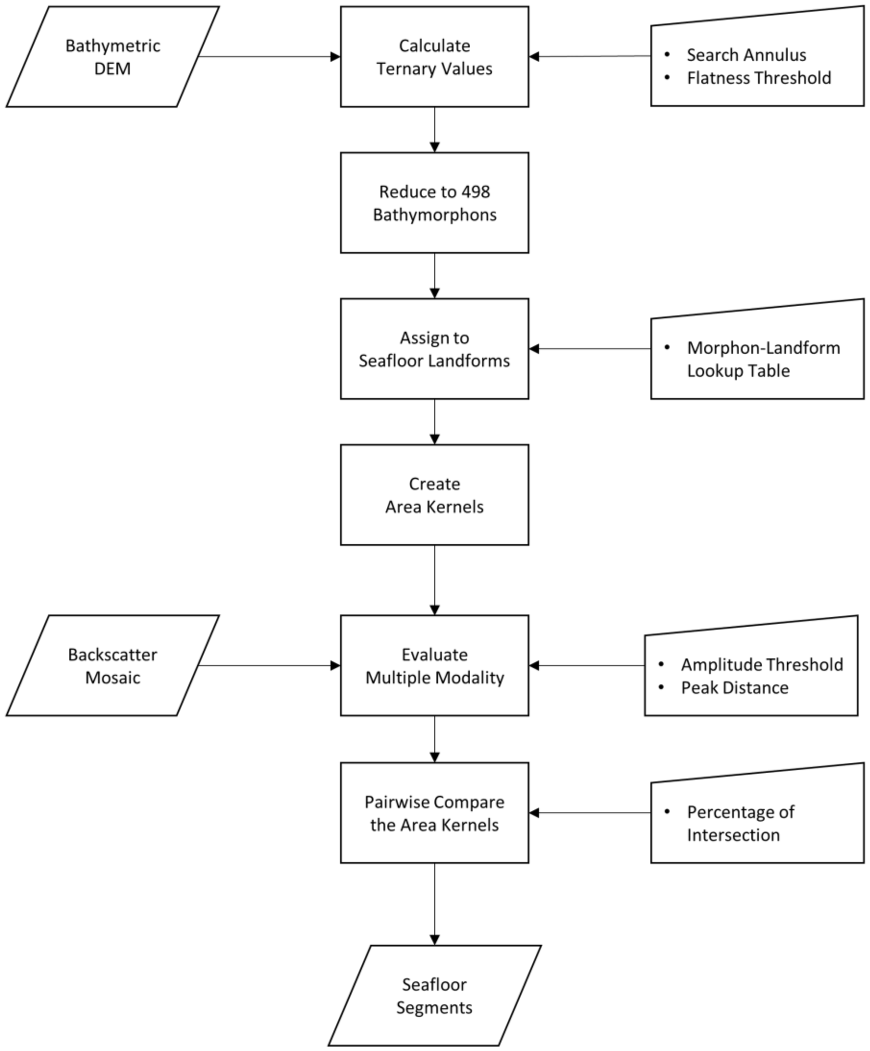
#5 Segments (splitting)

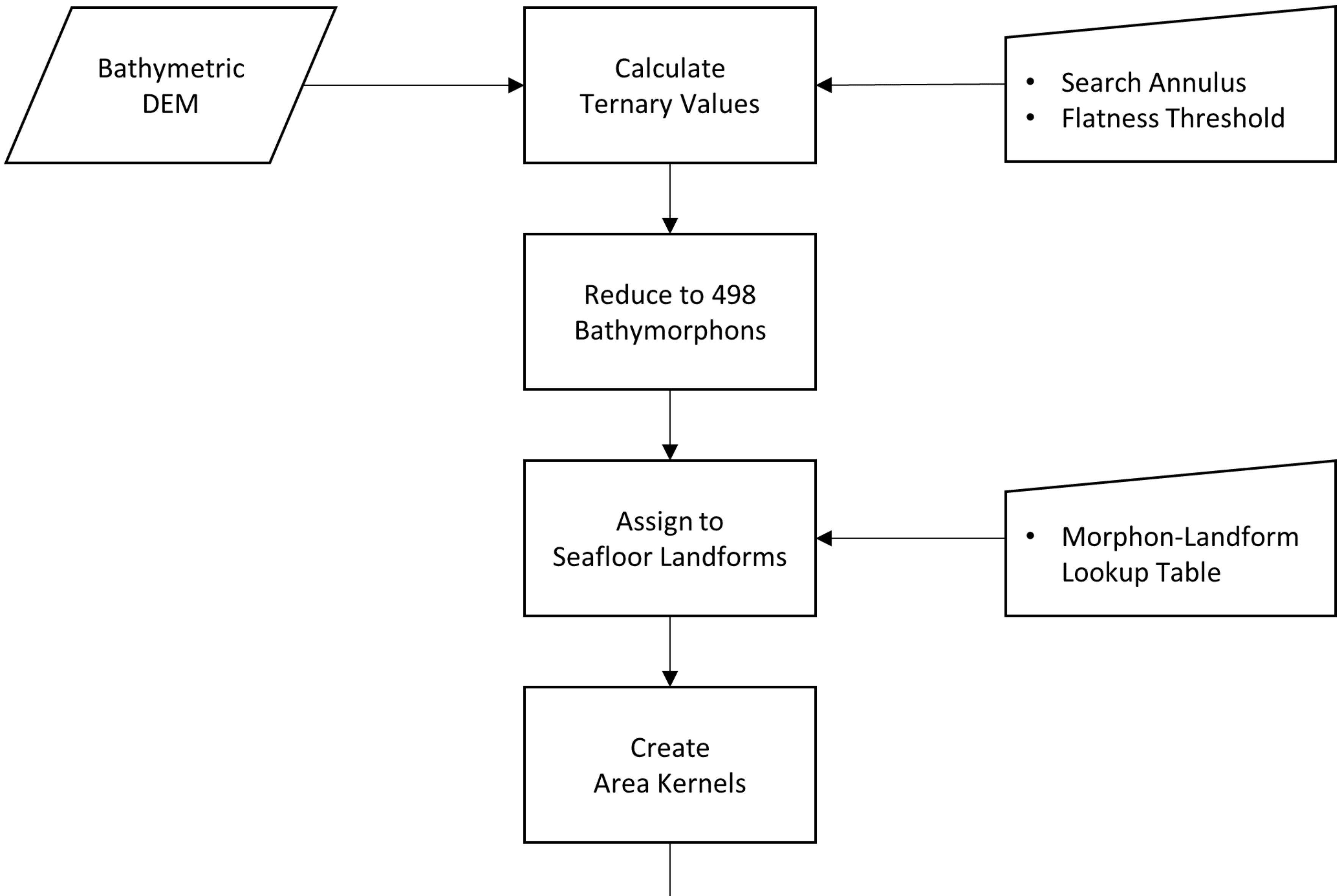


#5 Segments (merging)

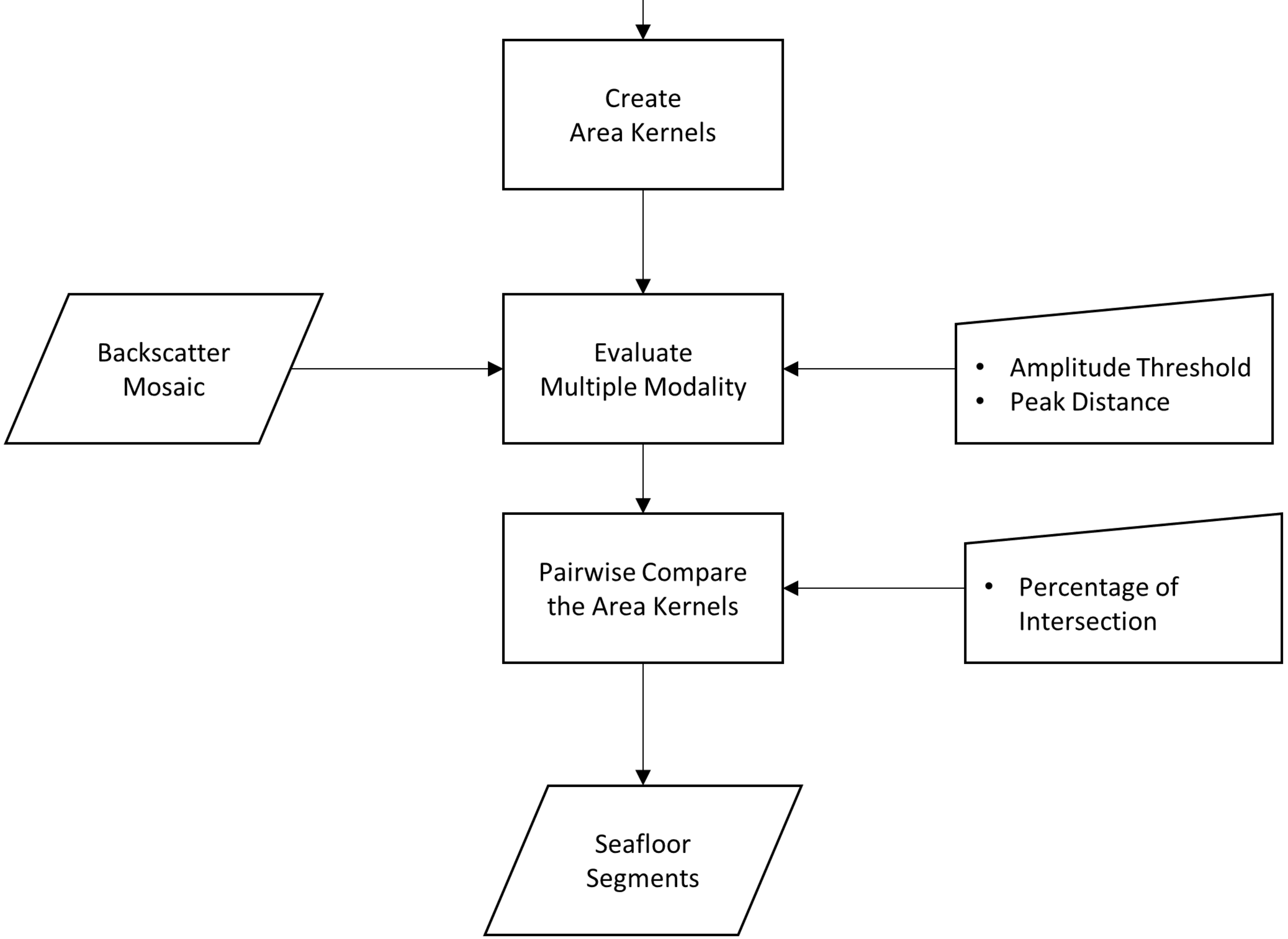


Algorithm Flowchart





Bathymetric DEM
Calculate Ternary Values
Search Annulus
Flatness Threshold
Reduce to 498 Bathymorphons
Assign to Seafloor Landforms
Morphon-Landform Lookup Table
Create Area Kernels

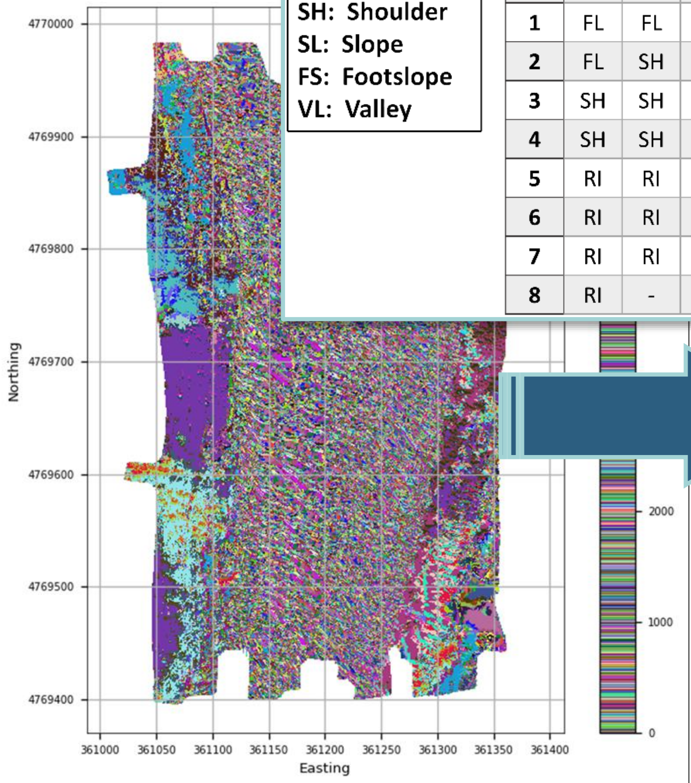


Create
Area Kernels
Backscatter
Mosaic
Evaluate
Multiple Modality
• Amplitude Threshold
• Peak Distance
Pairwise Compare
the Area Kernels
• Percentage of
Intersection
Seafloor
Segments

STEPS FROM #1 TO #3

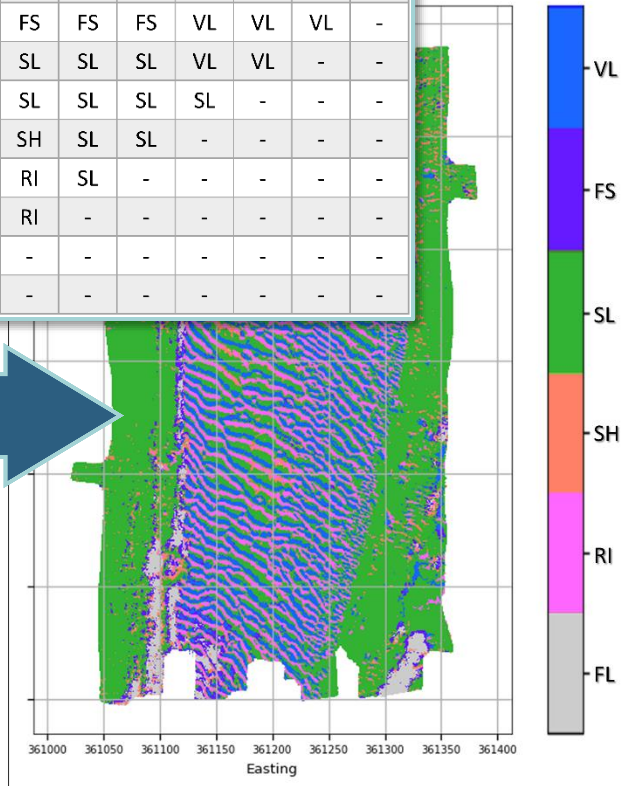
FL: Flat
RI: Ridge
SH: Shoulder
SL: Slope
FS: Footslope
VL: Valley

-\ +	0	1	2	3	4	5	6	7	8
0	FL	FL	FL	FS	FS	VL	VL	VL	VL
1	FL	FL	FS	FS	FS	VL	VL	VL	-
2	FL	SH	SL	SL	SL	VL	VL	-	-
3	SH	SH	SL	SL	SL	SL	-	-	-
4	SH	SH	SH	SL	SL	-	-	-	-
5	RI	RI	RI	SL	-	-	-	-	-
6	RI	RI	RI	-	-	-	-	-	-
7	RI	RI	-	-	-	-	-	-	-
8	RI	-	-	-	-	-	-	-	-



(a)

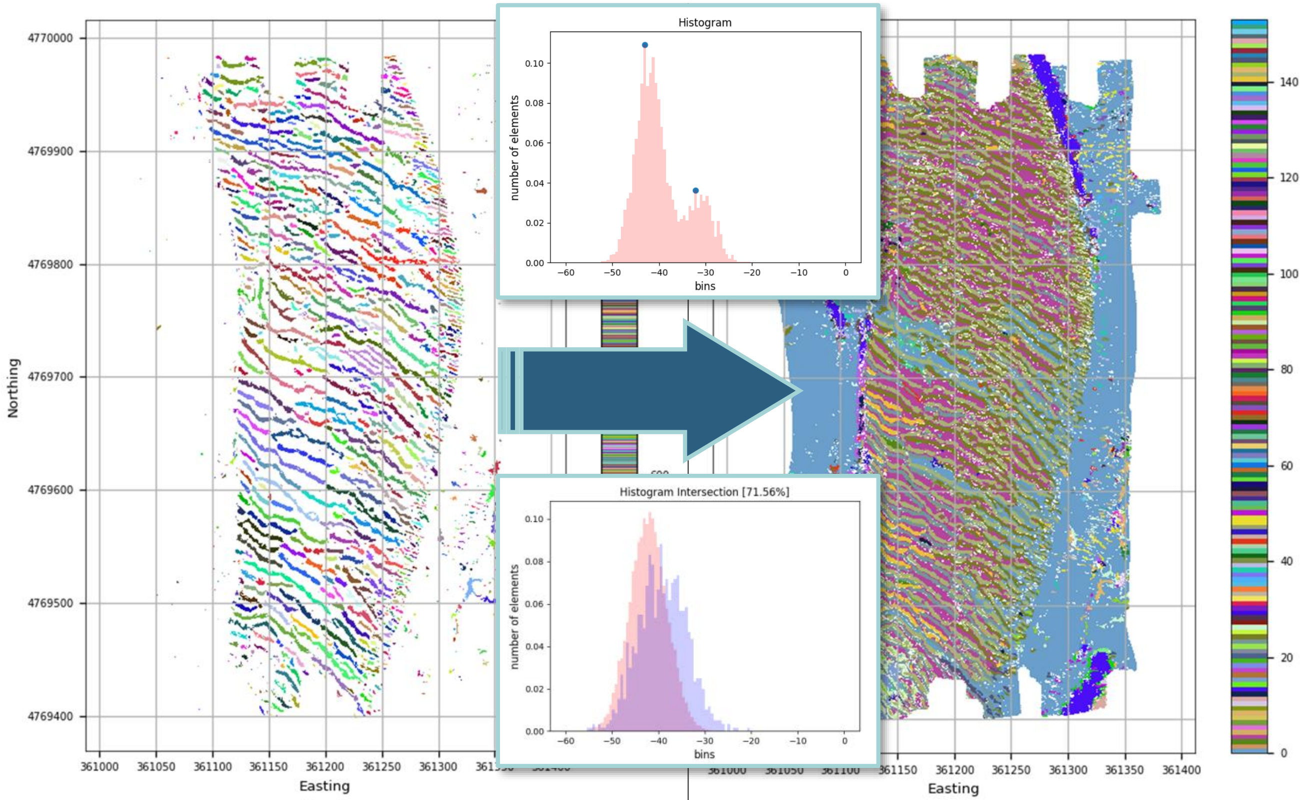
Local Ternary Patterns



(b)

Landform Classification

STEPS FROM #4 TO #5



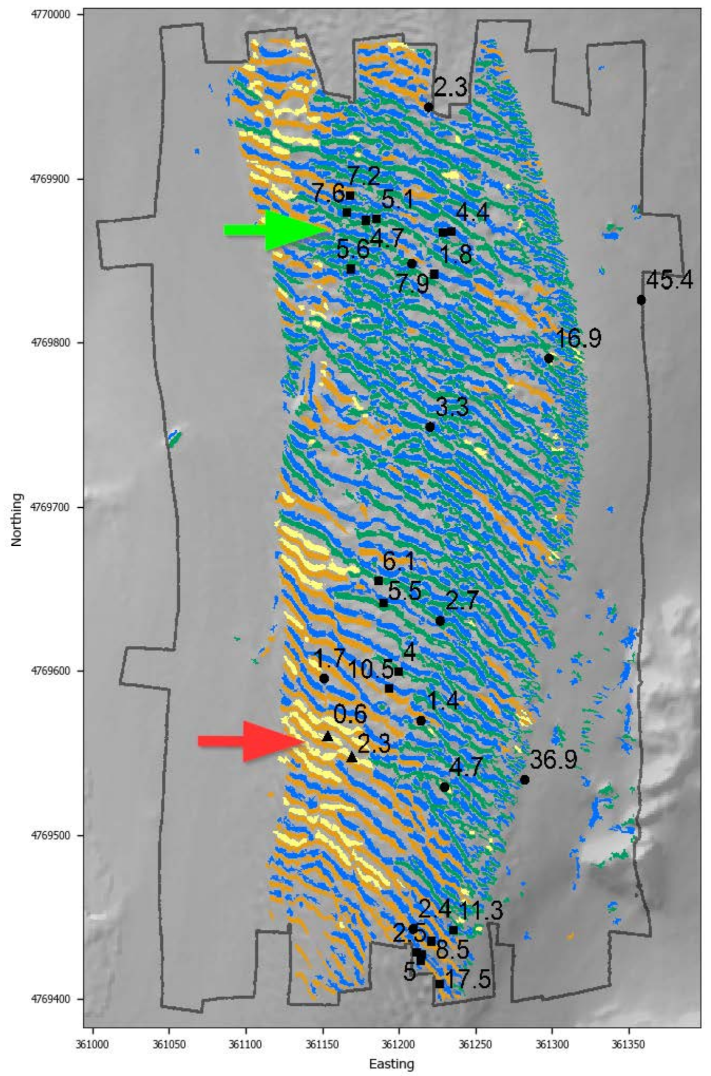
(c)

(d)

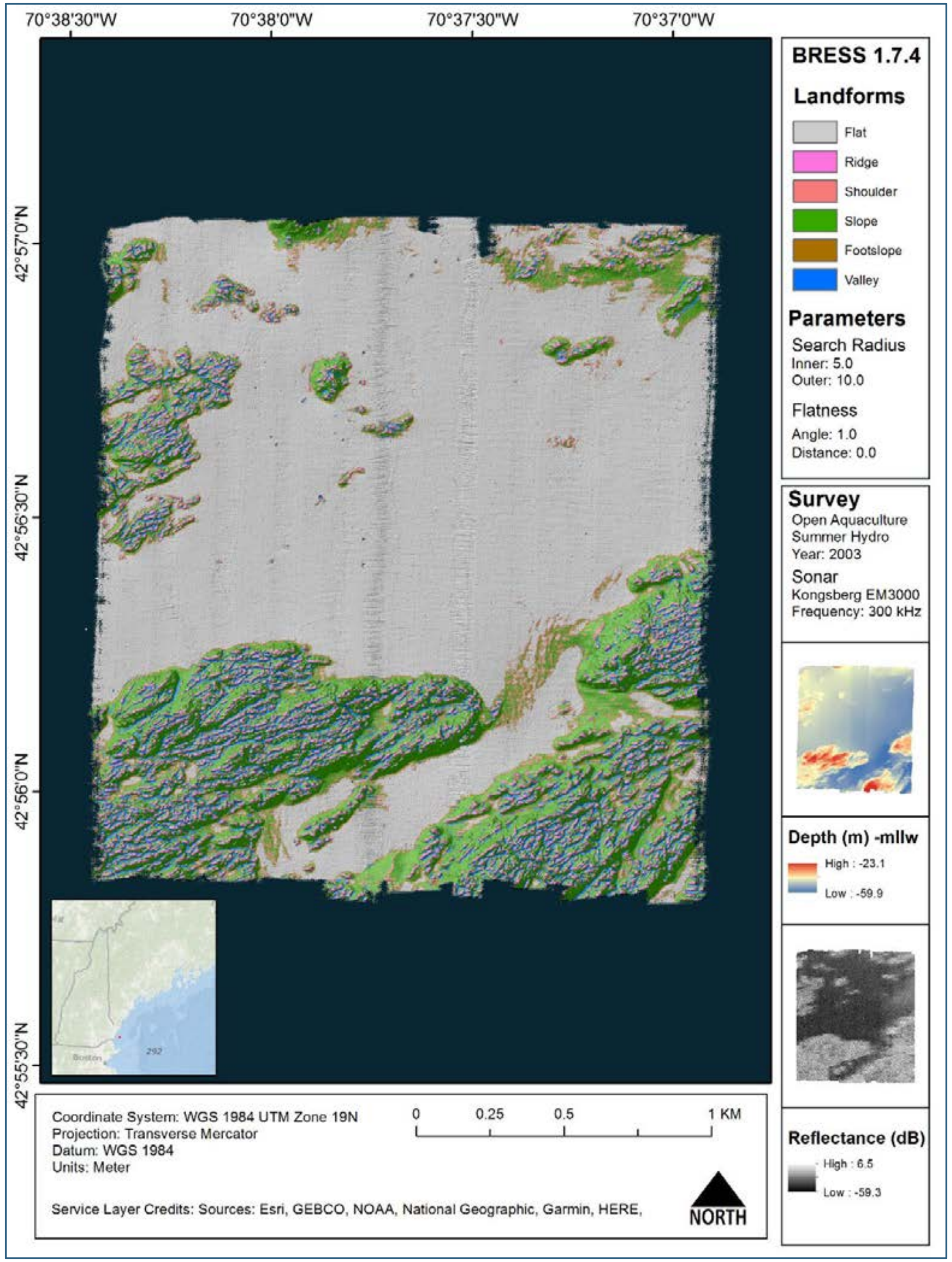
Area Kernels

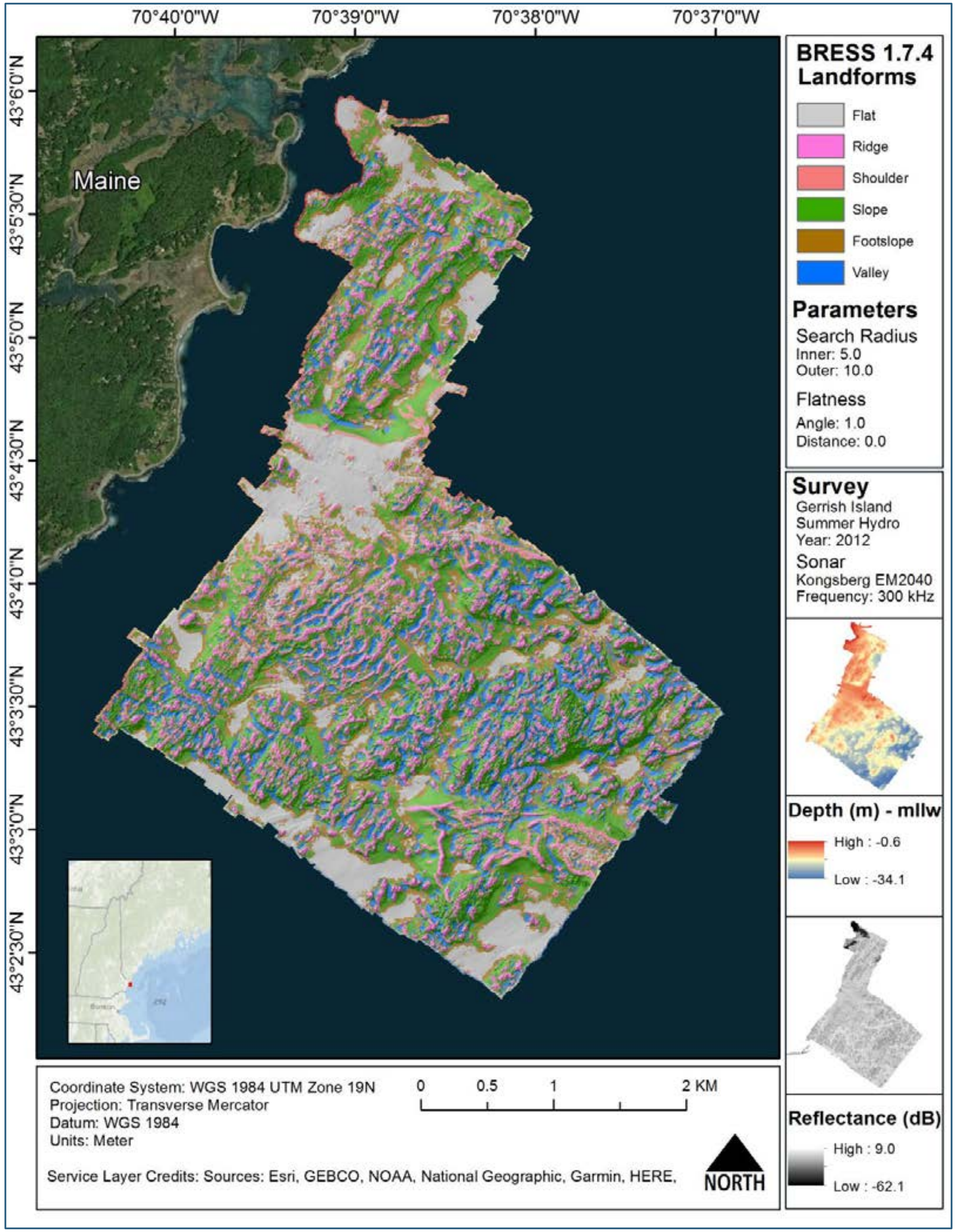
Output Segments

Validation



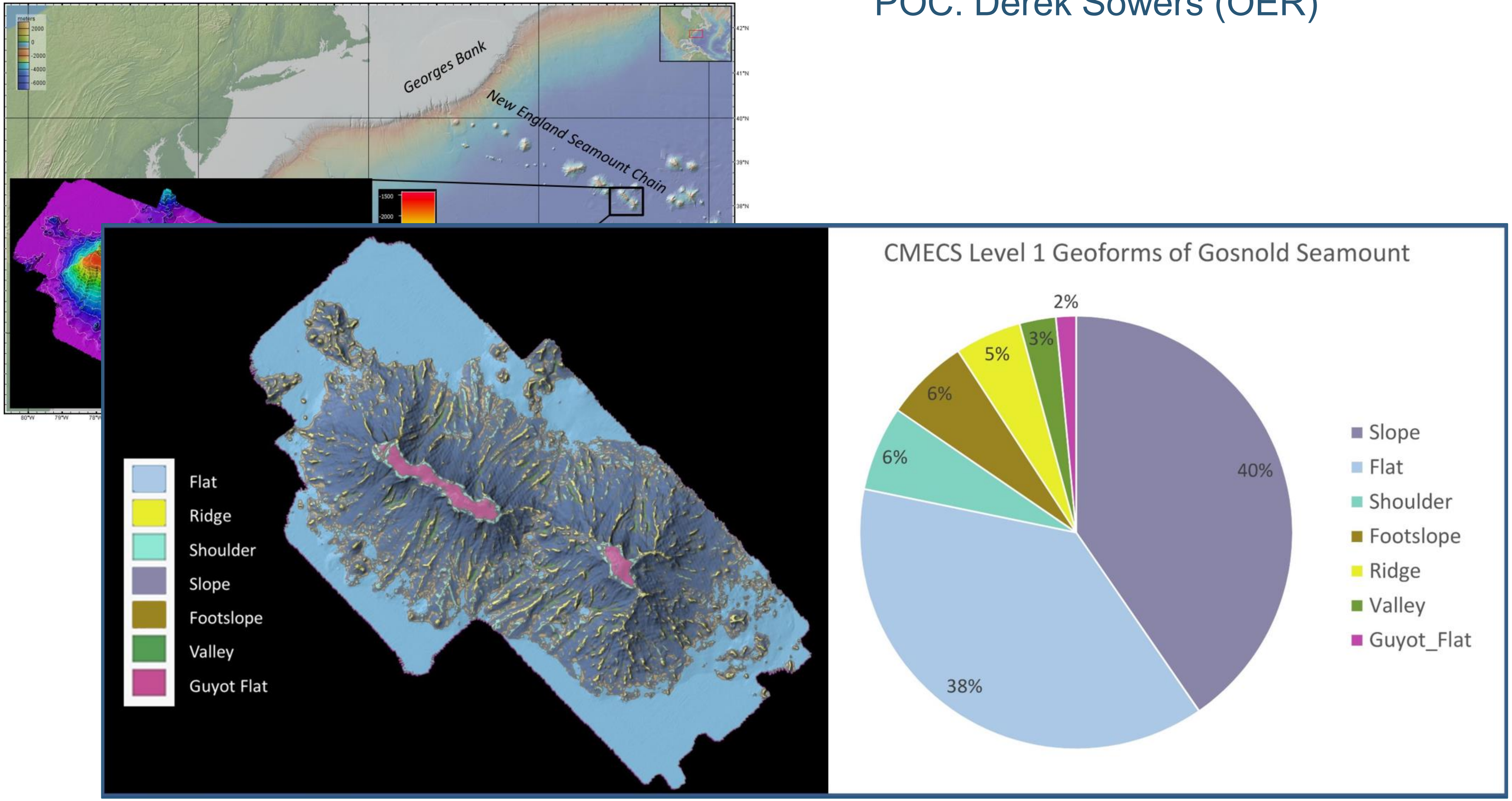
Percentage of gravel (in black).


70°38'30"W
70°38'0"W
70°37'30"W
70°37'0"W
42°57'0"N
42°56'30"N
42°56'0"N
42°55'30"N
BRESS 1.7.4
Landforms
Flat
Ridge
Shoulder
Slope
Footslope
Valley
Parameters
Search Radius
Inner: 5.0
Outer: 10.0
Flatness
Angle: 1.0
Distance: 0.0
Survey
Open Aquaculture
Summer Hydro
Year: 2003
Sonar
Kongsberg EM3000
Frequency: 300 kHz
Depth (m) -mllw
High : -23.1
Low : -59.9
Reflectance (dB)
High : 6.5
Low : -59.3
Coordinate System: WGS 1984 UTM Zone 19N
Projection: Transverse Mercator
Datum: WGS 1984
Units: Meter
0 0.25 0.5 1 KM
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE,
NORTH

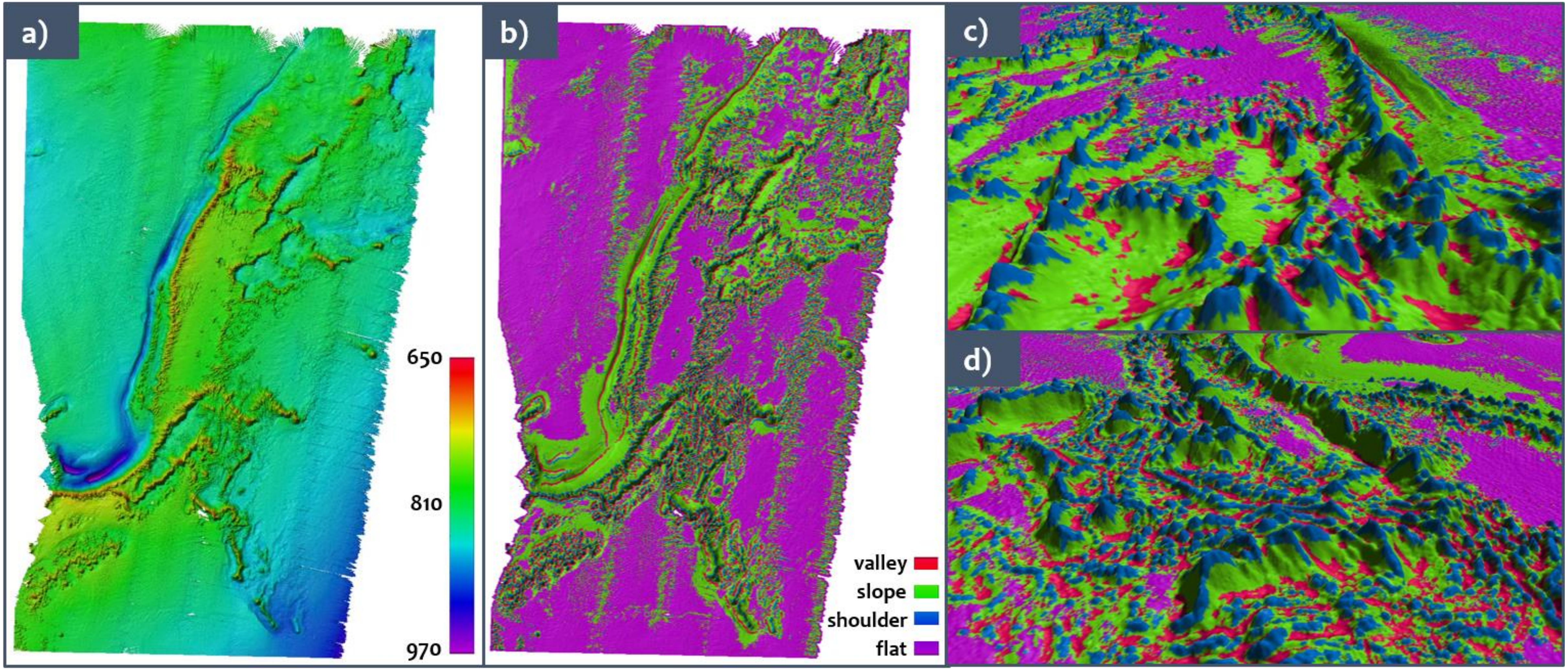

70°40'0"W
70°39'0"W
70°38'0"W
70°37'0"W
43°6'0"N
43°5'30"N
43°5'0"N
43°4'30"N
43°4'0"N
43°3'30"N
43°3'0"N
43°2'30"N
Maine
BRESS 1.7.4
Landforms
Flat
Ridge
Shoulder
Slope
Footslope
Valley
Parameters
Search Radius
Inner: 5.0
Outer: 10.0
Flatness
Angle: 1.0
Distance: 0.0
Survey
Gerrish Island
Summer Hydro
Year: 2012
Sonar
Kongsberg EM2040
Frequency: 300 kHz
Depth (m) - mllw
High : -0.6
Low : -34.1
Reflectance (dB)
High : 9.0
Low : -62.1
Coordinate System: WGS 1984 UTM Zone 19N
Projection: Transverse Mercator
Datum: WGS 1984
Units: Meter
0 0.5 1 2 KM
Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE,
NORTH

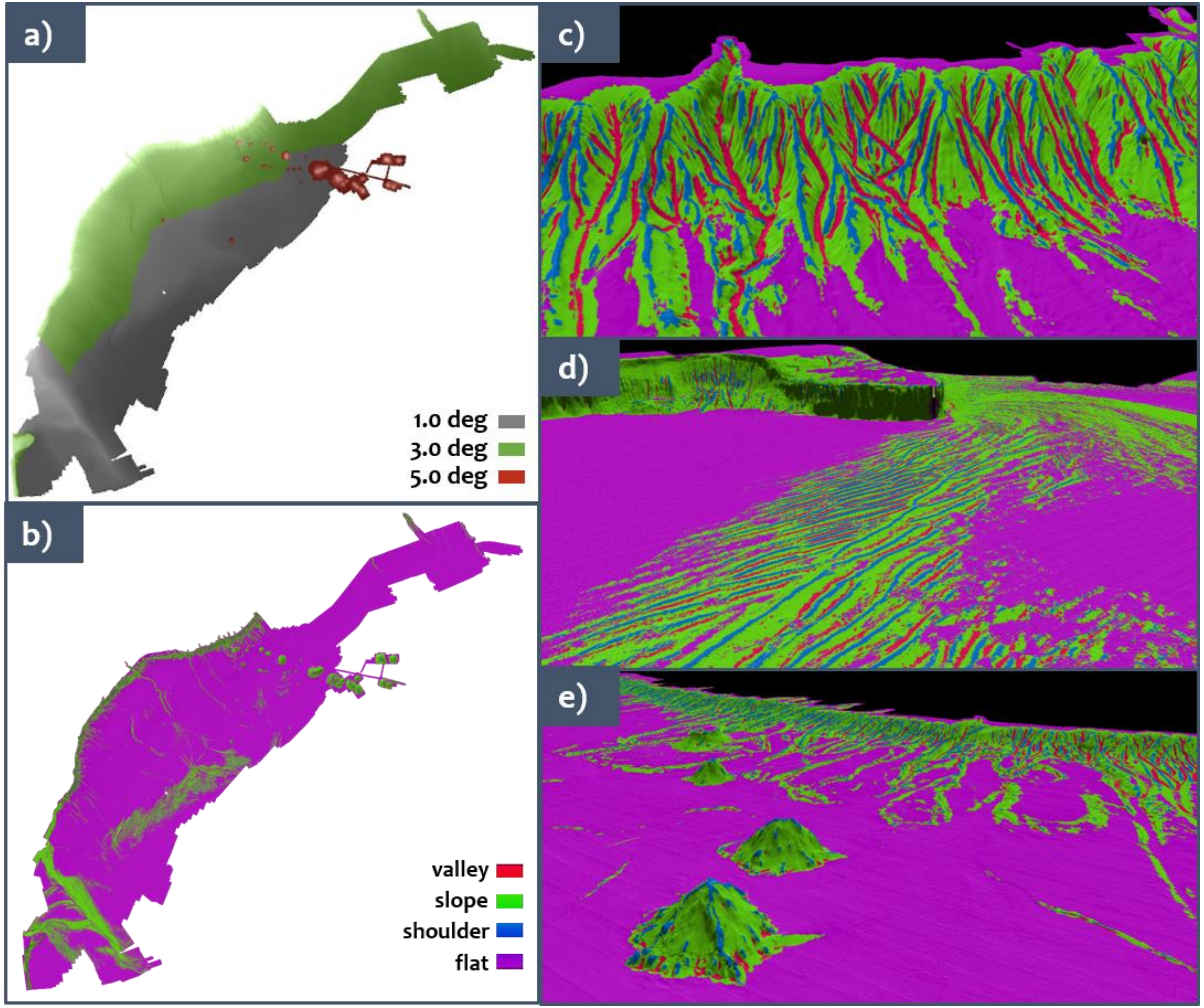
BRESS & CMECS Geoforms

POC: Derek Sowers (OER)

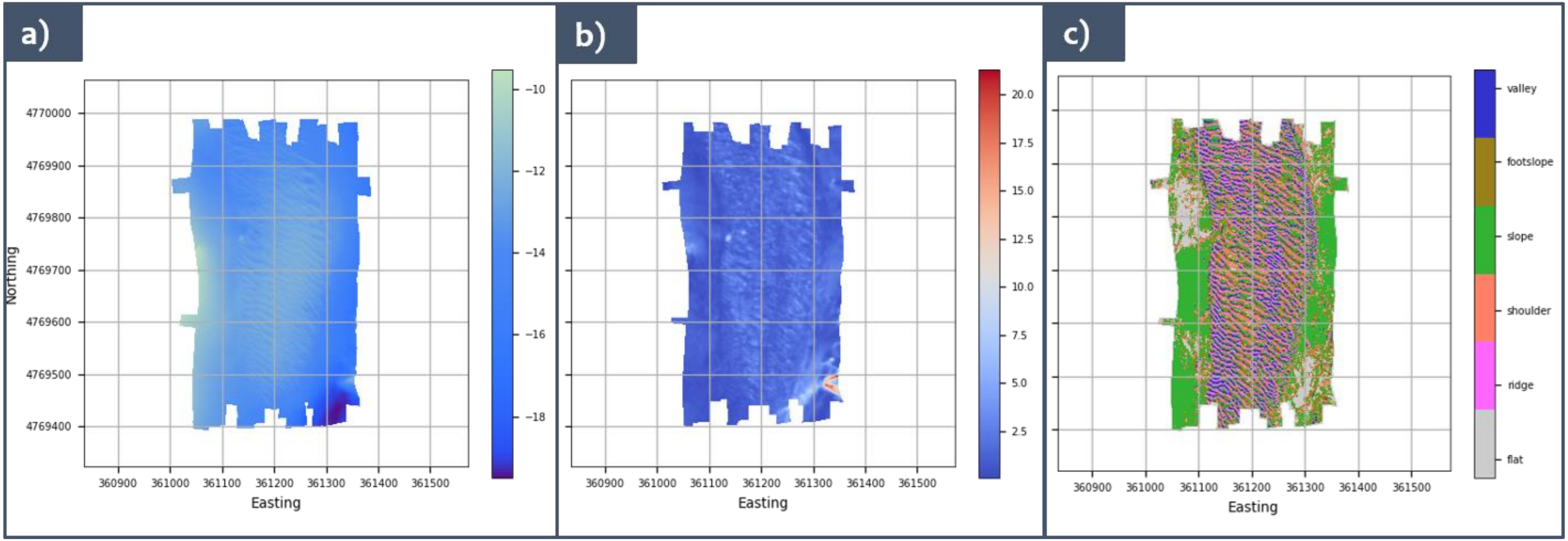


Ref.: Sowers, D. et al., *Application of the Coastal and Marine Ecological Classification Standard to Gosnold Seamount*, GeoHab Atlas, in print.

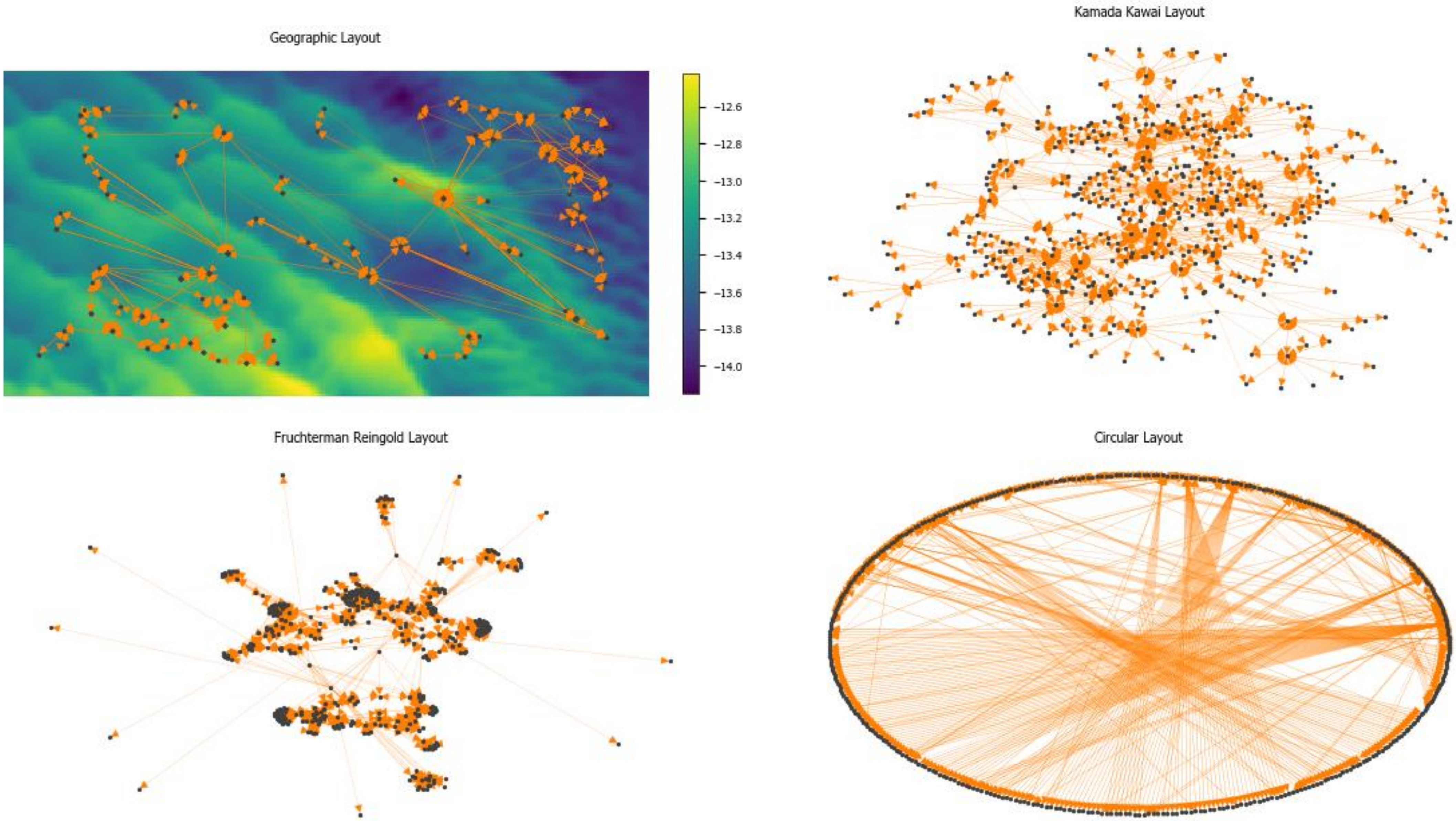

a)
b)
c)
d)
650
810
970
valley
slope
shoulder
flat



a)
1.0 deg
3.0 deg
5.0 deg
b)
valley
slope
shoulder
flat
c)
d)
e)

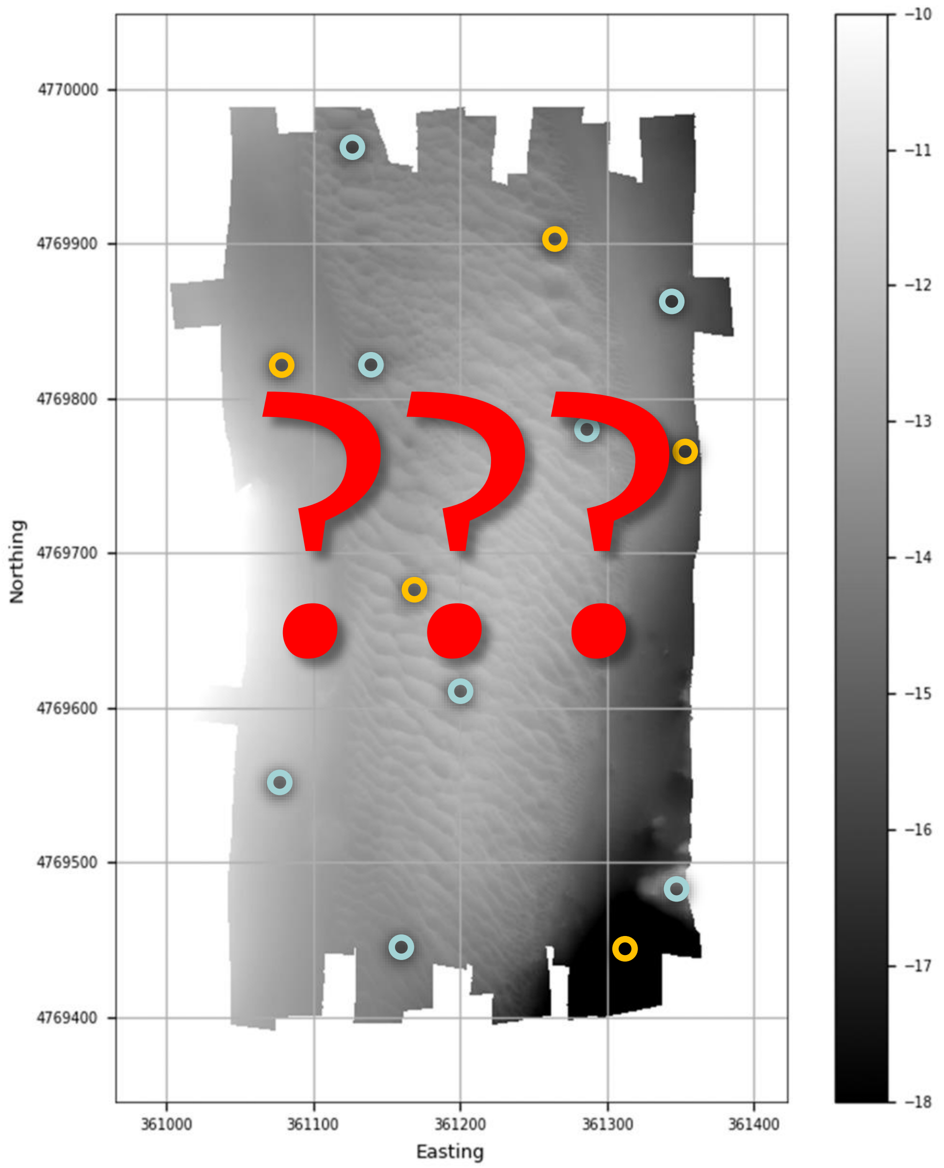

a)
b)
c)
Northing
4770000
4769900
4769800
4769700
4769600
4769500
4769400
360900
361000
361100
361200
361300
361400
361500
Easting
−10
−12
−14
−16
−18
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
valley
footslope
slope
shoulder
ridge
flat

Graph Analysis & Strategic Bottom Sampling



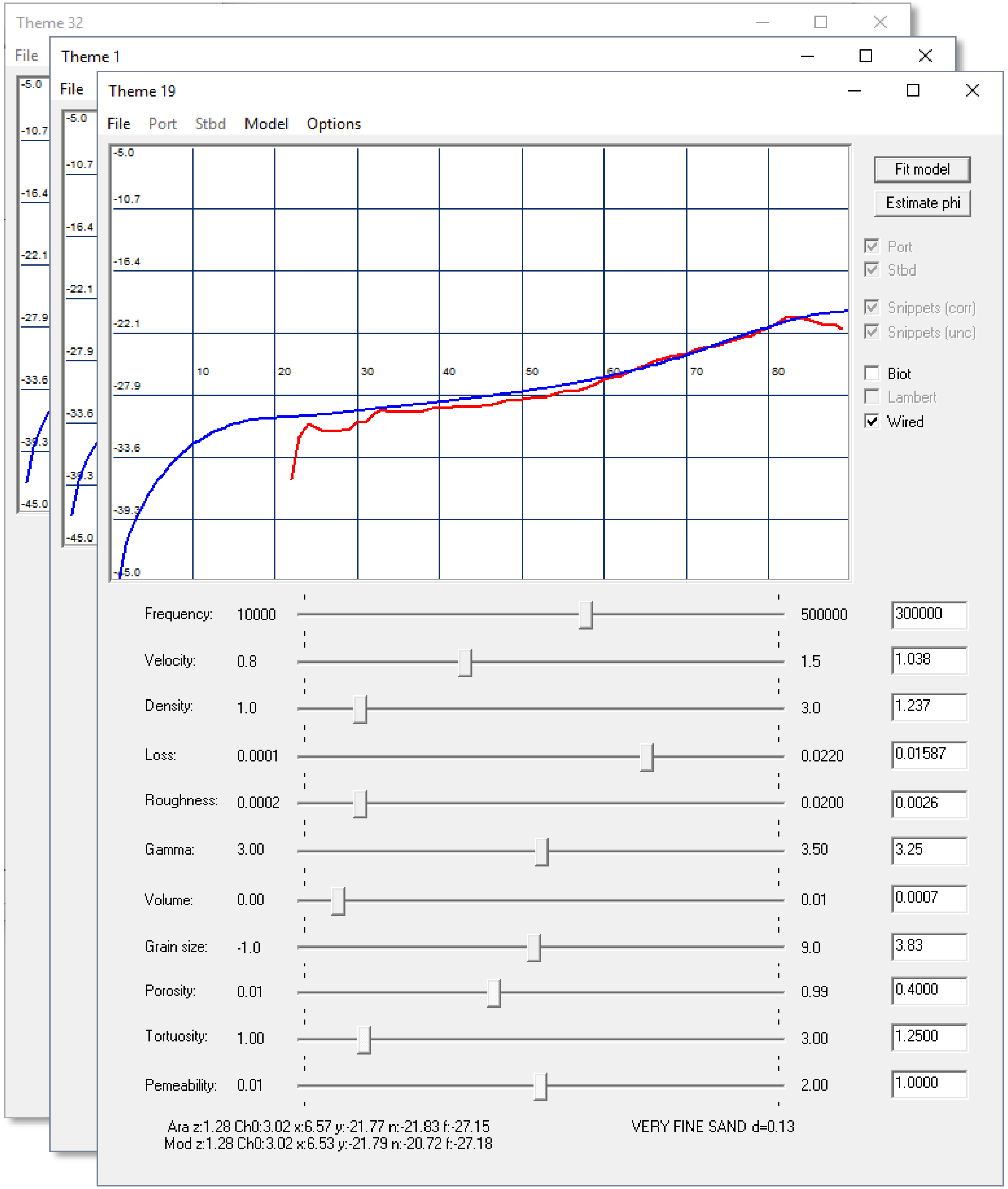
Ref.: Masetti, G. et al., *Bathymetric and Reflectivity-derived Data Fusion for Preliminary Seafloor Segmentation and Strategic Bottom Sampling*, GeoHAB, 2018.

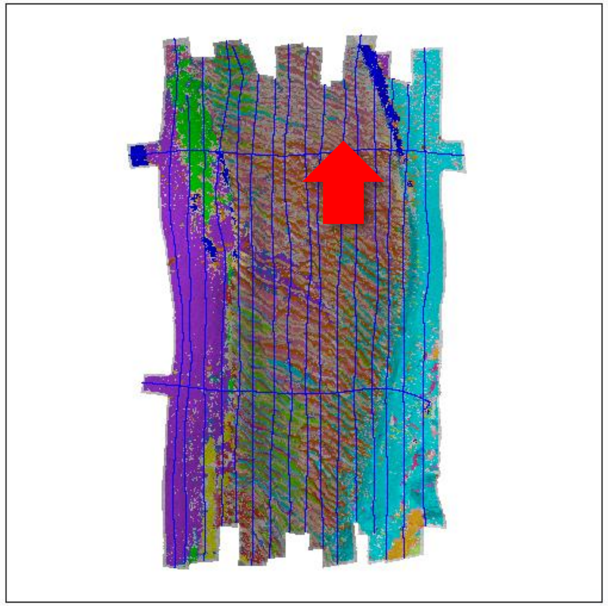
Graph Analysis & Strategic Bottom Sampling



Different Criteria:

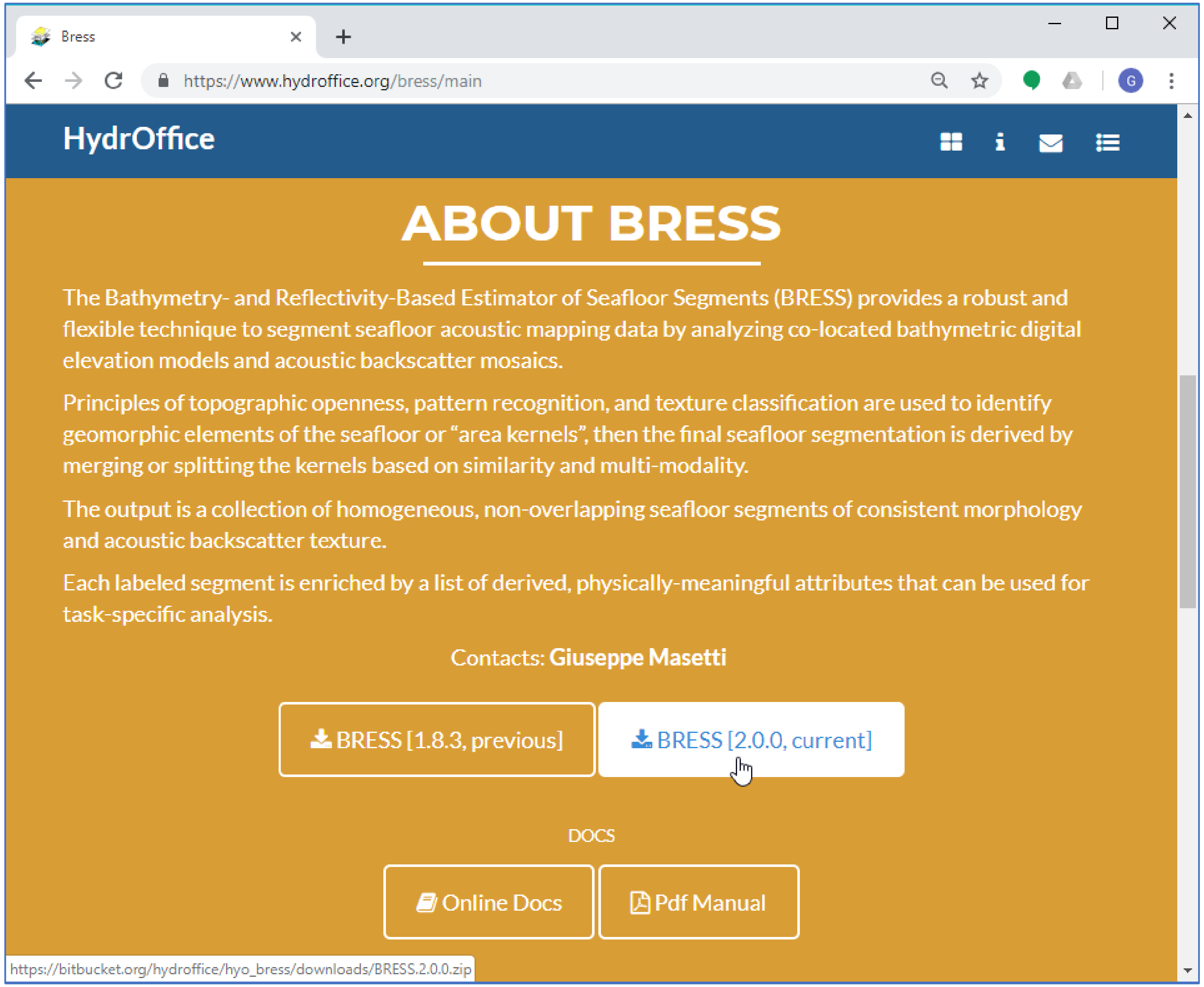
- Given a fixed number of samples, locations with largest coverage?
- How many samples to obtain a given percentage of coverage?
- What are the more **"meaningful"** locations for bottom sampling?


Theme 32
File
Theme 1
File
Theme 19
File Port Stbd Model Options
-5.0
-10.7
-16.4
-22.1
-27.9
-33.6
-39.3
-45.0
10
20
30
40
50
60
70
80
Fit model
Estimate phi
Port
Stbd
Snippets (corr)
Snippets (unc)
Biot
Lambert
Wired
Frequency: 10000 500000 300000
Velocity: 0.8 1.5 1.038
Density: 1.0 3.0 1.237
Loss: 0.0001 0.0220 0.01587
Roughness: 0.0002 0.0200 0.0026
Gamma: 3.00 3.50 3.25
Volume: 0.00 0.01 0.0007
Grain size: -1.0 9.0 3.83
Porosity: 0.01 0.99 0.4000
Tortuosity: 1.00 3.00 1.2500
Pemeability: 0.01 2.00 1.0000
Ara z:1.28 Ch0:3.02 x:6.57 y:-21.77 n:-21.83 f:-27.15
Mod z:1.28 Ch0:3.02 x:6.53 y:-21.79 n:-20.72 f:-27.18
VERY FINE SAND d=0.13



Where Can I Download BRESS?

https://www.hydroffice.org/bress



THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

v0

BSI PROJECT

BSIP & OpenBST

G. Masetti & T. Faulkes

Canberra, June 18-20 2019

CCOM JHC

BSIP

BSI PROJECT

A project that aims of checking the **consistency of the backscatter processing results** provided by various software suites

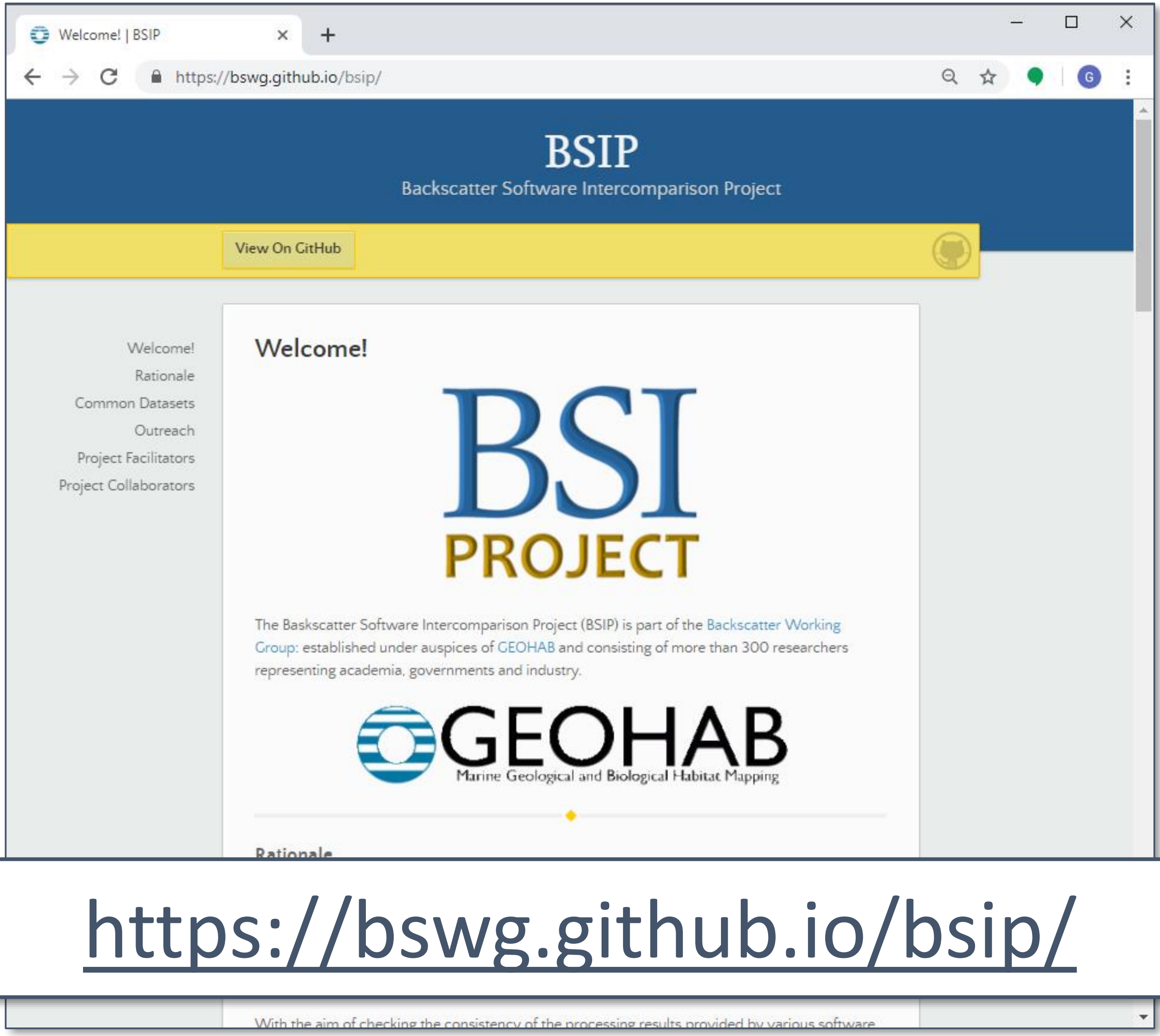
BSIP → RATIONALE

Significant differences in **backscatter products**
generated by **different software**
using the **same dataset**

Major limitation for:

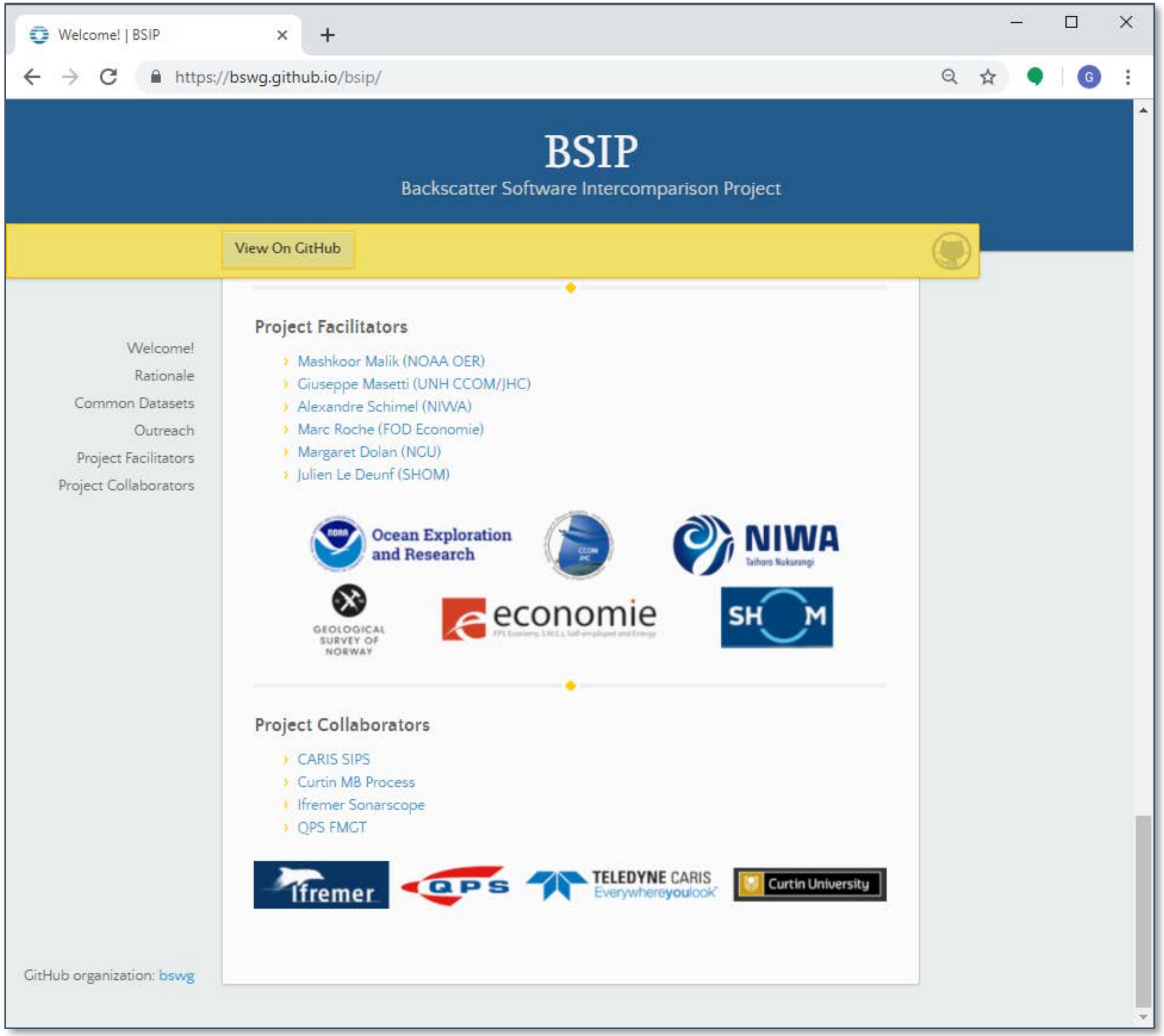
- Quantitative analysis
- Combining multiple sources
- Time-monitoring of seafloor changes

BSIP → WEBSITE



https://bswg.github.io/bsip/

BSIP → PARTICIPANTS



Mar Geophys Res (2018) 39:23–40
DOI 10.1007/s11001-017-9316-5

CrossMark

ORIGINAL RESEARCH PAPER

User expectations for multibeam echo sounders backscatter strength data-looking back into the future

Vanessa Lucieer[1] · Marc Roche[2] · Koen Degrendele[2] · Mashkoor Malik[3] · Margaret Dolan[4] · Geoffroy Lamarche[5]

Received: 19 December 2016 / Accepted: 4 May 2017 / Published online: 11 May 2017

Abstract With the ability of multibeam echo sounders (MBES) to measure backscatter strength (BS) as a function of true angle of insonification across the seafloor, came a new recognition of the potential of backscatter measurements to remotely characterize the properties of the seafloor. Advances in transducer design, digital electronics, signal processing capabilities, navigation, and graphic display devices, have improved the resolution and particularly the dynamic range available to sonar and processing software manufacturers. Alongside these improvements the expectations of what the data can deliver has also grown. In this paper, we identify these user-expectations and explore how MBES backscatter is utilized by different communities involved in marine seabed research at present, and the aspirations that these communities have for the data in the future. The results presented here are based on a user survey conducted by the GeoHab (Marine Geological and Biological Habitat Mapping) association. This paper summarises the different processing procedures employed to extract useful information from MBES backscatter data and the various intentions for which the user community collect the data. We show how a range of backscatter output products are generated from the different processing procedures, and how these results are taken up by different scientific disciplines, and also identify common constraints in handling MBES BS data. Finally, we outline our expectations for the future of this unique and important data source for seafloor mapping and characterisation.

Keywords Multibeam acoustics · Backscatter · Habitat mapping · Marine geology · Seafloor facies

Introduction

The applications for multibeam echosounder (MBES) backscatter data have grown exponentially in the past 30 years since it was first presented as a potential data source for characterising the seafloor in 1985 by de Moustier (1985). This paper presents a short review of data use, informed from the results of survey conducted in 2014 by the International Marine Geological and Biological Habitat Mapping (GeoHab) forum (GeoHab: http://geohab.org/) [the survey can be found at: http://geohab.org/bswg/bswg_participation/userneeds/ (last accessed 28/03/2017)]. This survey revealed both the specific details regarding the current utility of backscatter within the user-community and the range of intended future application areas, which may help shape the future evolution of the technology. The utility of backscatter data can be summarised into two main categories; mapping the seafloor for (a) exploration and (b) monitoring implying different levels of technical constraints. This paper follows on from the report "Backscatter

Electronic supplementary material The online version of this article (doi:10.1007/s11001-017-9316-5) contains supplementary material, which is available to authorized users.

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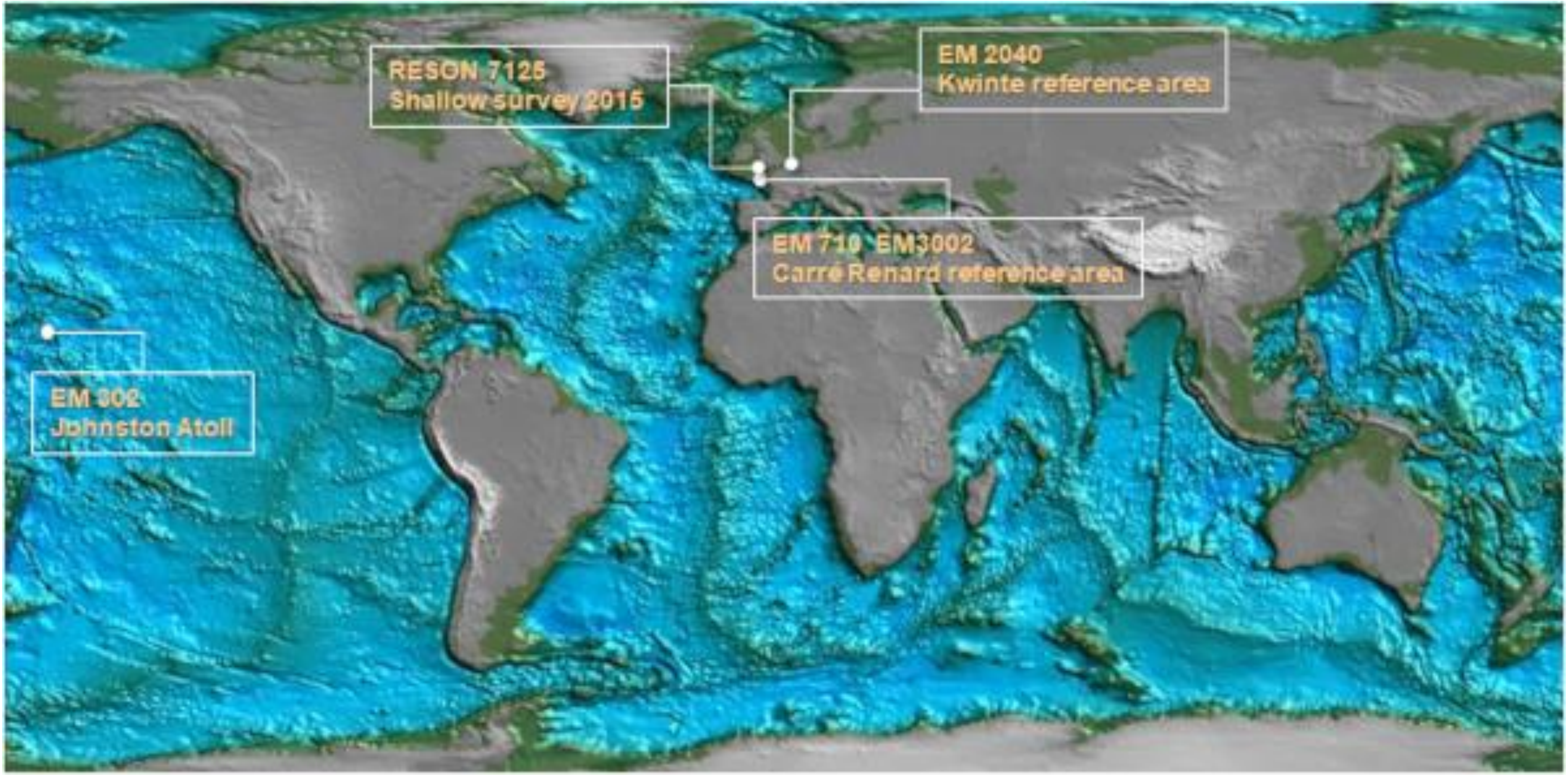
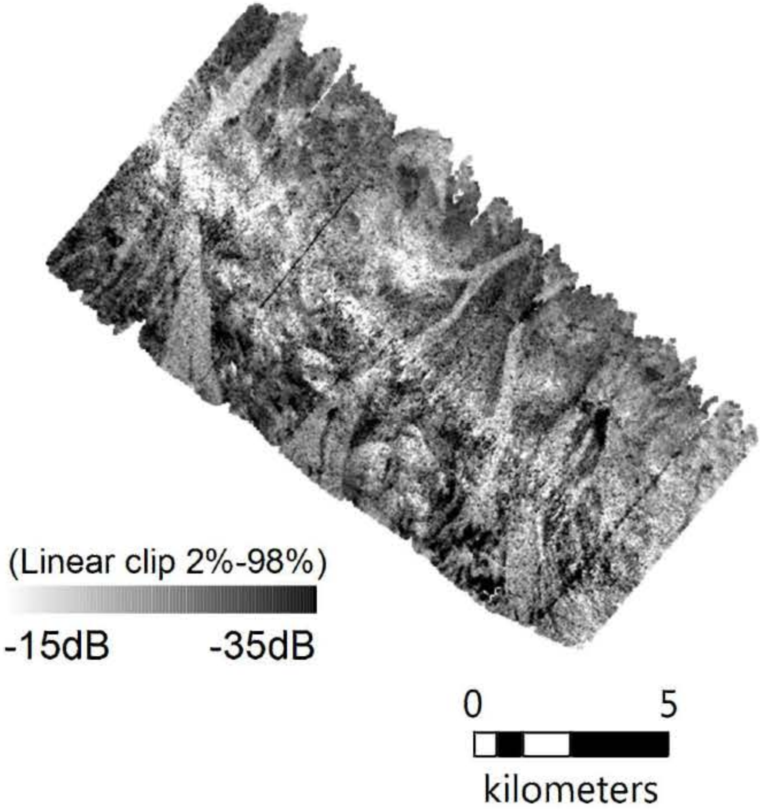
the increasing use of backscatter data. The limitation regarding software was mentioned in relation to both acquisition software packages and processing software packages and that sometimes the data formats between the different platforms were not compatible in the recent past. The majority of users in the survey used the following software: Sonarscope®, QPS Fledermaus®, ArcGIS®, CARIS® and MB Systems. From this list only Sonarscope®, QPS Fledermaus®, CARIS® and MB Systems are able to provide some level of backscatter data processing while ArcGIS provides image analysis only once backscatter image has been produced by the earlier listed software tools. Amongst the four backscatter processing tools, users can apply backscatter corrections and produce mosaics (image processing) with various levels of signal processing available. One

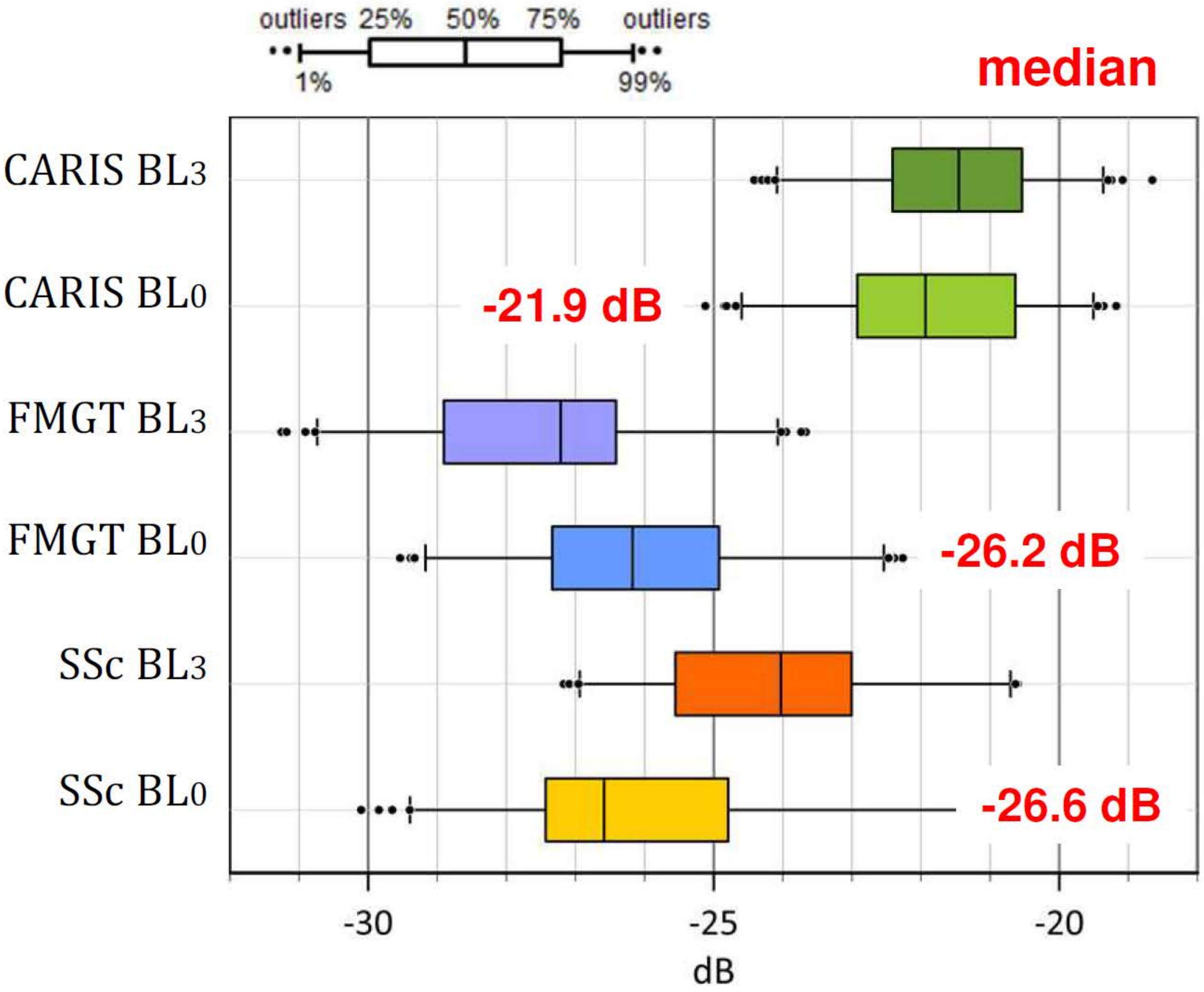
Ref.: Lucieer, V. et al., *User expectations for multibeam echo sounders backscatter strength data-looking back into the future*, Marine Geophysical Research, vol. 39(1), pp. 23-40, 2018.

Common Data Sets

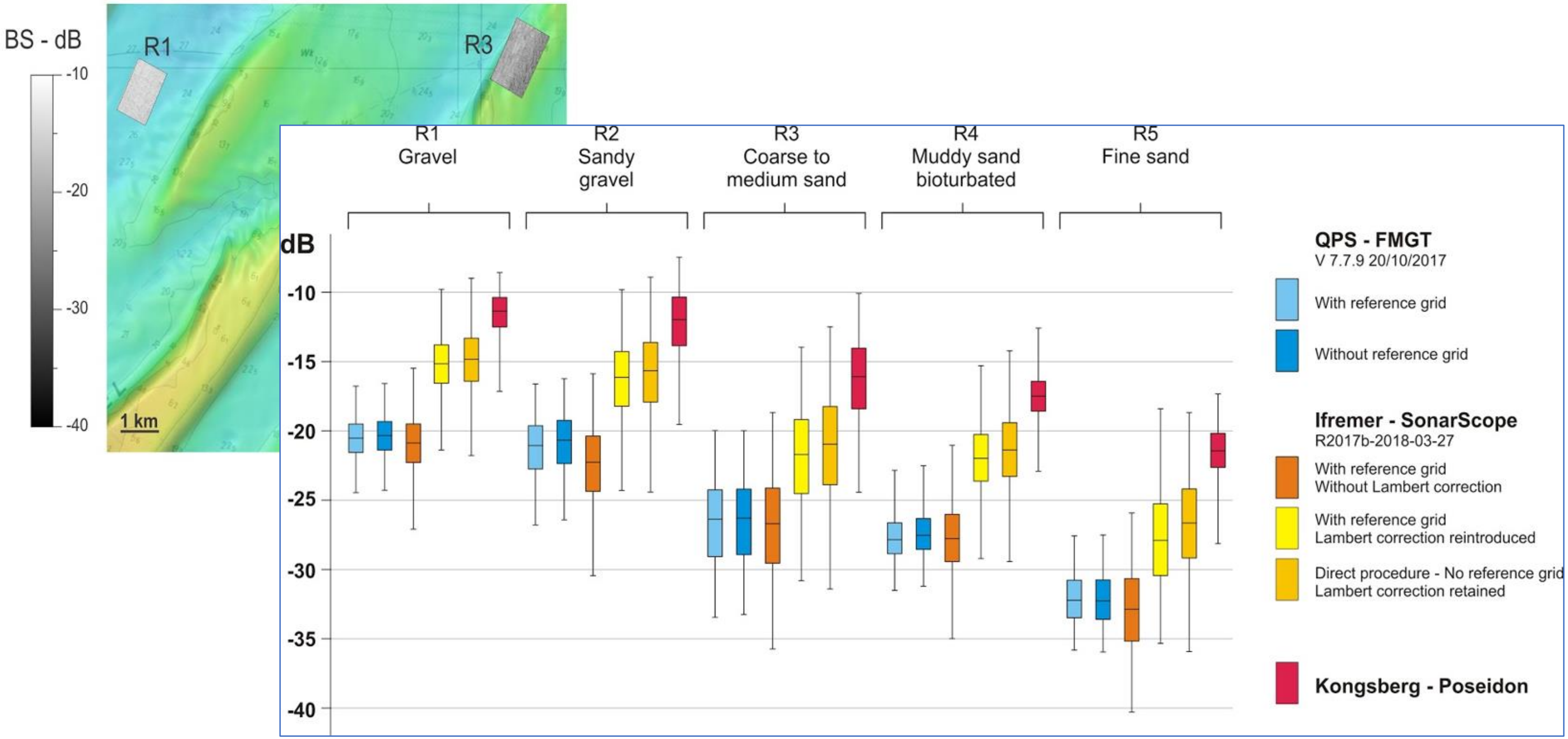




Johnston Atoll

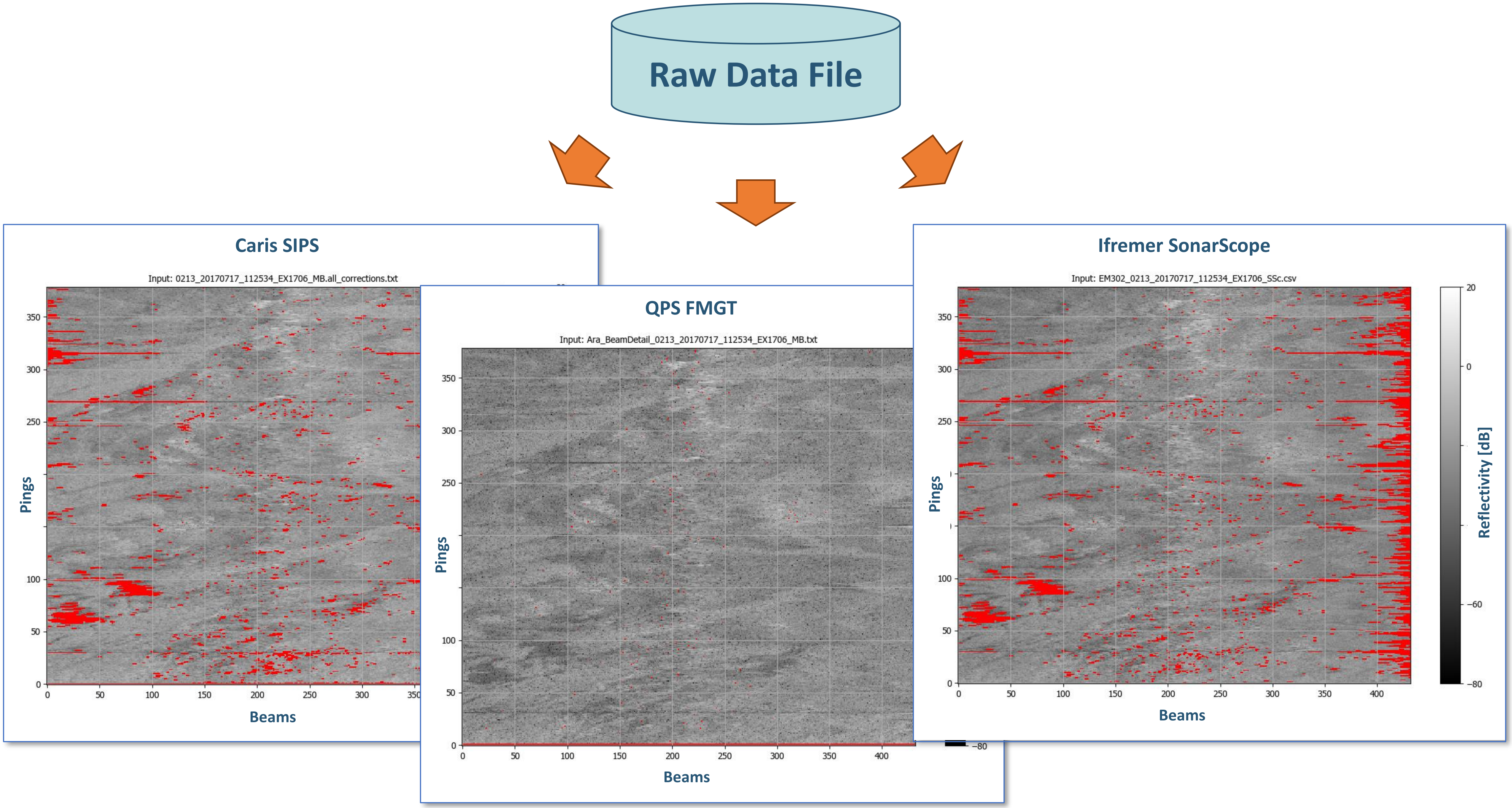


BSIP → OpenBST

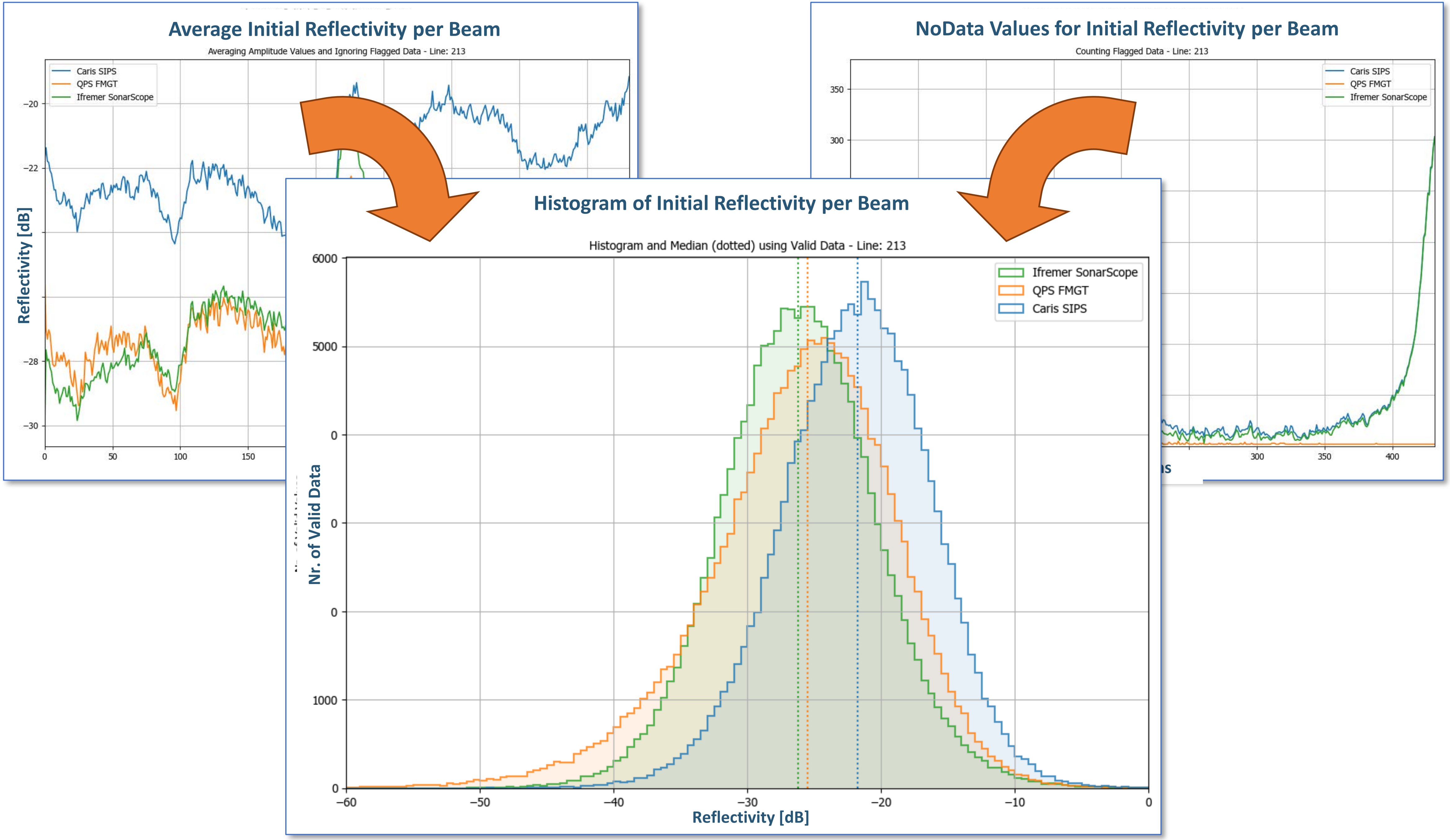


OpenBST

An open-source
toolchain for
processing acoustic
backscatter data



Raw Data File
Caris SIPS
Input: 0213_20170717_112534_EX1706_MB.all_corrections.txt
Pings
Beams
QPS FMGT
Input: Ara_BeamDetail_0213_20170717_112534_EX1706_MB.txt
Pings
Beams
Ifremer SonarScope
Input: EM302_0213_20170717_112534_EX1706_SSc.csv
Pings
Beams
Reflectivity [dB]


Average Initial Reflectivity per Beam
Averaging Amplitude Values and Ignoring Flagged Data - Line: 213
Caris SIPS
QPS FMGT
Ifremer SonarScope
Reflectivity [dB]
NoData Values for Initial Reflectivity per Beam
Counting Flagged Data - Line: 213
Histogram of Initial Reflectivity per Beam
Histogram and Median (dotted) using Valid Data - Line: 213
Nr. of Valid Data
Reflectivity [dB]

A SHIFT IS **REQUIRED** FROM THE EXISTING CLOSED-SOURCE APPROACH

OPEN BST

AN OPEN-SOURCE AND METADATA-RICH

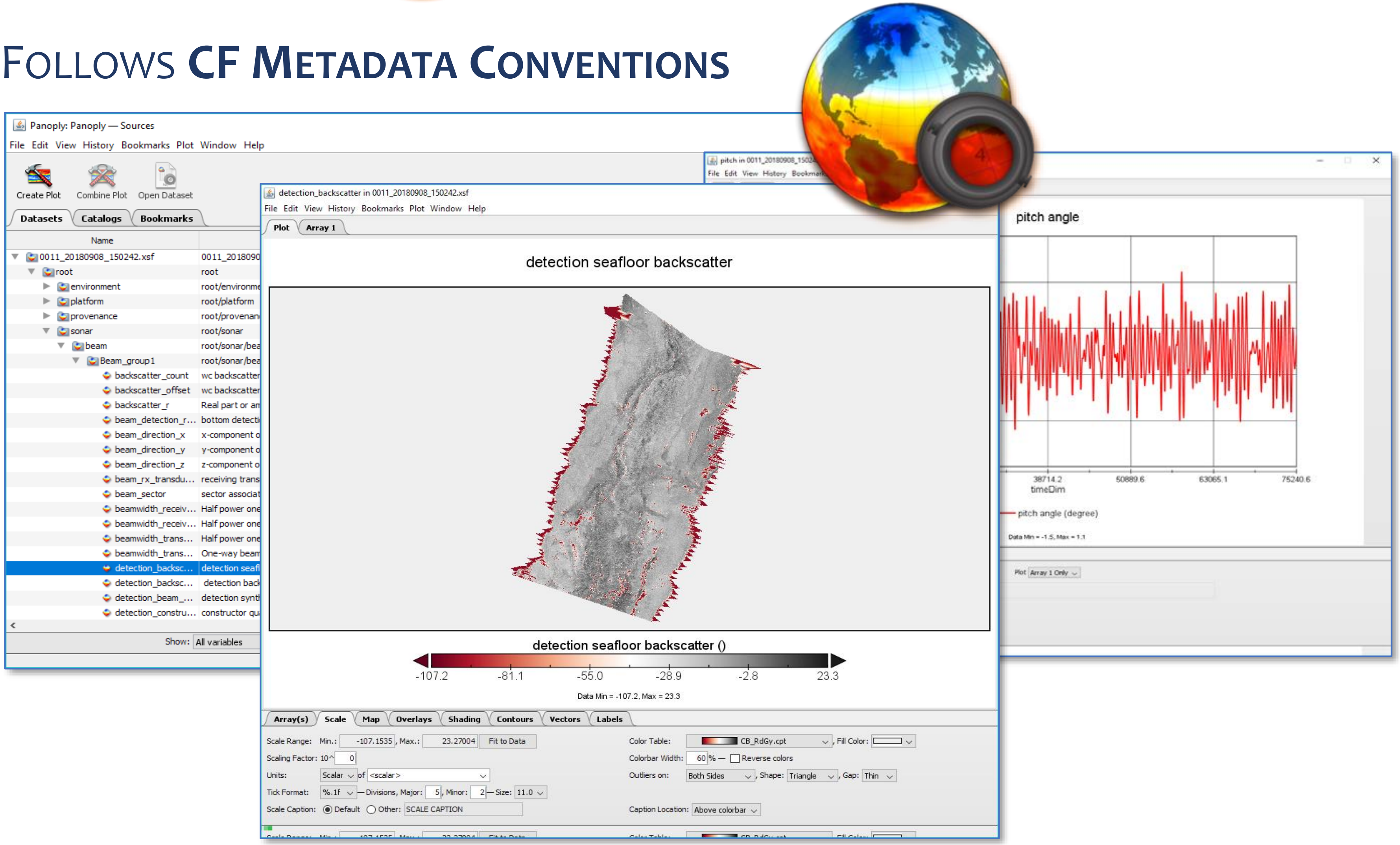
MODULAR IMPLEMENTATION

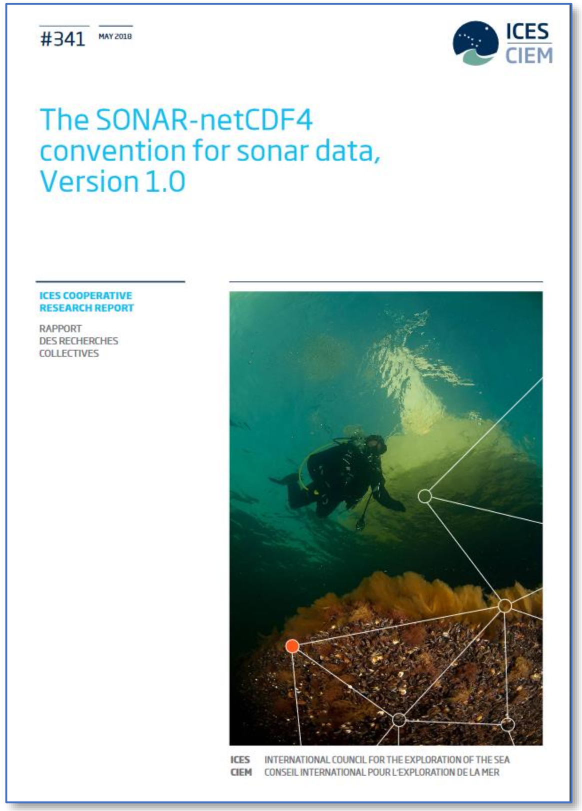
NOT COMPETING WITH COMMERCIAL SOLUTIONS, BUT

A SET OF COMMUNITY-VETTED, REFERENCE ALGORITHMS

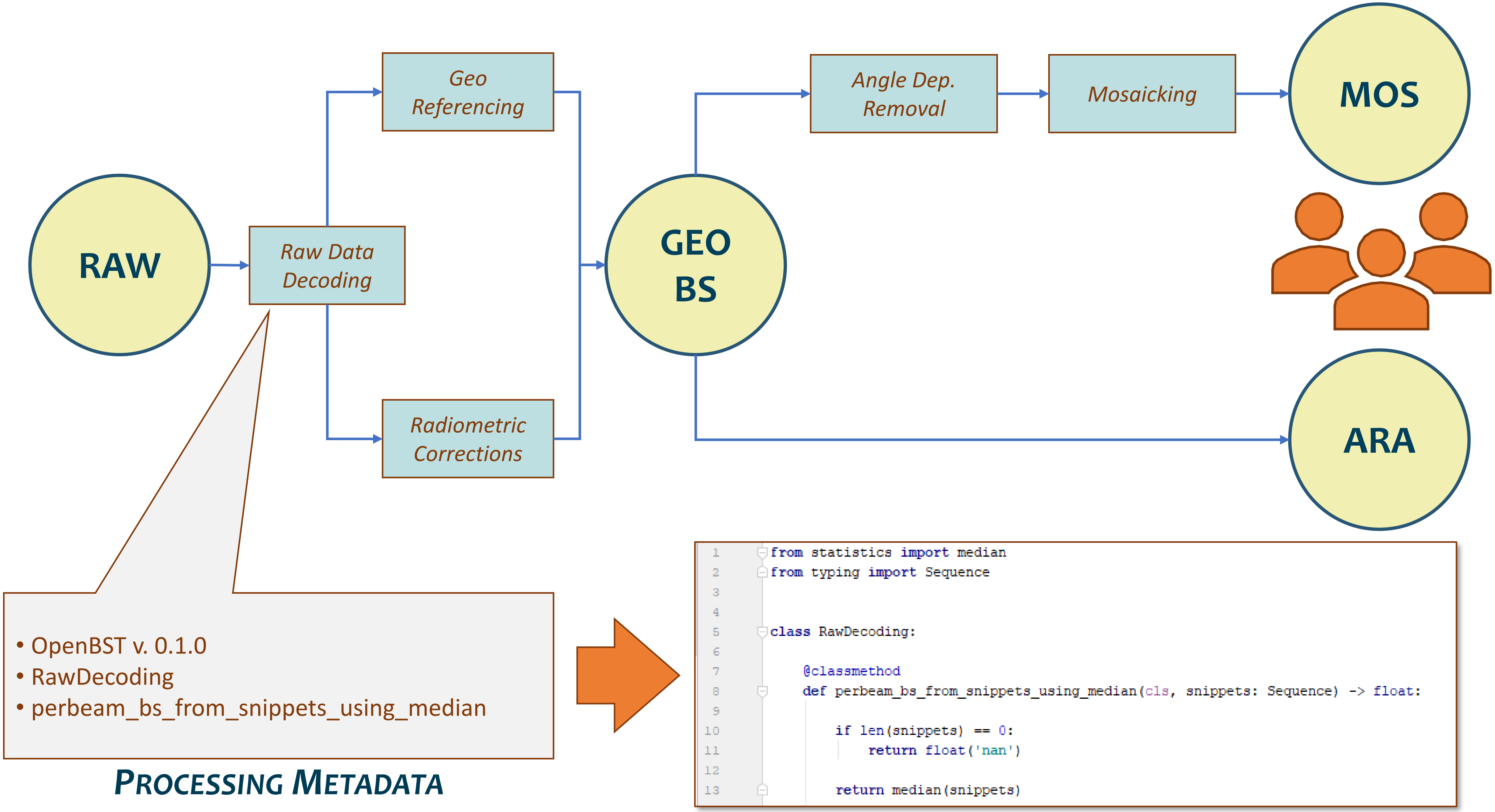
XSF

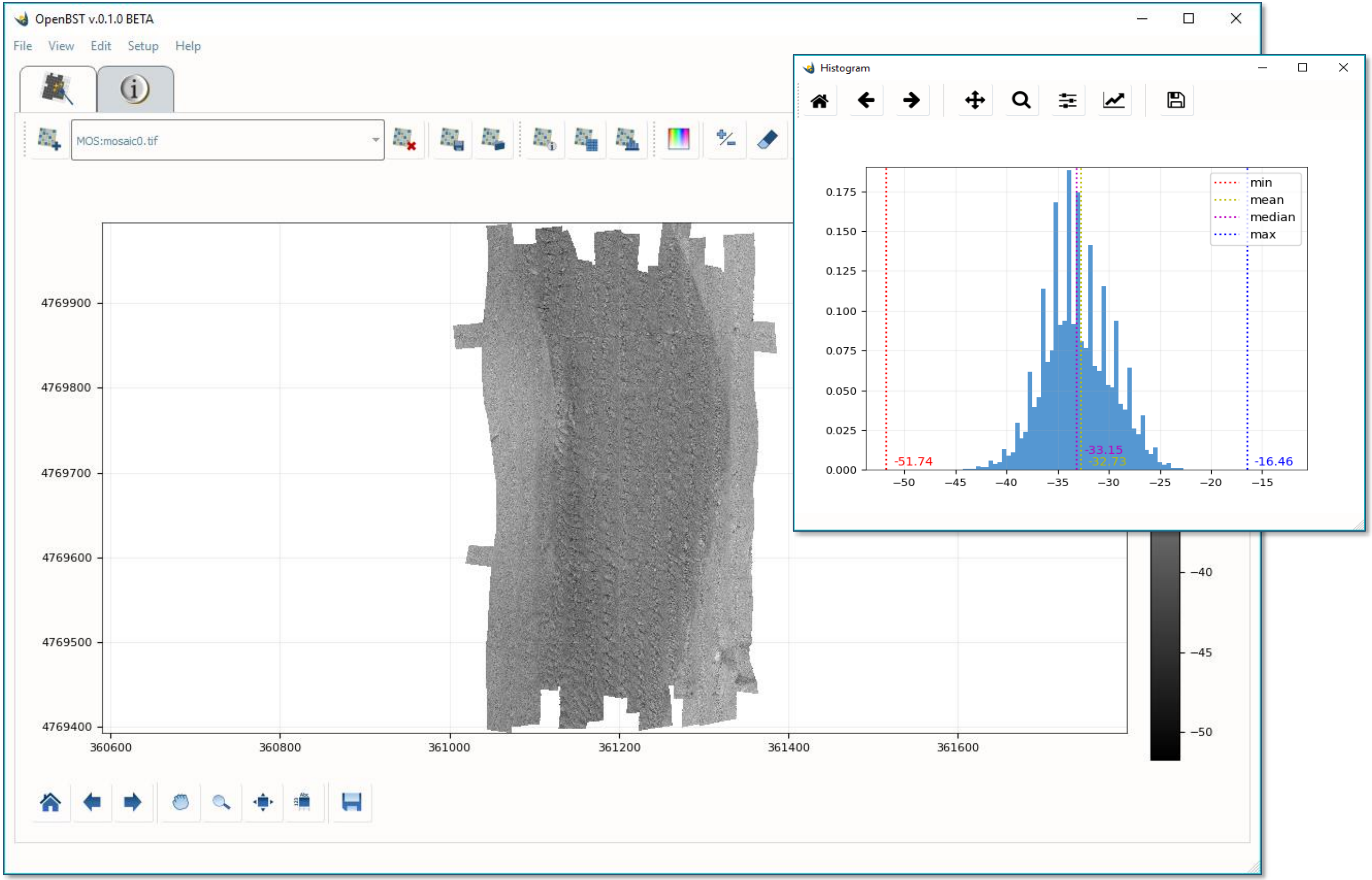
Follows CF Metadata Conventions





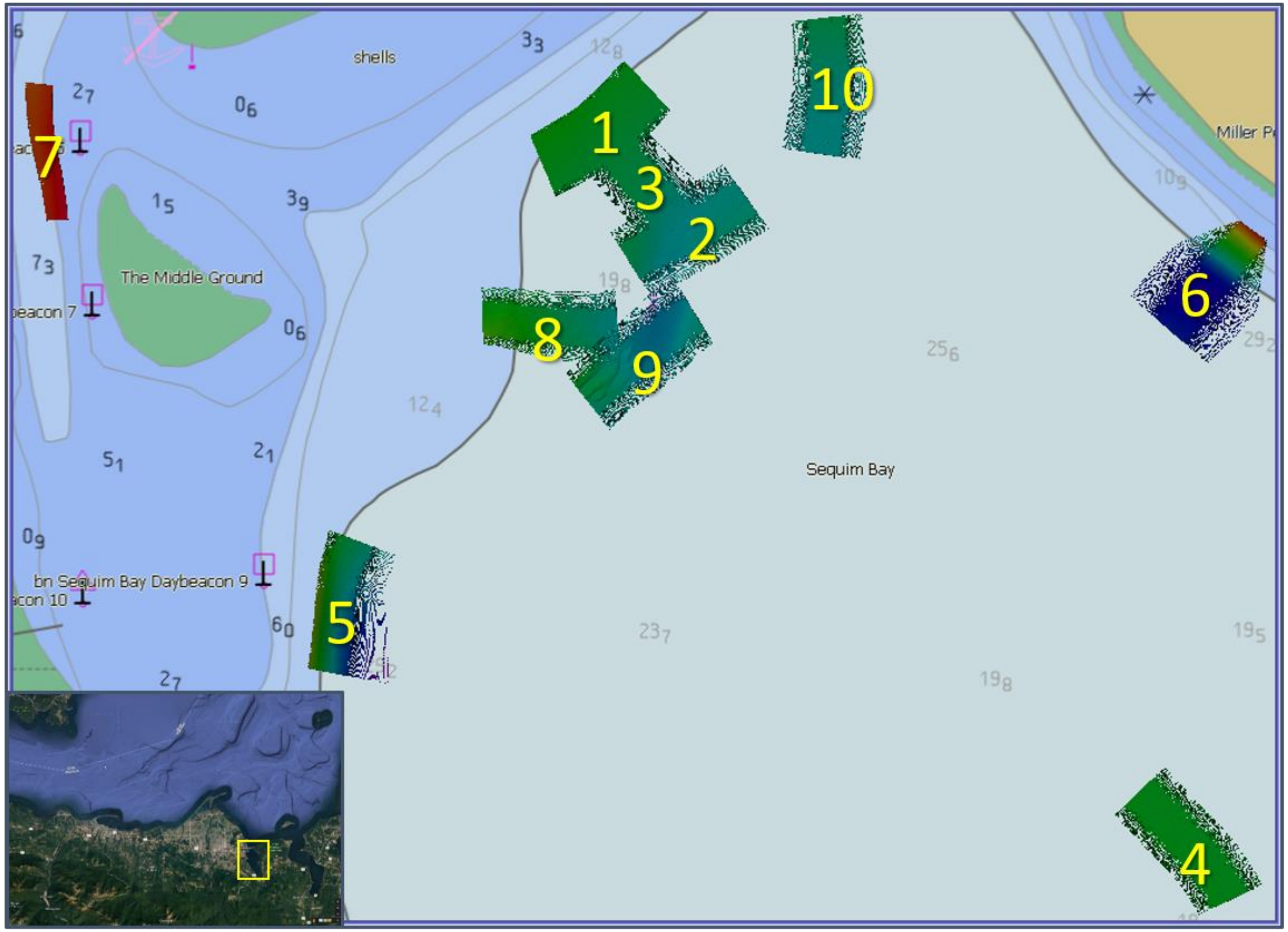
Extends
SONAR-netCDF4


RAW
Raw Data Decoding
Geo Referencing
Radiometric Corrections
GEO BS
Angle Dep. Removal
Mosaicking
MOS
ARA
• OpenBST v. 0.1.0
• RawDecoding
• perbeam_bs_from_snippets_using_median
PROCESSING METADATA
from statistics import median
from typing import Sequence
class RawDecoding:
@classmethod
def perbeam_bs_from_snippets_using_median(cls, snippets: Sequence) -> float:
if len(snippets) == 0:
return float('nan')
return median(snippets)

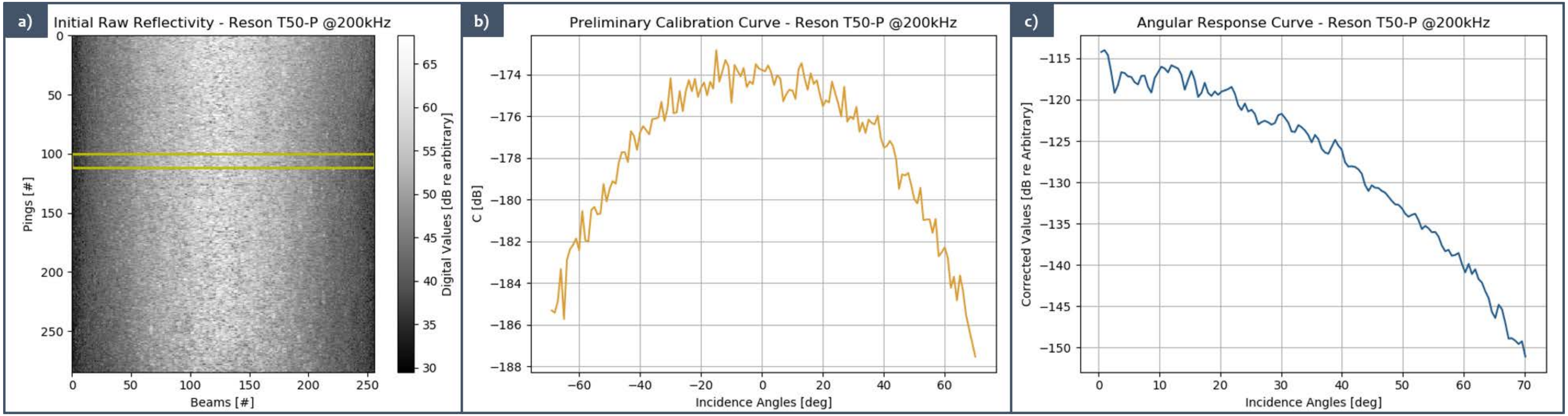


OpenBST v.0.1.0 BETA
File
View
Edit
Setup
Help
MOS:mosaic0.tif
4769900
4769800
4769700
4769600
4769500
4769400
360600
360800
361000
361200
361400
361600
−40
−45
−50
Histogram
min
mean
median
max
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
-51.74
-33.15
-32.73
-16.46
−50
−45
−40
−35
−30
−25
−20
−15

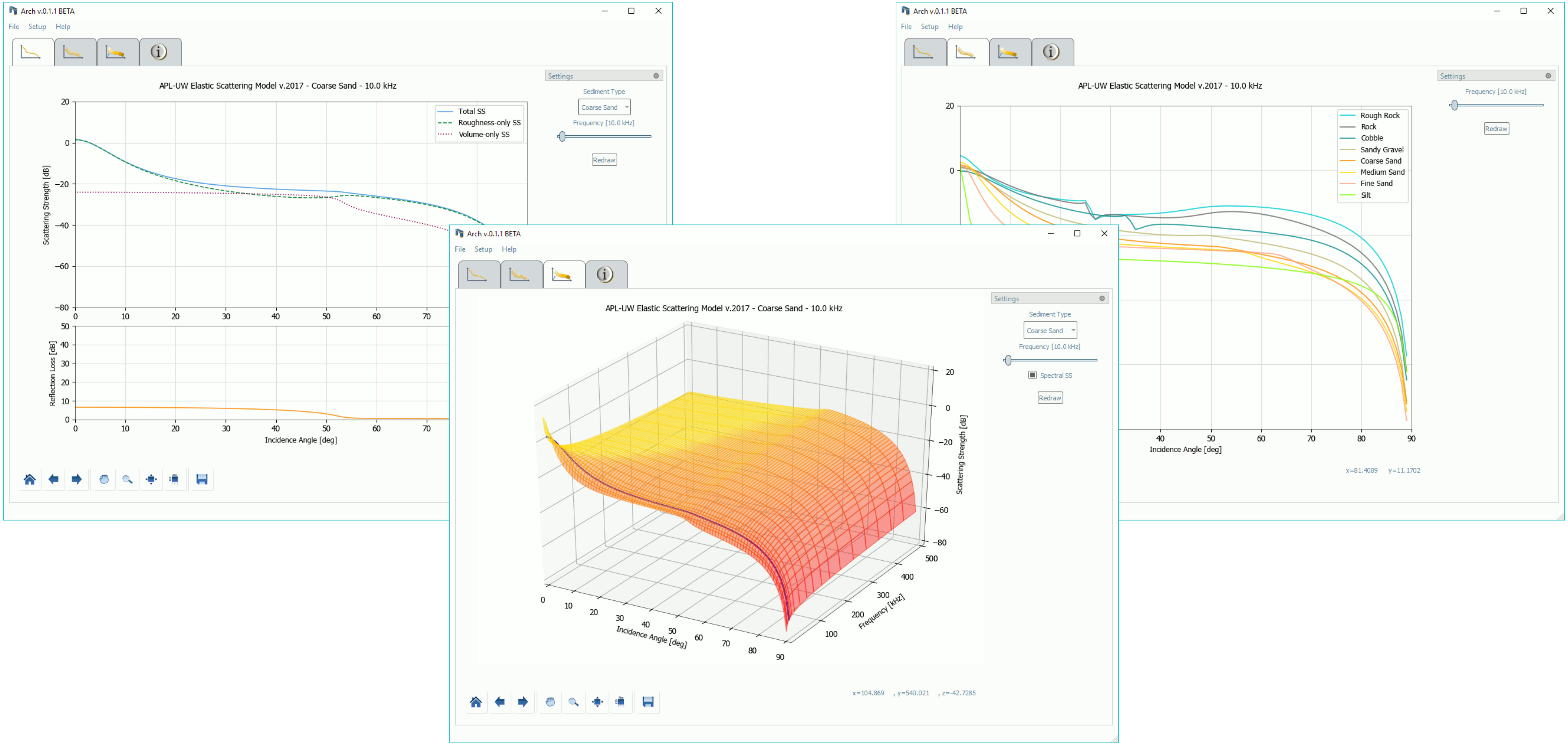
OpenBST → Sequim Bay Experiment



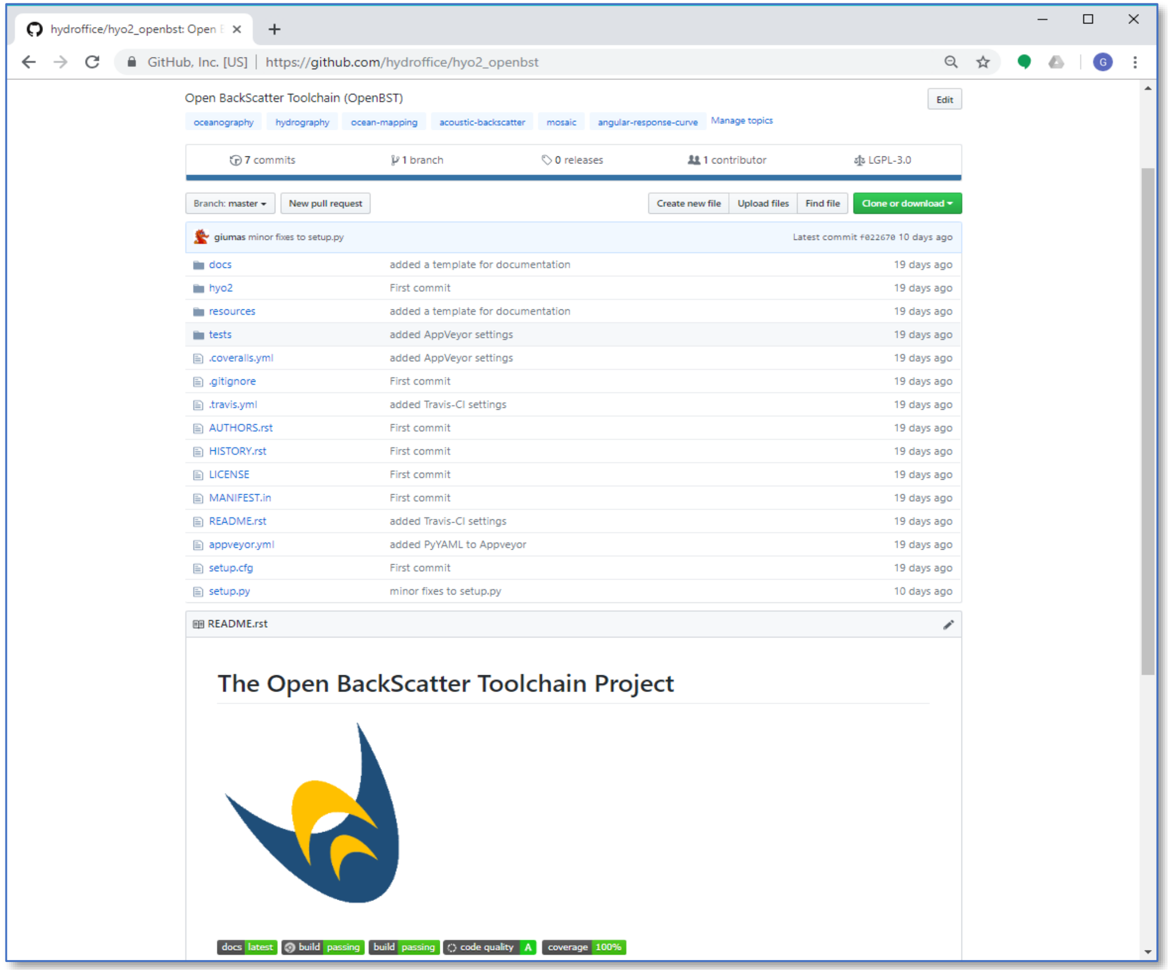
OpenBST → Sequim Bay Experiment



OpenBST → Arch Engine



GitHub



+

Pydro 2020

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

v0

Fix

StormFix

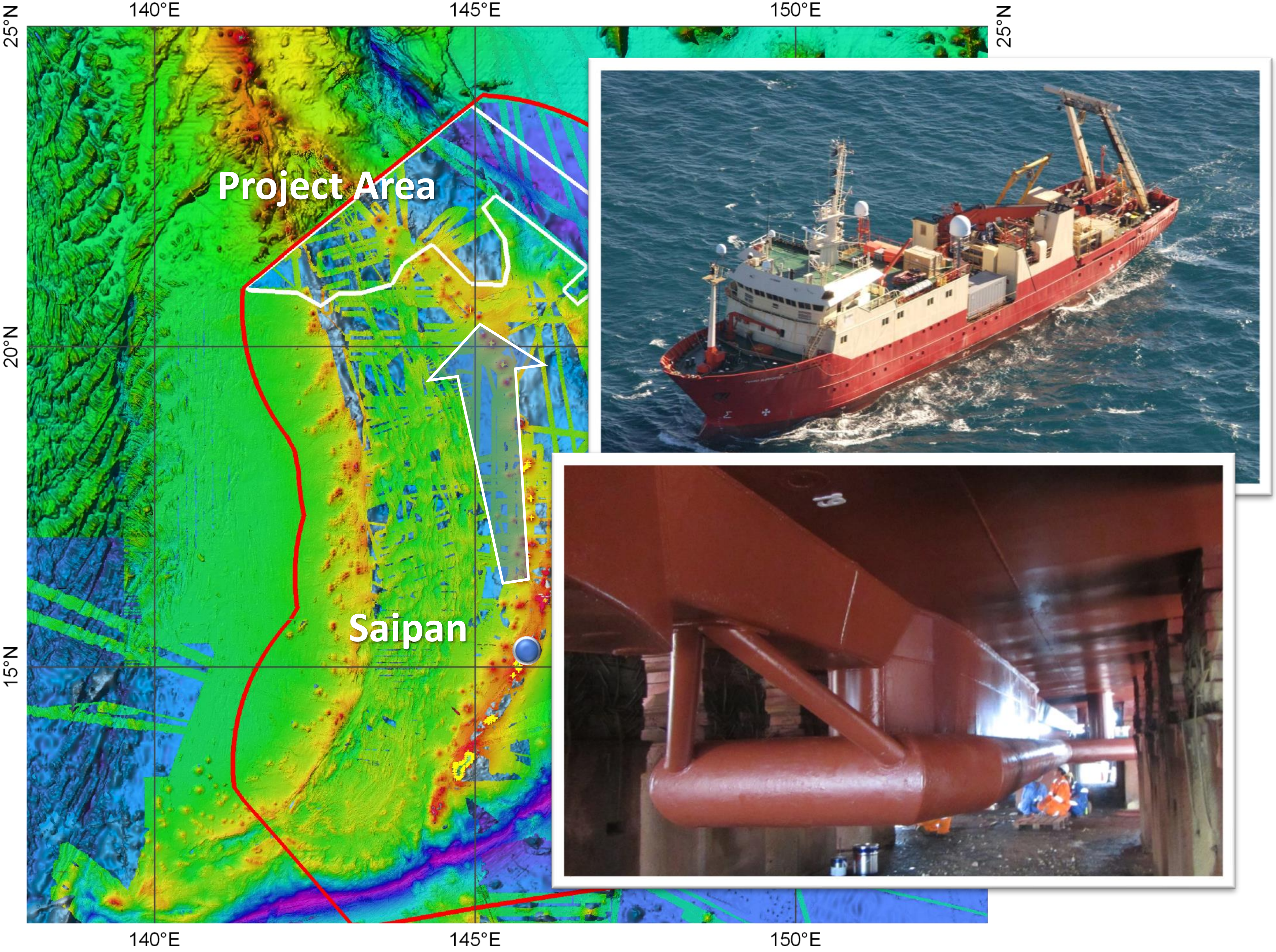
G. Masetti & T. Faulkes

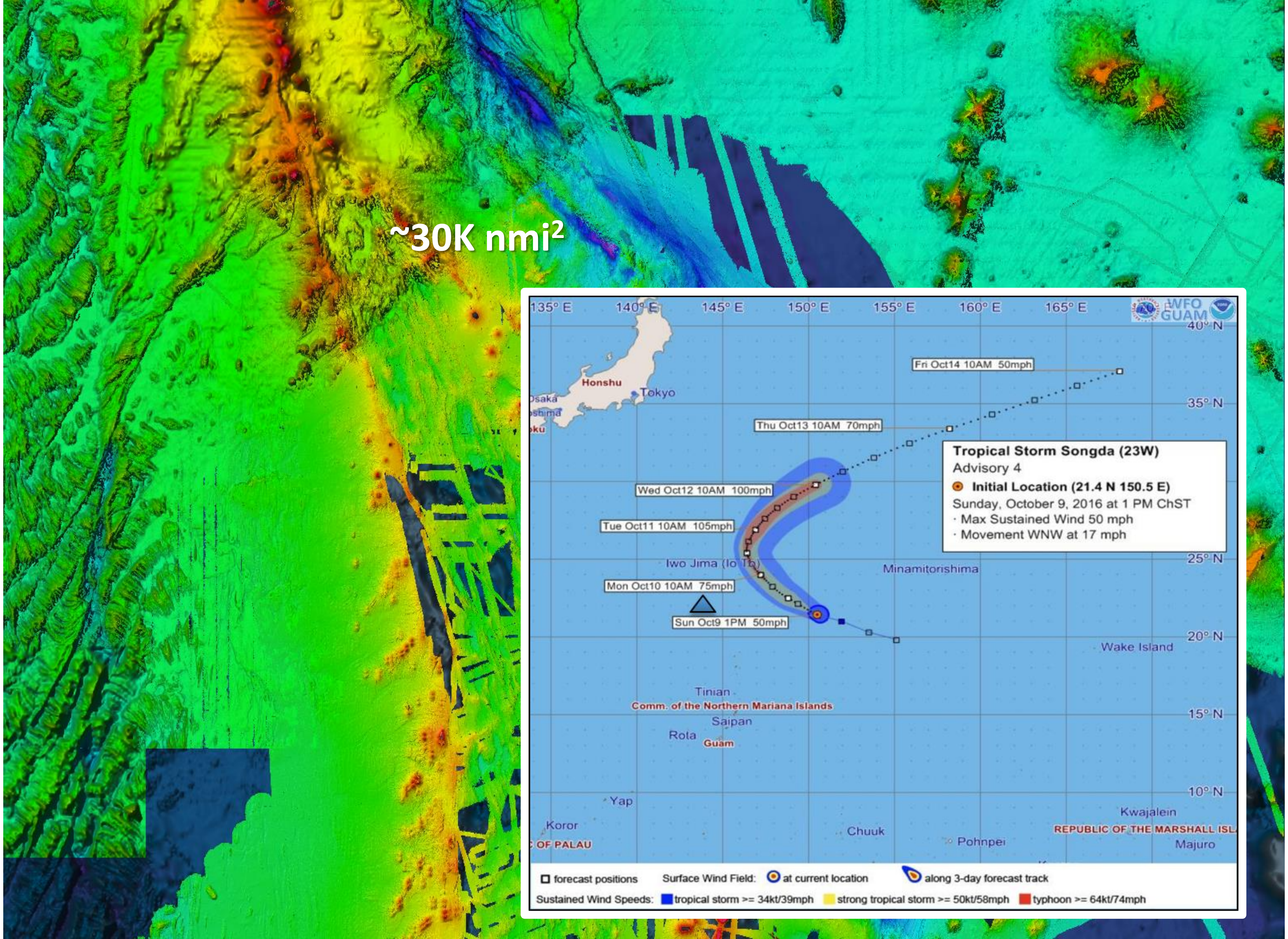
Canberra, June 18-20 2019

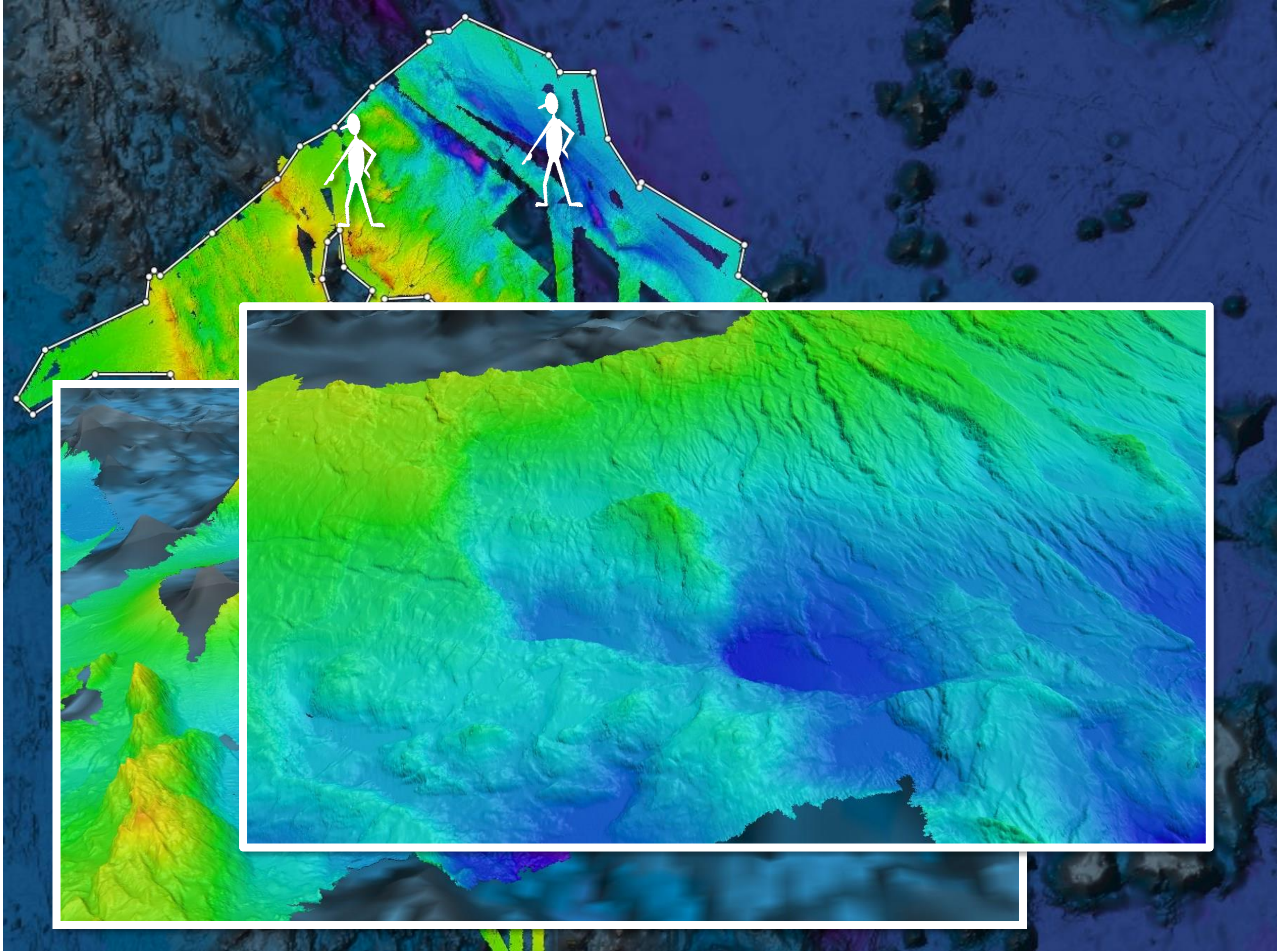
StormFix

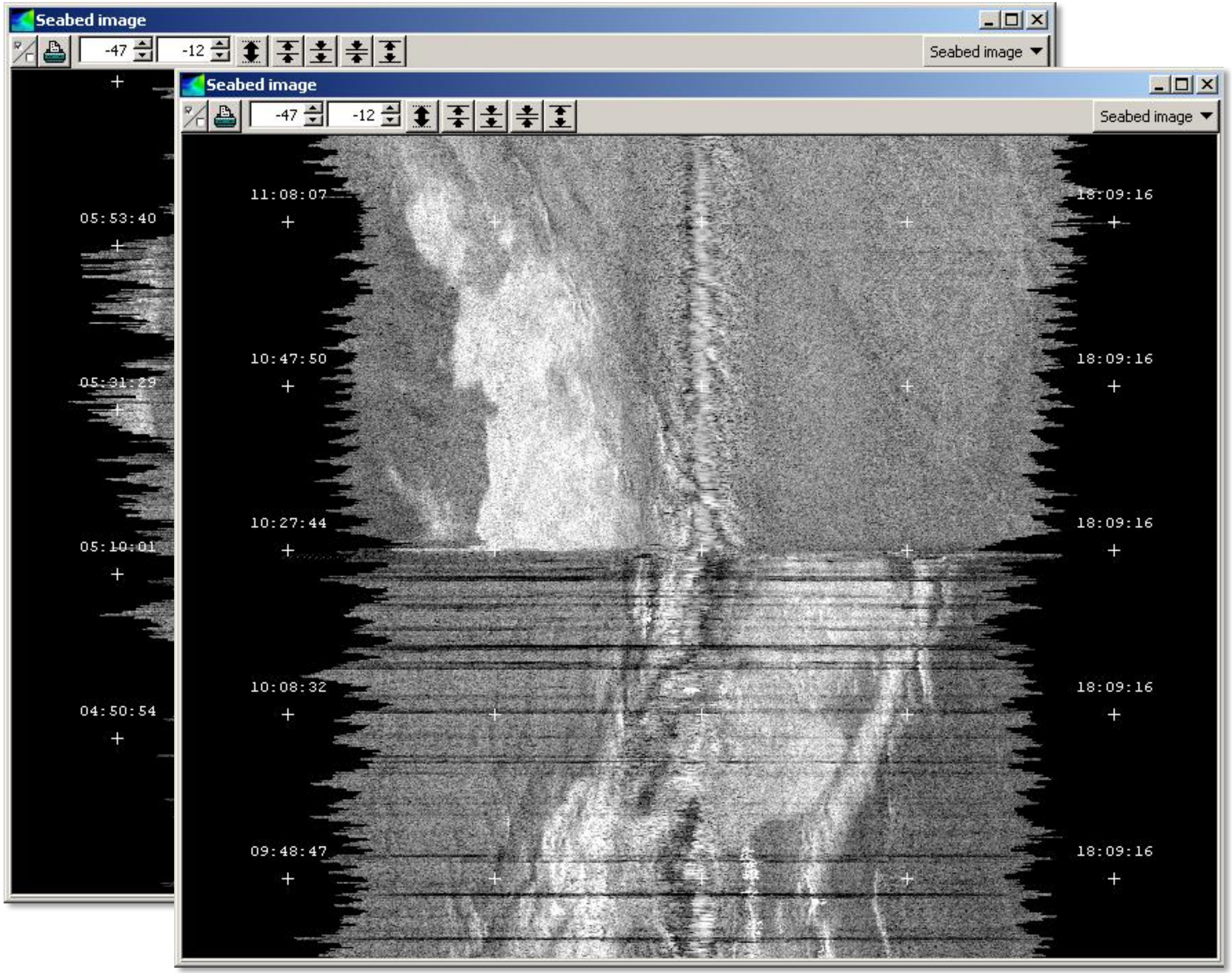
A collection of methods
for **artifact identification**
and reduction
in acoustic backscatter
mosaicking

Ref.: Masetti, G., Calder, B. R., and Hughes Clarke, J. E., *Methods for Artifact Identification and Reduction in Acoustic Backscatter Mosaicking*, U.S. Hydro, Galveston, TX, 2017.

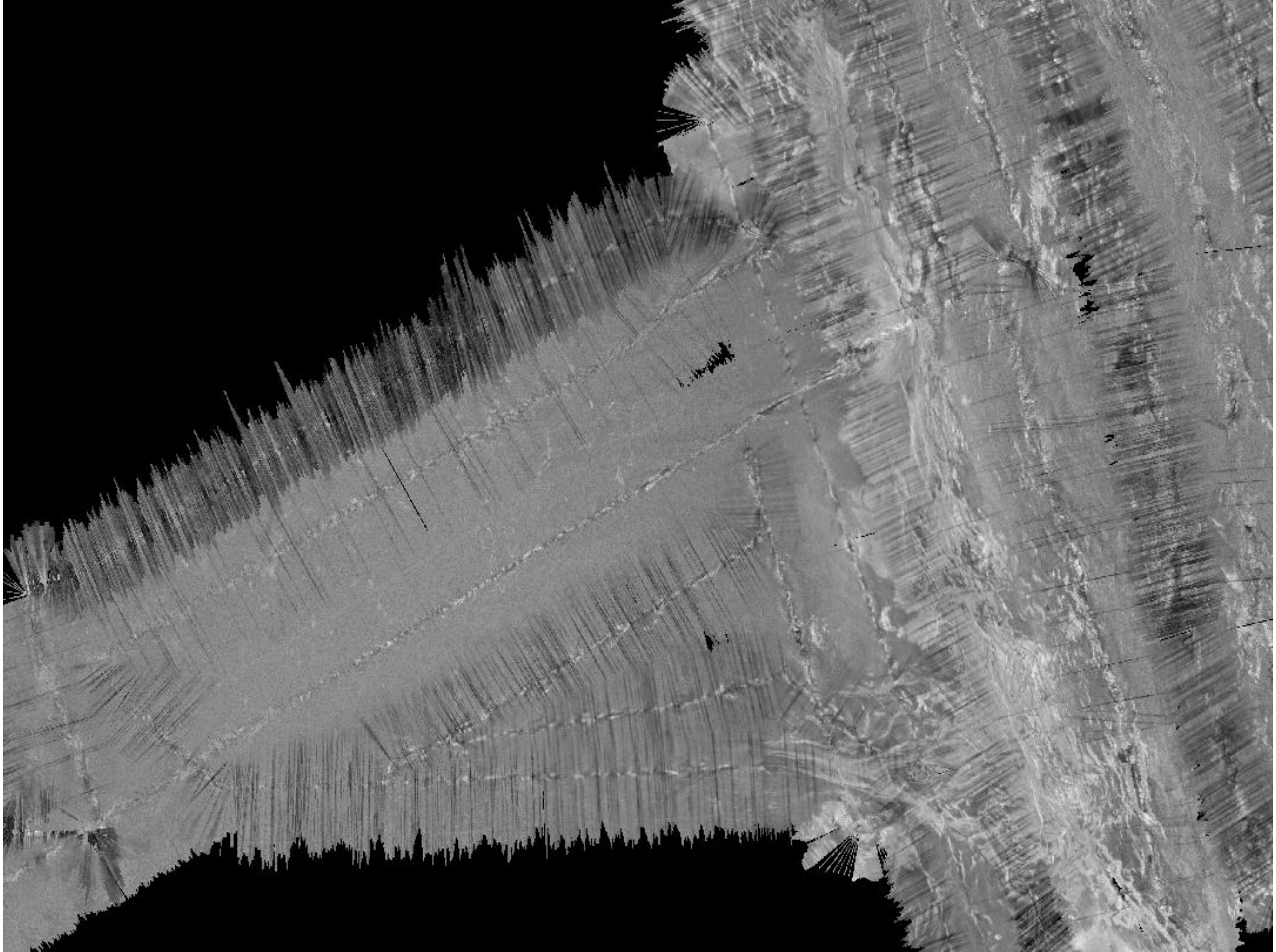

140°E
145°E
150°E
25°N
20°N
15°N
Project Area
Saipan


~30K nmi²
135° E
140° E
145° E
150° E
155° E
160° E
165° E
WFO GUAM
40° N
35° N
25° N
20° N
15° N
10° N
Honshu
Tokyo
Osaka
Fri Oct14 10AM 50mph
Thu Oct13 10AM 70mph
Wed Oct12 10AM 100mph
Tue Oct11 10AM 105mph
Mon Oct10 10AM 75mph
Sun Oct9 1PM 50mph
Tropical Storm Songda (23W)
Advisory 4
Initial Location (21.4 N 150.5 E)
Sunday, October 9, 2016 at 1 PM ChST
· Max Sustained Wind 50 mph
· Movement WNW at 17 mph
Iwo Jima (Io To)
Minamitorishima
Wake Island
Tinian
Comm. of the Northern Mariana Islands
Saipan
Rota
Guam
Yap
Koror
OF PALAU
Chuuk
Pohnpei
Kwajalein
REPUBLIC OF THE MARSHALL ISL
Majuro
forecast positions
Surface Wind Field:
at current location
along 3-day forecast track
Sustained Wind Speeds:
tropical storm >= 34kt/39mph
strong tropical storm >= 50kt/58mph
typhoon >= 64kt/74mph

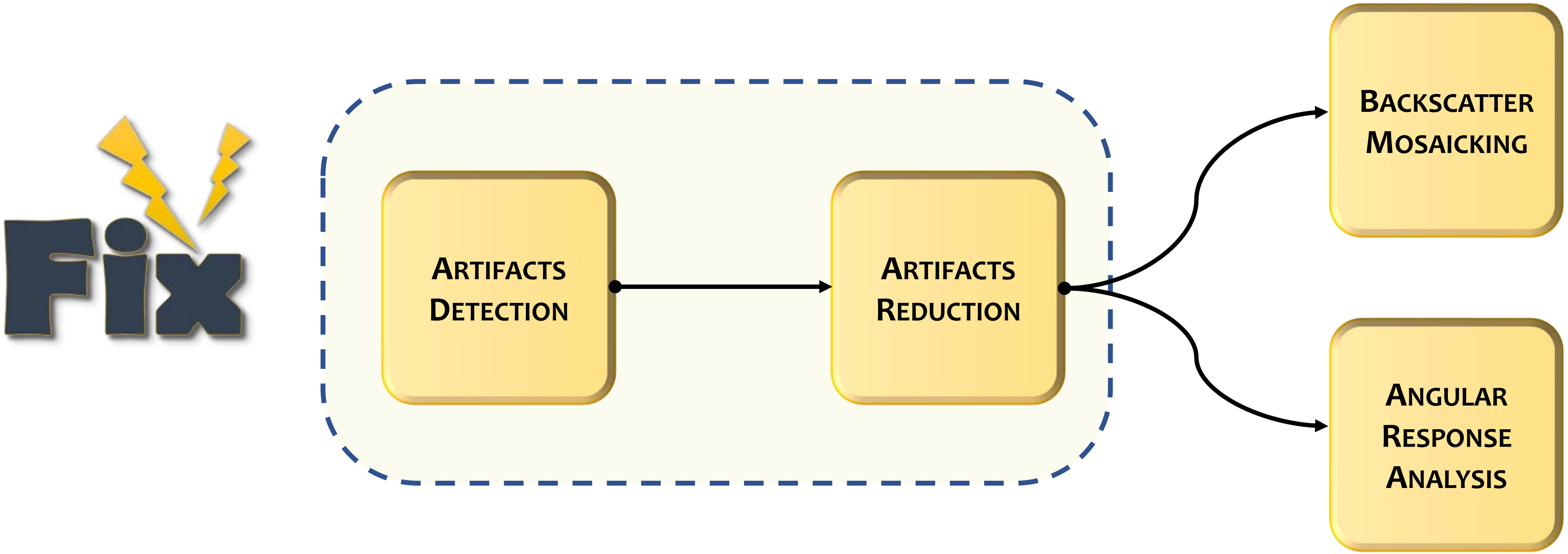




Seabed image
-47
-12
Seabed image
05:53:40
05:31:29
05:10:01
04:50:54
Seabed image
-47
-12
Seabed image
11:08:07
10:47:50
10:27:44
10:08:32
09:48:47
18:09:16
18:09:16
18:09:16
18:09:16
18:09:16

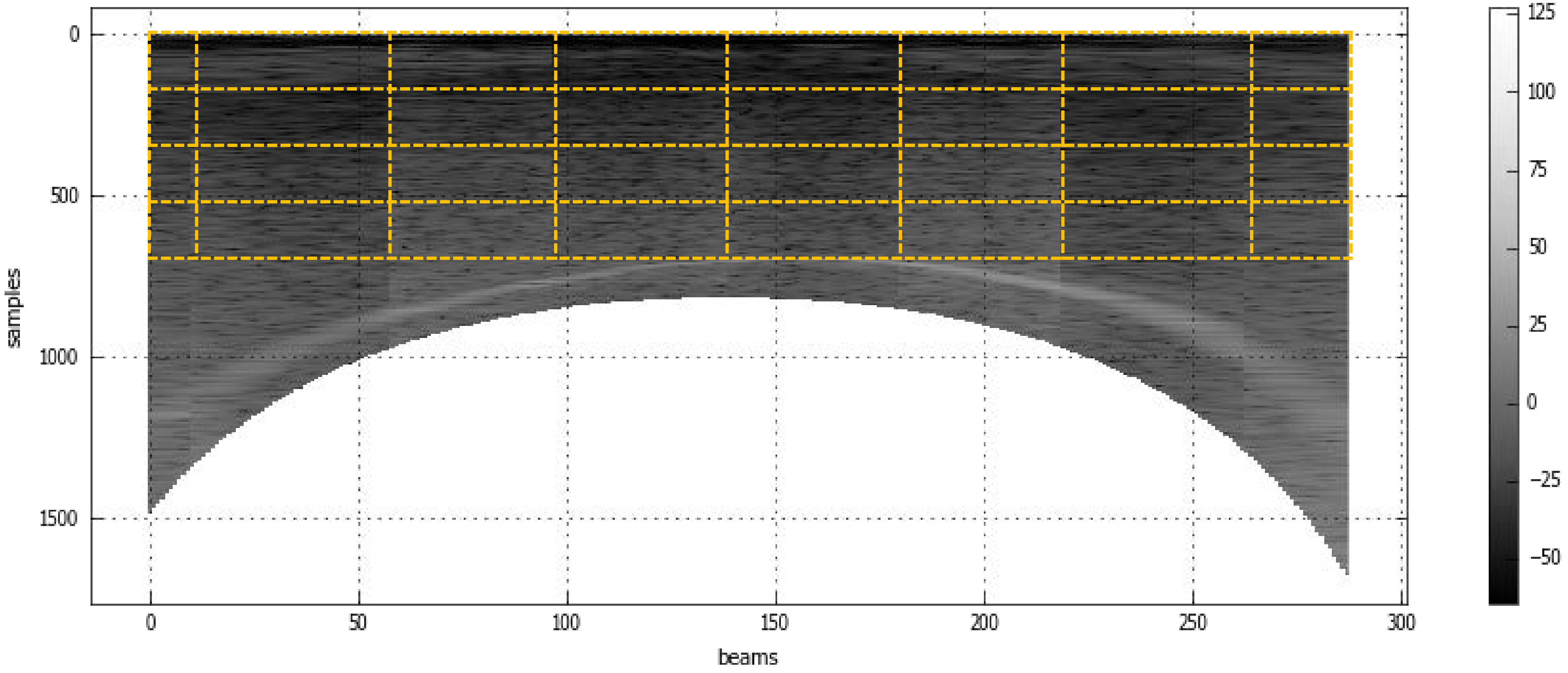


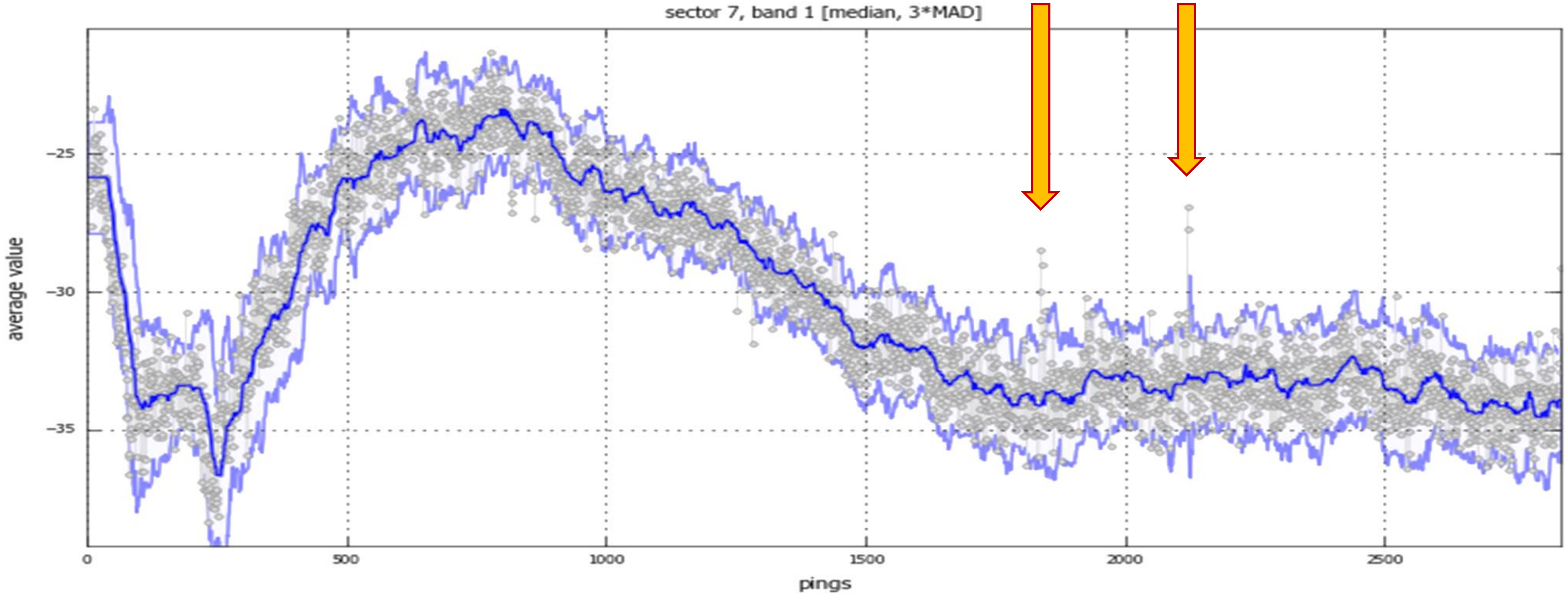
StormFix

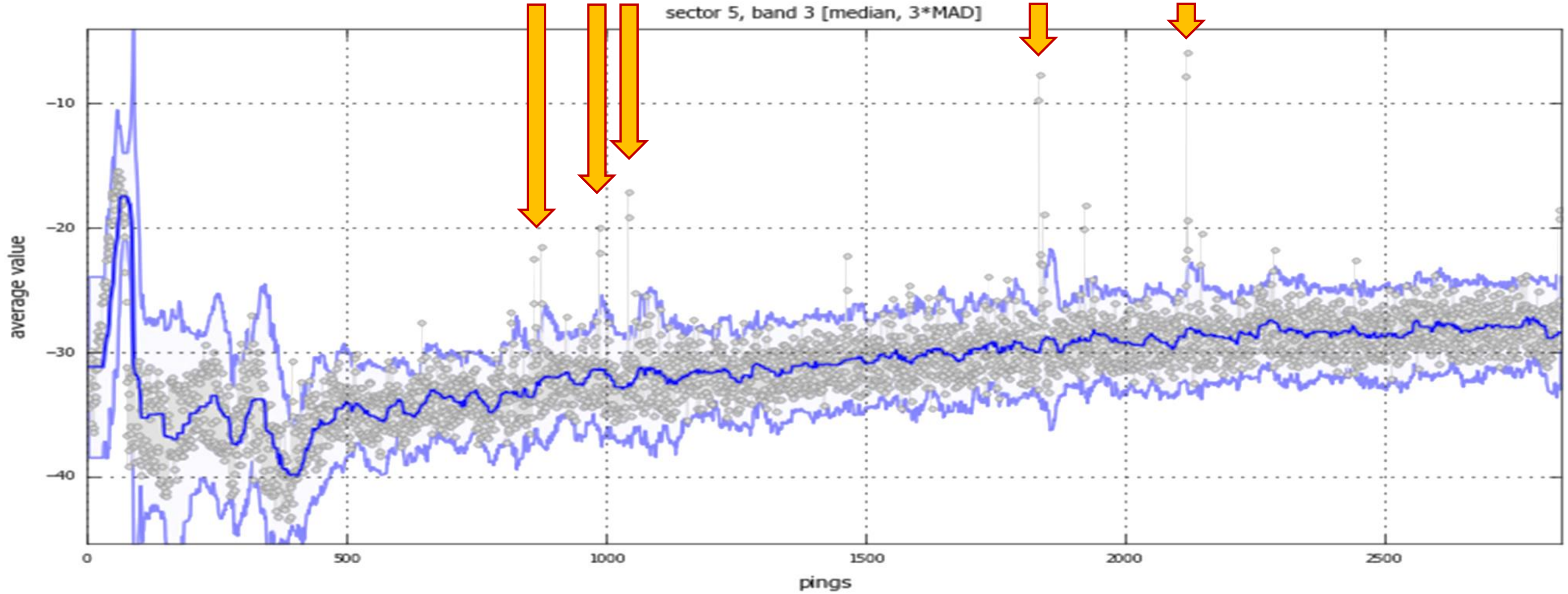


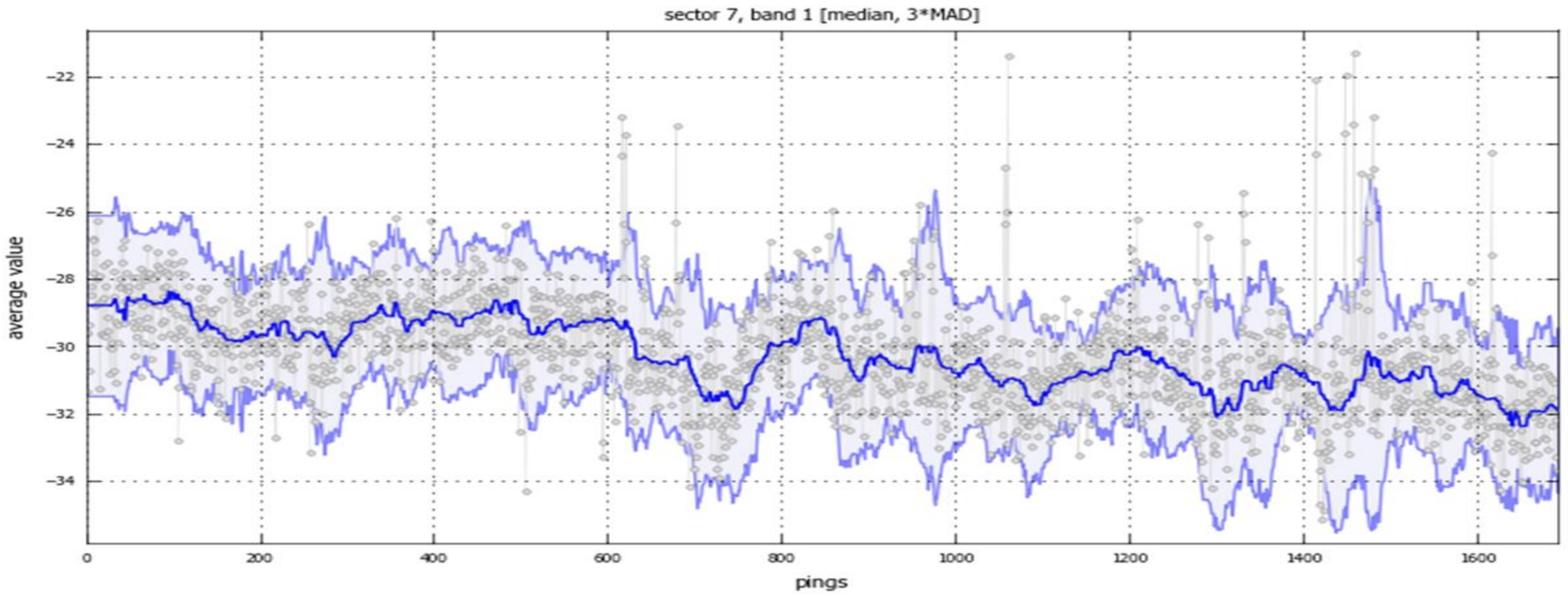
Ref.: G. Masetti et al., “How to Improve the Quality and the Reproducibility for Acoustic Seafloor Characterization”, GeoHab 2017. p. Nova Scotia, Canada, 2017.

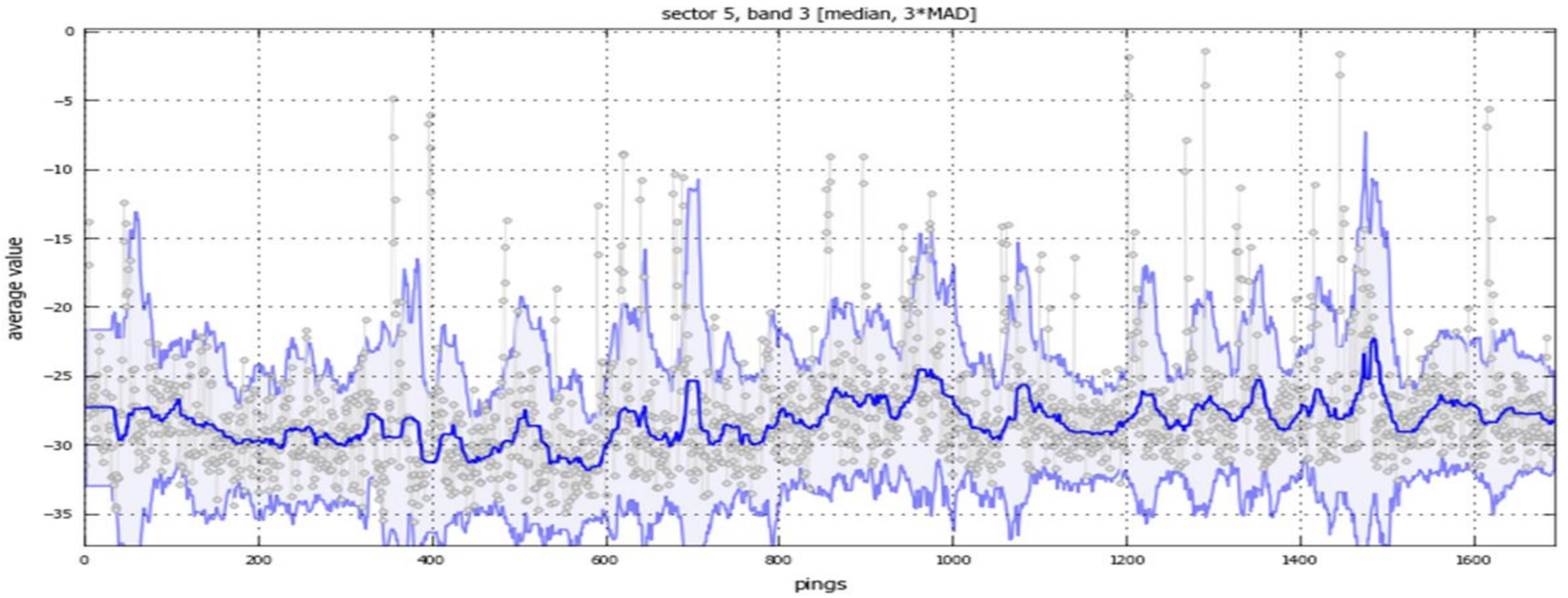
StormFix: How it works?

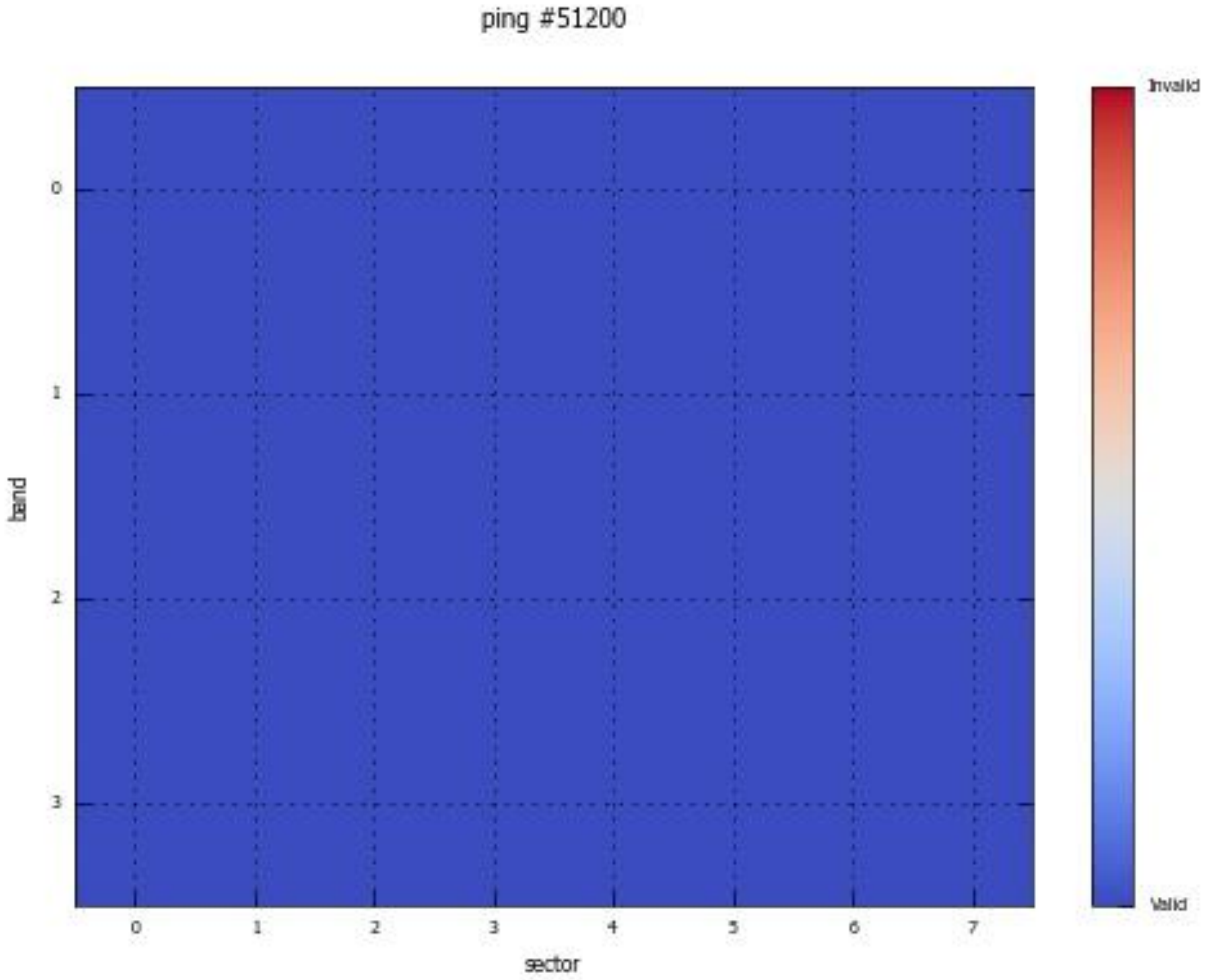



sector 7, band 1 [median, 3*MAD]
average value
-25
-30
-35
0
500
1000
1500
2000
2500
pings

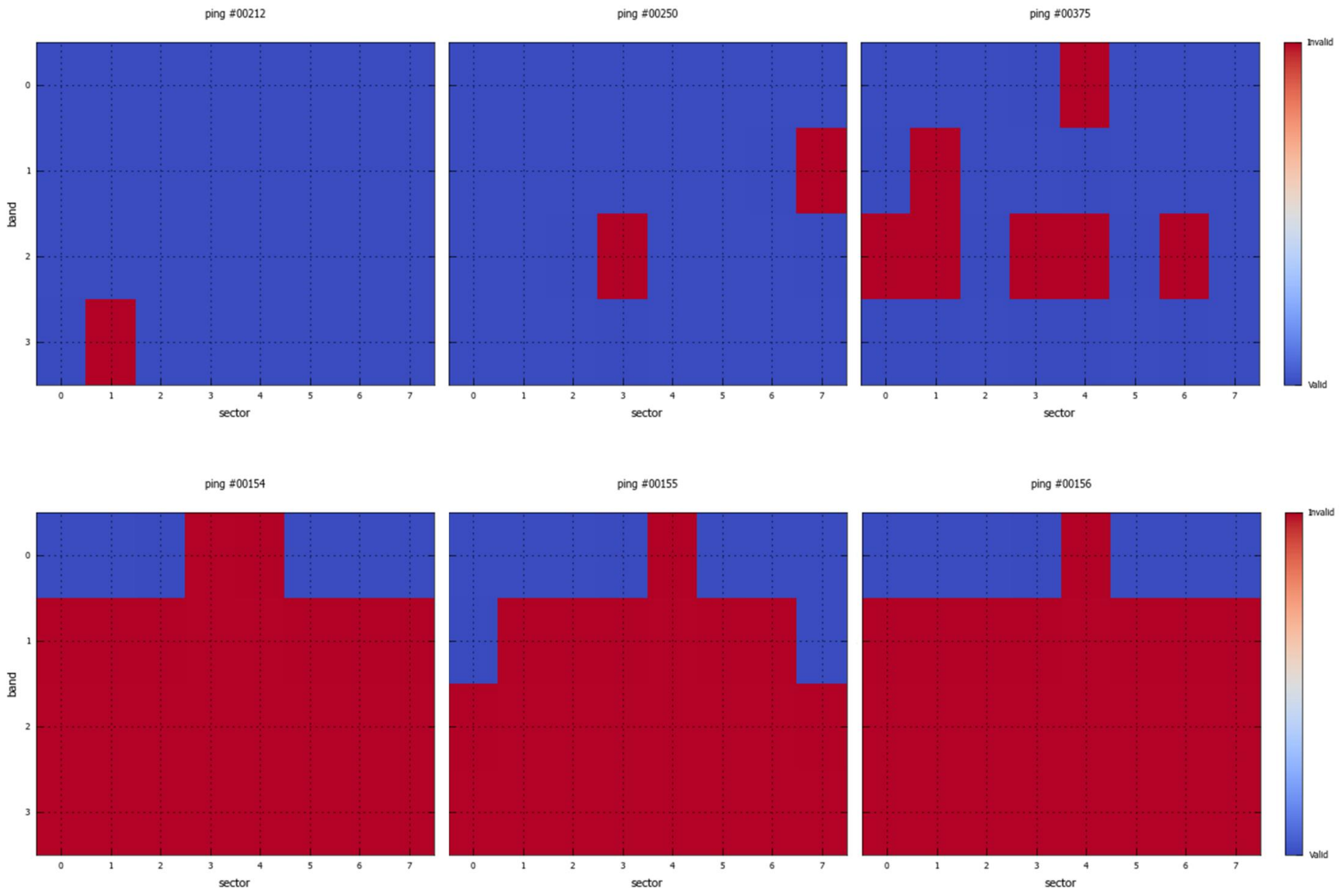

sector 5, band 3 [median, 3*MAD]
average value
-10
-20
-30
-40
0
500
1000
1500
2000
2500
pings


sector 7, band 1 [median, 3*MAD]
average value
pings

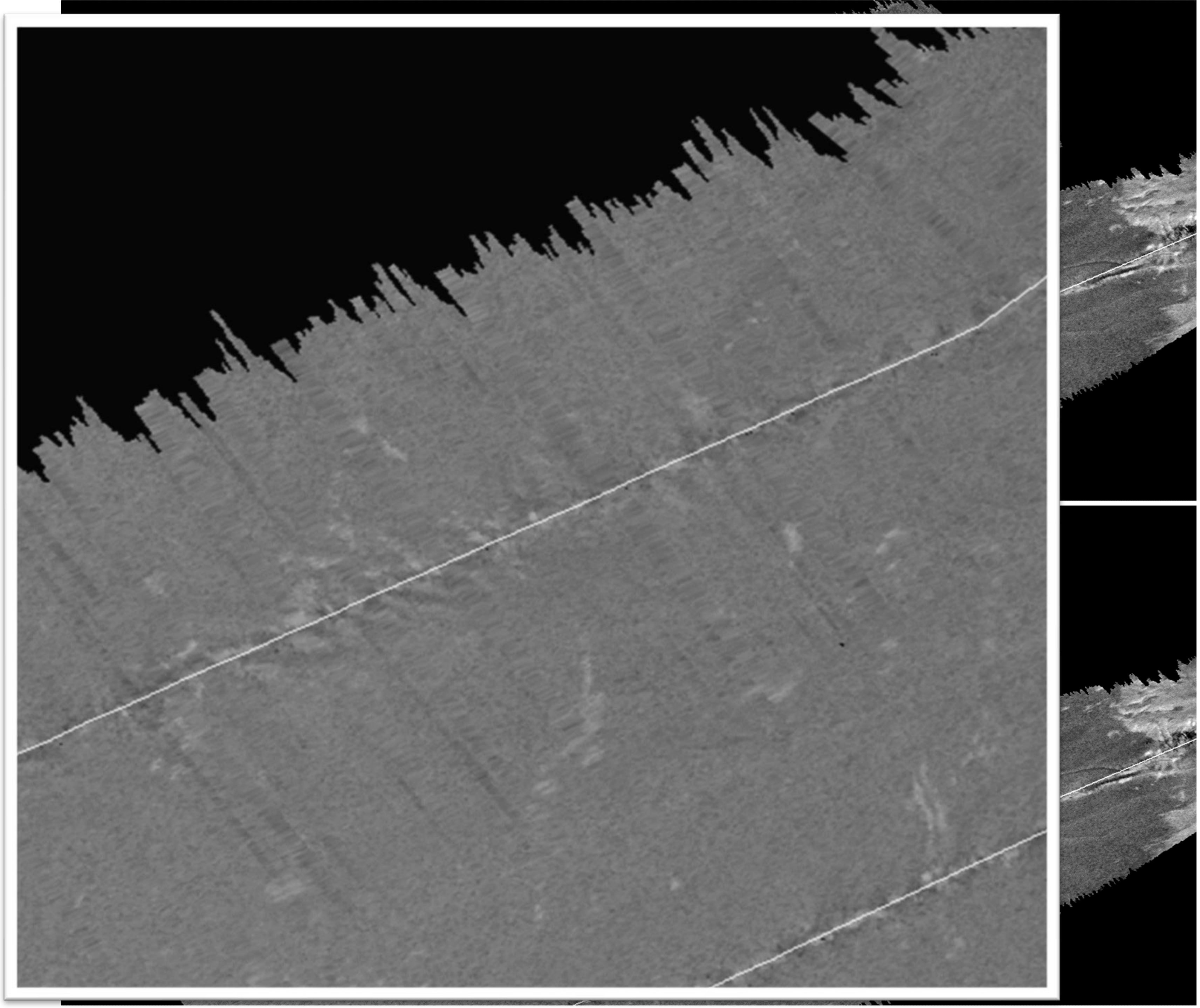

sector 5, band 3 [median, 3*MAD]
average value
pings

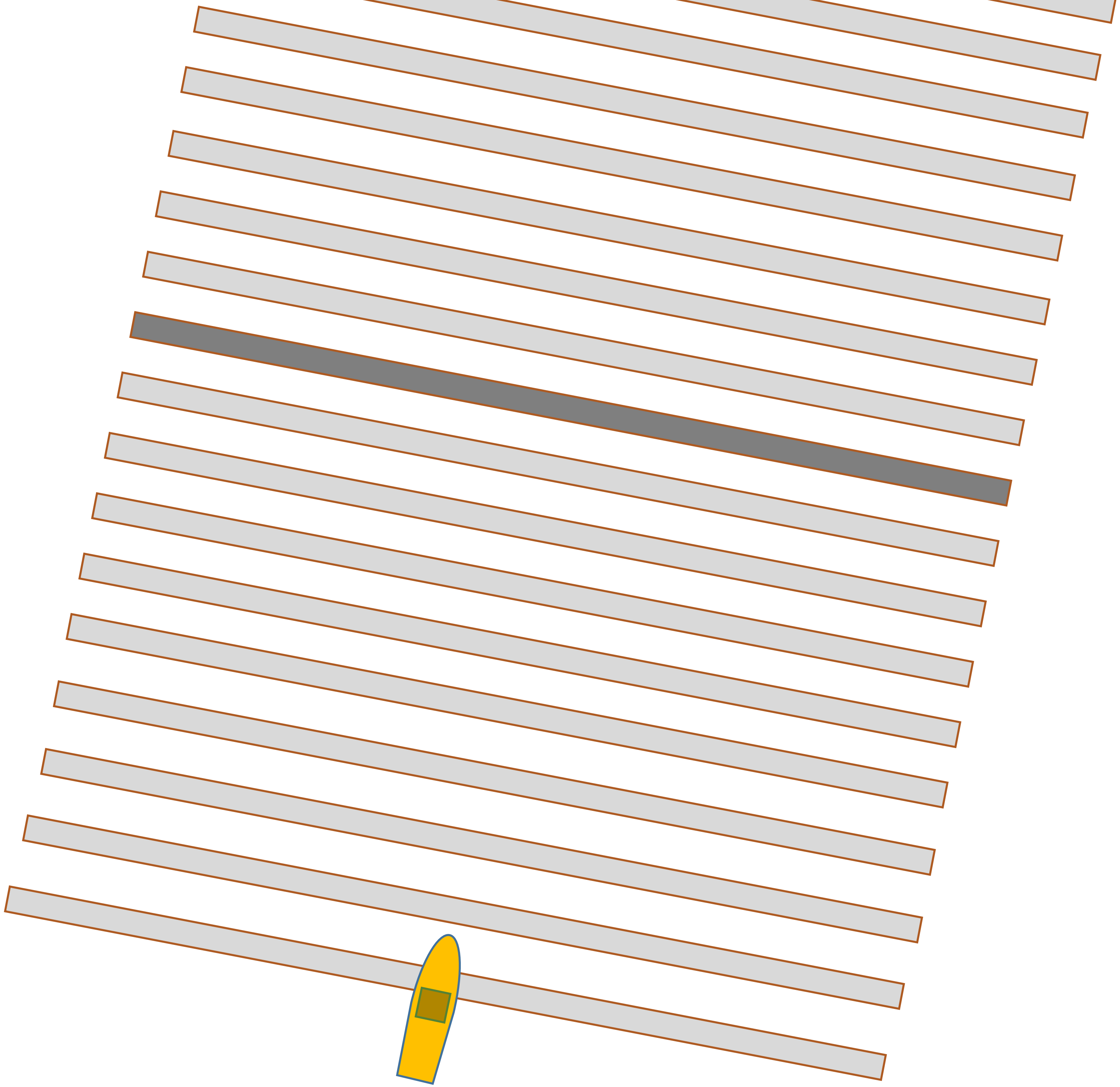


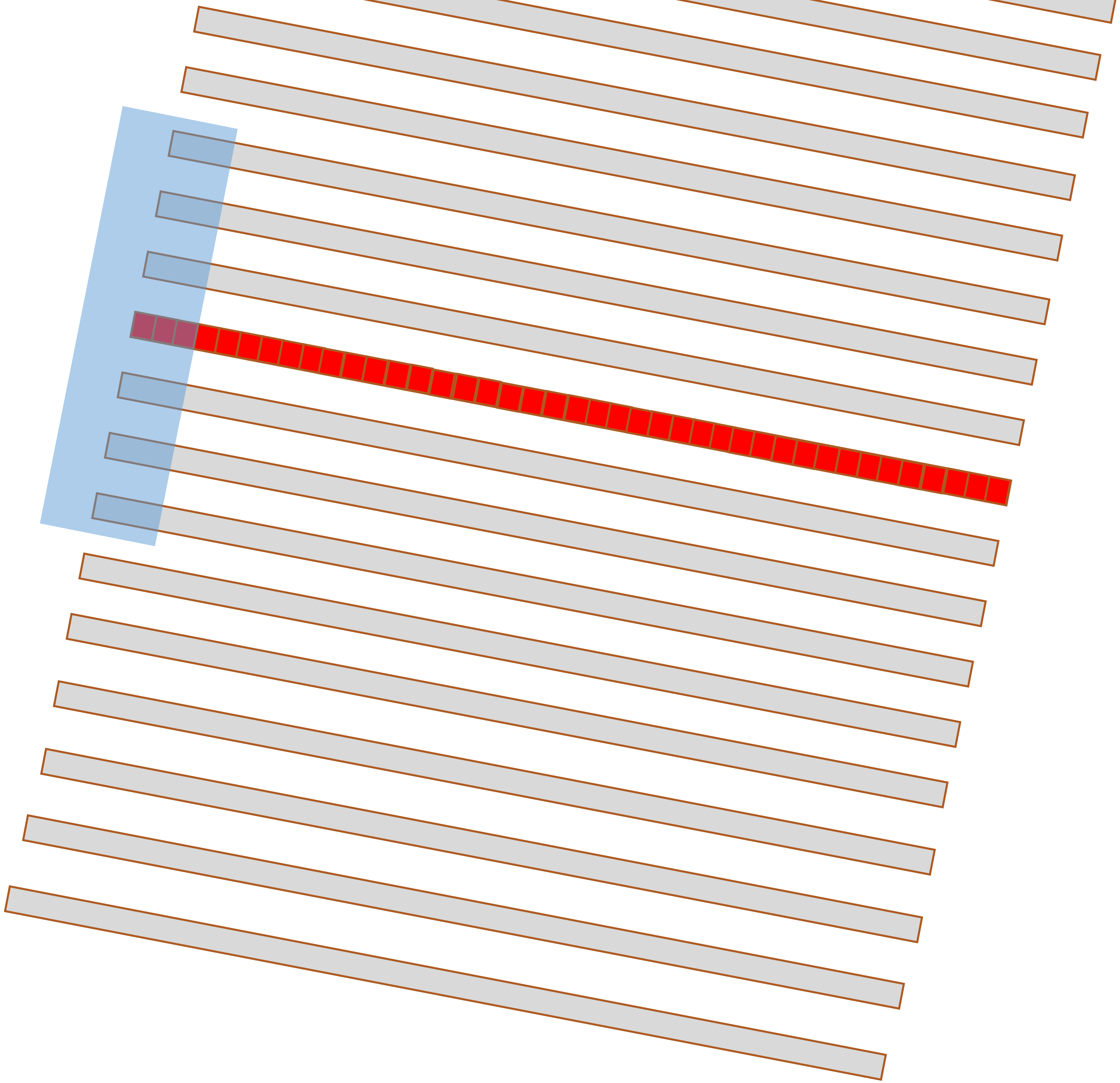
ping #51200
Invalid
Valid
band
sector
0
1
2
3
0
1
2
3
4
5
6
7



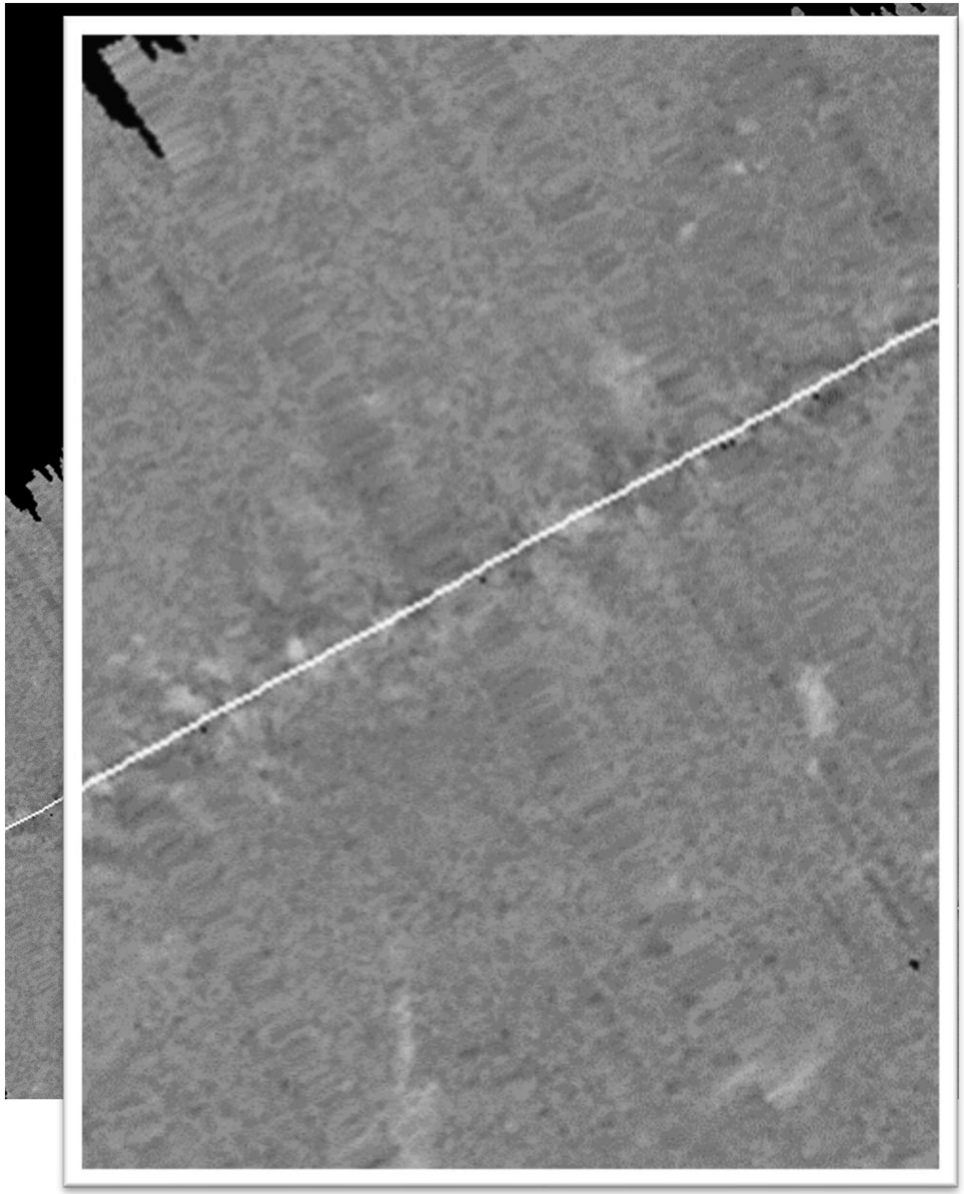
ping #00212
ping #00250
ping #00375
ping #00154
ping #00155
ping #00156
band
sector
Invalid
Valid

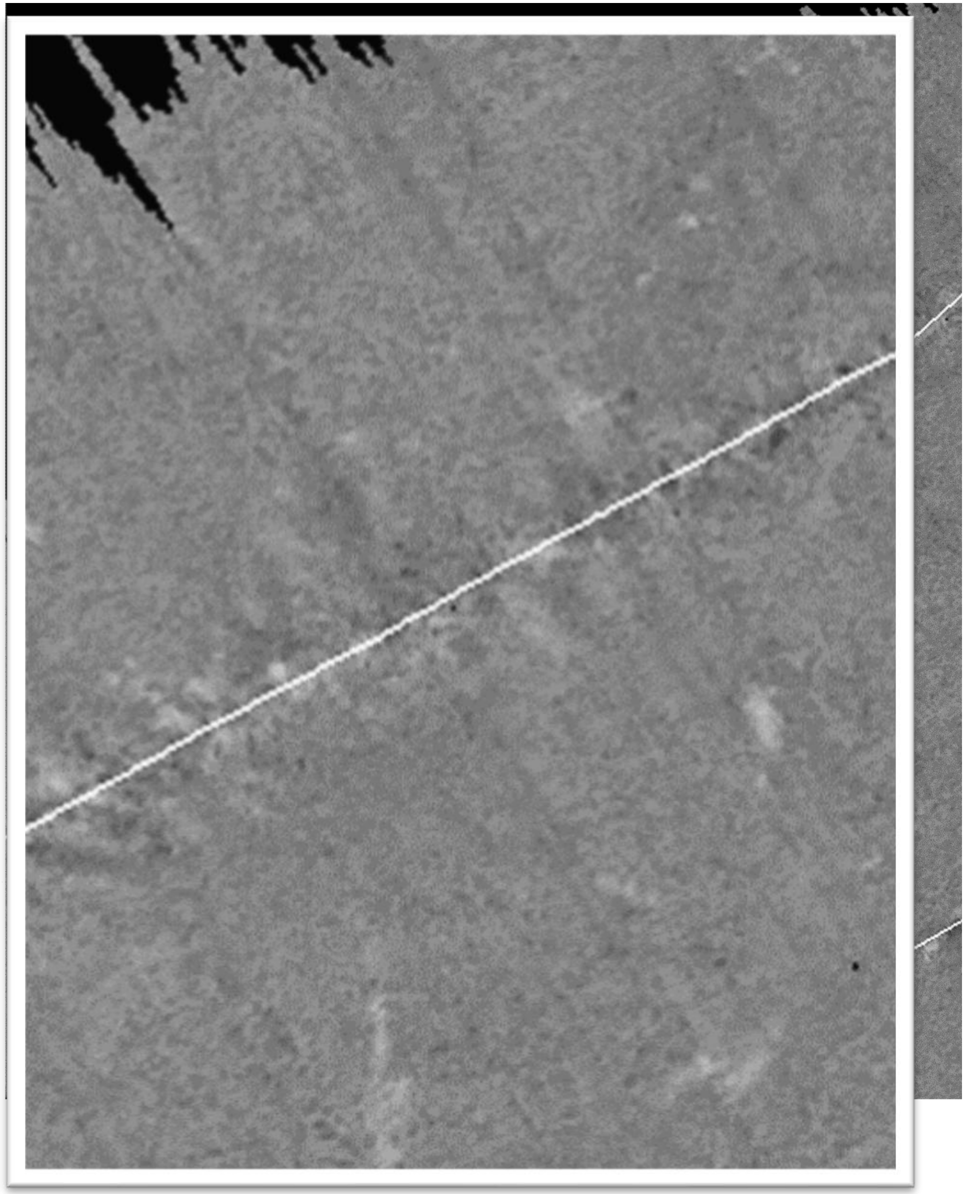


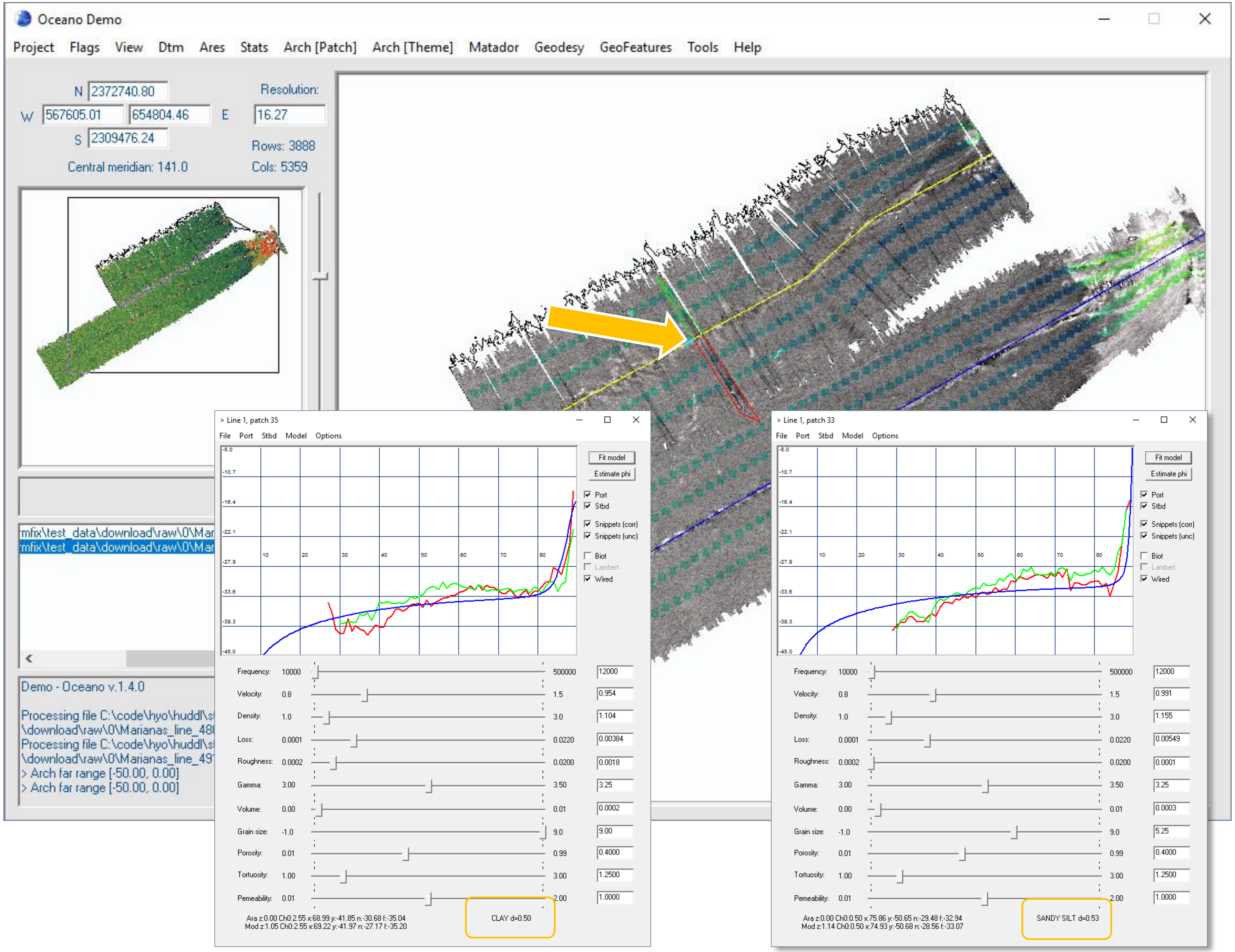


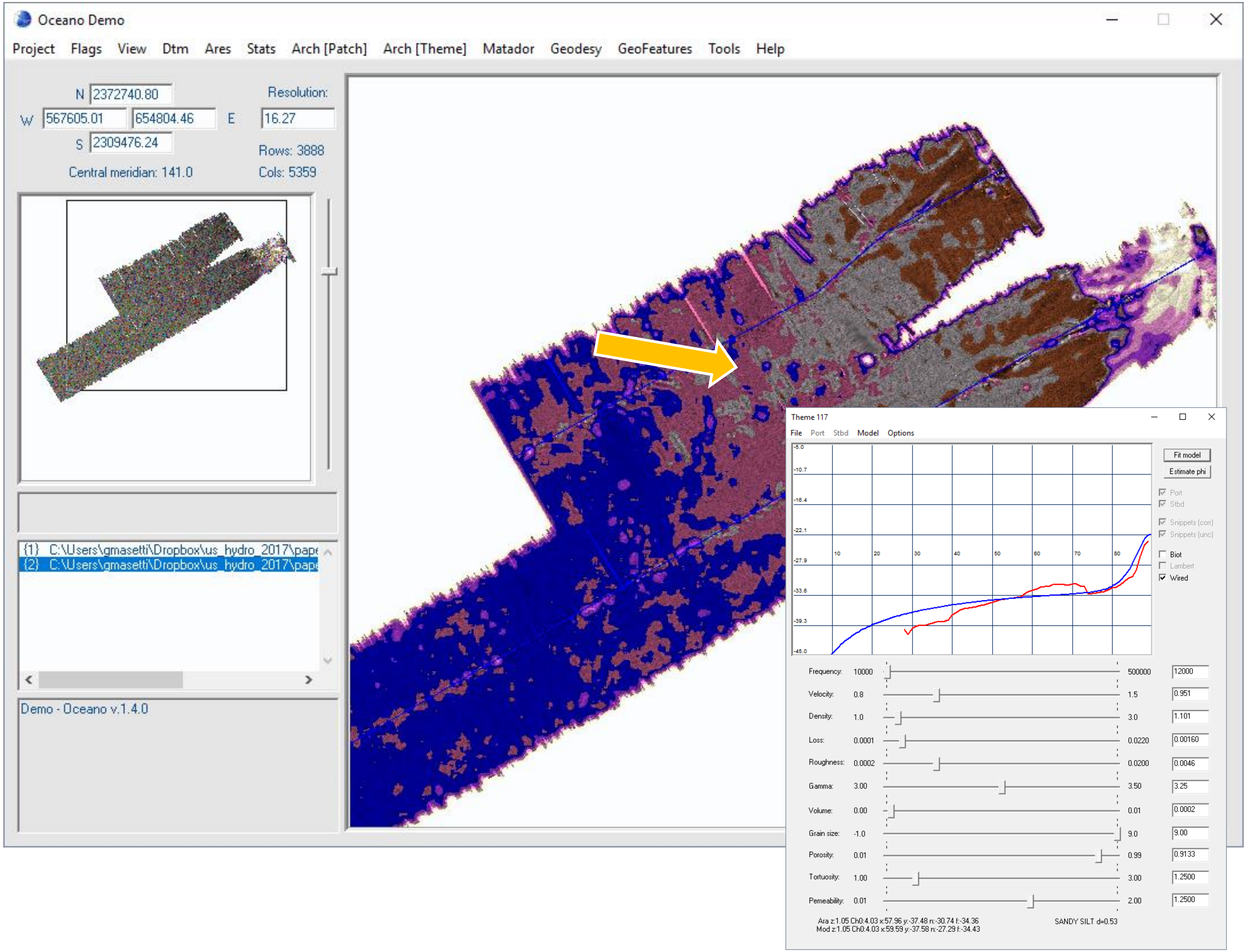


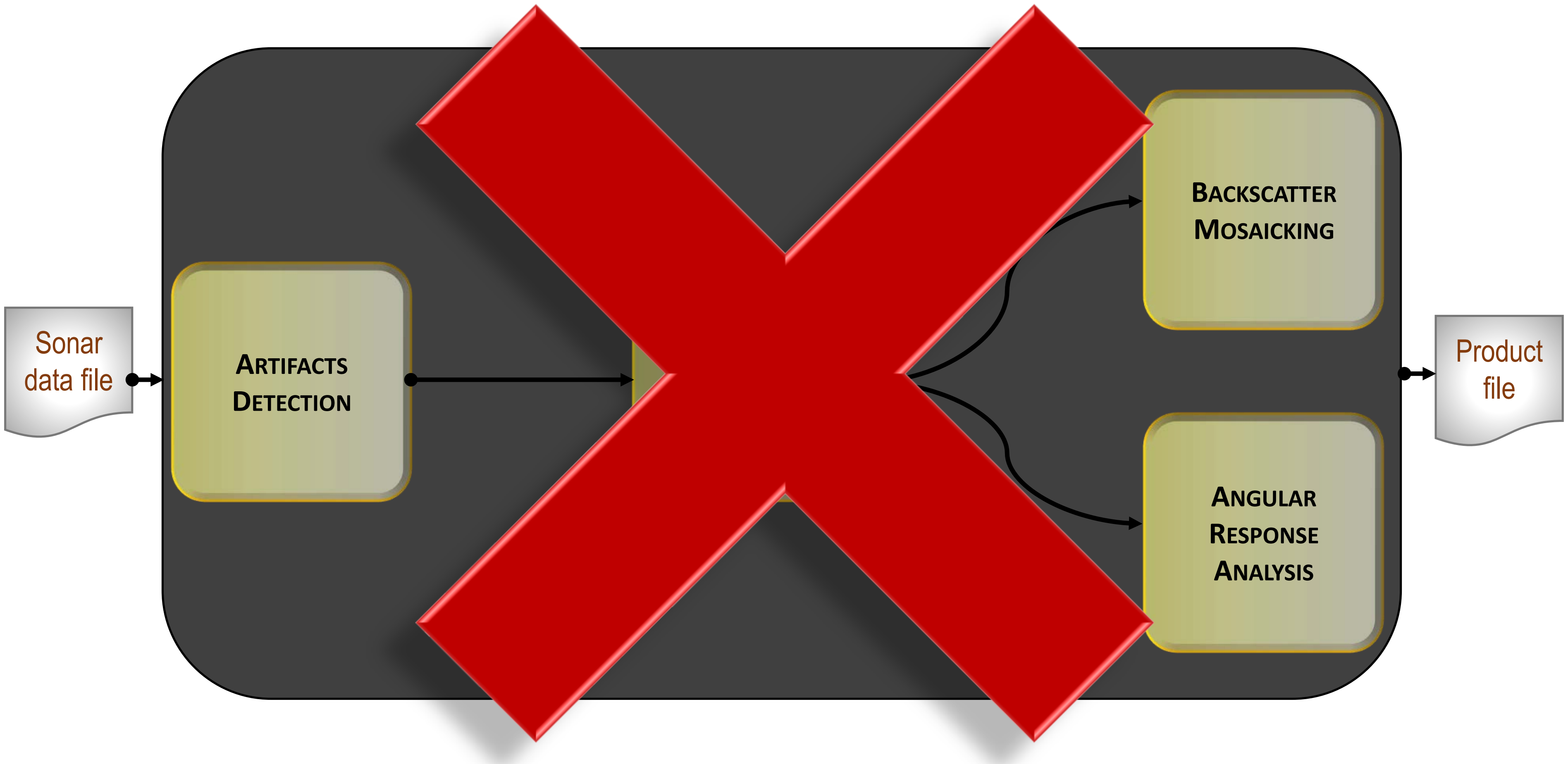
JUST REMOVAL VS RANDOMIZATION SCHEMA

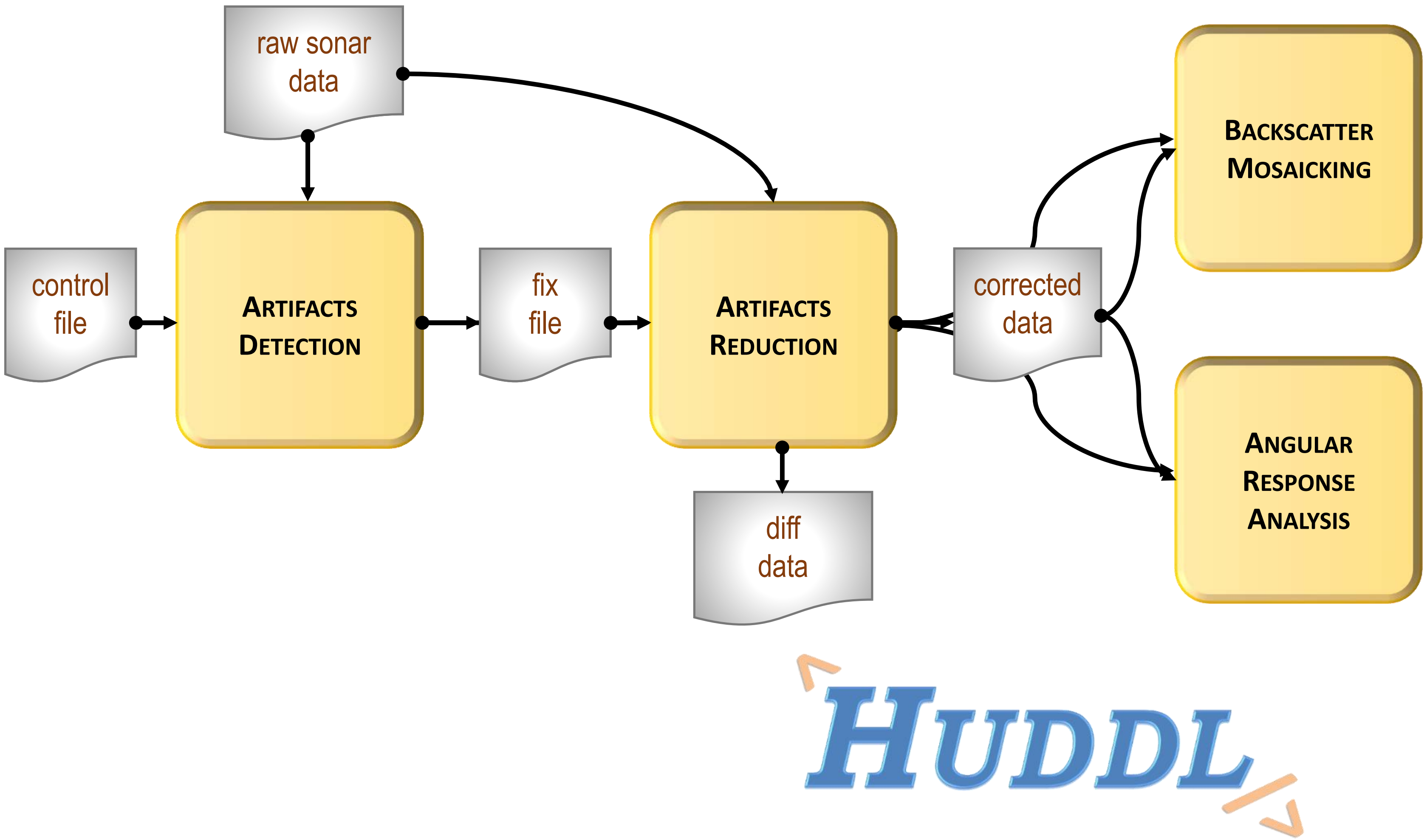





Oceano Demo
Project Flags View Dtm Ares Stats Arch [Patch] Arch [Theme] Matador Geodesy GeoFeatures Tools Help
N 2372740.80
W 567605.01
654804.46 E
S 2309476.24
Resolution:
16.27
Rows: 3888
Cols: 5359
Central meridian: 141.0
Demo - Oceano v.1.4.0
Processing file C:\code\hyo\huddl\s
\download\raw\0\Marianas_line_48
Processing file C:\code\hyo\huddl\s
\download\raw\0\Marianas_line_49
> Arch far range [-50.00, 0.00]
> Arch far range [-50.00, 0.00]
> Line 1, patch 35
File Port Stbd Model Options
Fit model
Estimate phi
Port
Stbd
Snippets (corr)
Snippets (unc)
Biot
Lambert
Wired
Frequency: 10000 500000 12000
Velocity: 0.8 1.5 0.954
Density: 1.0 3.0 1.104
Loss: 0.0001 0.0220 0.00384
Roughness: 0.0002 0.0200 0.0018
Gamma: 3.00 3.50 3.25
Volume: 0.00 0.01 0.0002
Grain size: -1.0 9.0 9.00
Porosity: 0.01 0.99 0.4000
Tortuosity: 1.00 3.00 1.2500
Pemeability: 0.01 2.00 1.0000
Ara z:0.00 Ch0:2.55 x:68.99 y:-41.85 n:-30.68 f:-35.04
Mod z:1.05 Ch0:2.55 x:69.22 y:-41.97 n:-27.17 f:-35.20
CLAY d=0.50
> Line 1, patch 33
File Port Stbd Model Options
Fit model
Estimate phi
Port
Stbd
Snippets (corr)
Snippets (unc)
Biot
Lambert
Wired
Frequency: 10000 500000 12000
Velocity: 0.8 1.5 0.991
Density: 1.0 3.0 1.155
Loss: 0.0001 0.0220 0.00549
Roughness: 0.0002 0.0200 0.0001
Gamma: 3.00 3.50 3.25
Volume: 0.00 0.01 0.0003
Grain size: -1.0 9.0 5.25
Porosity: 0.01 0.99 0.4000
Tortuosity: 1.00 3.00 1.2500
Pemeability: 0.01 2.00 1.0000
Ara z:0.00 Ch0:0.50 x:75.86 y:-50.65 n:-29.48 f:-32.94
Mod z:1.14 Ch0:0.50 x:74.93 y:-50.68 n:-28.56 f:-33.07
SANDY SILT d=0.53


Oceano Demo
Project Flags View Dtm Ares Stats Arch [Patch] Arch [Theme] Matador Geodesy GeoFeatures Tools Help
N 2372740.80
W 567605.01
654804.46 E
S 2309476.24
Resolution:
16.27
Rows: 3888
Cols: 5359
Central meridian: 141.0
{1} C:\Users\gmasetti\Dropbox\us_hydro_2017\pape
{2} C:\Users\gmasetti\Dropbox\us_hydro_2017\pape
Demo - Oceano v.1.4.0
Theme 117
File Port Stbd Model Options
Fit model
Estimate phi
Port
Stbd
Snippets (corr)
Snippets (unc)
Biot
Lambert
Wired
Frequency: 10000 500000 12000
Velocity: 0.8 1.5 0.951
Density: 1.0 3.0 1.101
Loss: 0.0001 0.0220 0.00160
Roughness: 0.0002 0.0200 0.0046
Gamma: 3.00 3.50 3.25
Volume: 0.00 0.01 0.0002
Grain size: -1.0 9.0 9.00
Porosity: 0.01 0.99 0.9133
Tortuosity: 1.00 3.00 1.2500
Pemeability: 0.01 2.00 1.2500
Ara z:1.05 Ch0:4.03 x:57.96 y:-37.48 n:-30.74 f:-34.36
Mod z:1.05 Ch0:4.03 x:59.59 y:-37.58 n:-27.29 f:-34.43
SANDY SILT d=0.53


Sonar data file
Artifacts Detection
Backscatter Mosaicking
Angular Response Analysis
Product file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fix file
ARTIFACTS REDUCTION
corrected data
diff data
BACKSCATTER MOSAICKING
ANGULAR RESPONSE ANALYSIS
HUDDL

THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

V0

ePOM

G. Masetti & T. Faulkes

Canberra, June 18-20 2019

ePOM

A project that aims to provide
e-Learning resources for **P**ython coding specific to the **O**cean **M**apping field

ePOM → CCOM/JHC Rationale

Incoming students in Ocean Mapping (OM) courses
come from very **different backgrounds**

Some have **limited programming experience**

Need to ensure
a **minimum common level of programming skills**

ePOM → GOALS

- To familiarize with **key programming concepts**
- To teach **programming habits and skills**
- To introduce the **effective use of the extensive help and online resources** available for Python
- To provide just **enough basic Python knowledge** to start to code

Not a full course on how to program in Python!

Why Python?

- Simple to learn
- Increasingly popular
- Freely available

Society | DOI:10.1145/2716560 Esther Shein

Python for Beginners

A survey found the language in use in introductory programming classes in the top U.S. computer science schools.

THE WAY TAYLOR POULO sees it, learning to code in Python is comparable "to learning Latin and romantic languages." Once someone grasps the logic behind Python, the concepts can be more easily transferred to other languages, maintains Poulos, a senior majoring in industrial engineering at the Georgia Institute of Technology (Georgia Tech). "Once you get comfortable thinking in a different type of logic and using different words, it's much more comfortable to learn new things," she says, adding that she was required to take three computer science classes at Georgia Tech, all in Python. "Python did that."

Python, an open source scripting language, has become the most popular introductory teaching language at top U.S. universities—Georgia Tech among them—according to a recent survey by Philip Guo, an assistant professor of computer science at the University of Rochester. Guo decided to conduct the research after noticing anecdotally over the past few years that Python was replacing languages such as Java as the de facto introduction to programming class in more and more computer science classes at universities around the country.

Because it is a scripting language, Python automates tasks that would otherwise need to be performed manually. Java and C++ also are popular and widely used. The main difference is that Python programs tend to run slower than Java programs, but they take significantly less time to develop, according to the Python Software Foundation. Python programs also tend to be shorter than equivalent programs written in Java because of "Python's built-in high-level data types and its dynamic typing," the Foundation notes. While the same is true of C++, Python code is generally one-fifth to one-tenth the length of equivalent C++ code, and "Anecdotal evidence suggests that one Python programmer can finish in two months what two C++ programmers can't complete in a year," the Foundation's website states.

During the summer of 2014, Guo went to the websites of the top 39 U.S. schools for computer science as ranked by *U.S. News & World Report* in 2014, and collected as much data as he could from looking at their introductory computer science courses. He stopped at 39, he explains, because there was an eight-way tie for 40 and "we had to stop somewhere." At schools including the Massachusetts Institute of Technology (MIT), Carnegie Mellon University, and the University of California, Berkeley, Python emerged as the leading language to teach novices (the full list, along with Guo's blog on the topic, can be found at at http://bit.ly/W0vtox).

Proponents say it is no surprise Python has become the most popular teaching language in colleges, because compared to programs like Java, it is easier to learn and to use to write programs that do practical things with very little code.

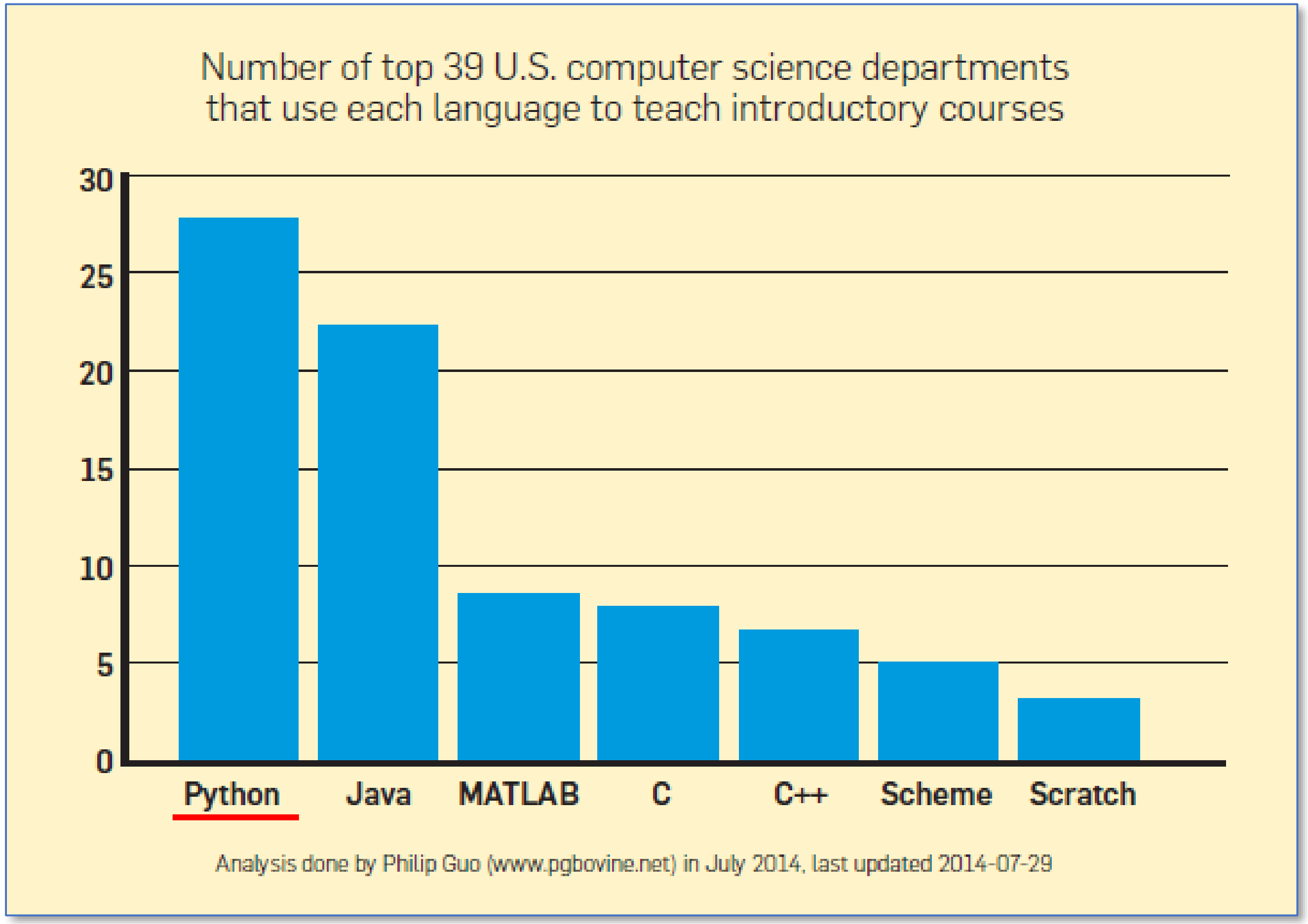
With Python, "There's very little overhead in getting to the point where people can start to write interesting programs; the syntax is pretty straightforward," observes John Guttag, professor of electrical engineering and computer science at MIT, and the author of several books, including one about learning to program in Python. In contrast to Java, which has a "fairly complicated syntax and fairly complicated static semantics," Python makes more sense for people who are writing small programs, he says. Java is designed to support people writing large, "industrial-quality" programs containing thousands of lines of code, says Guttag, who teaches one of two introductory courses offered by his department.

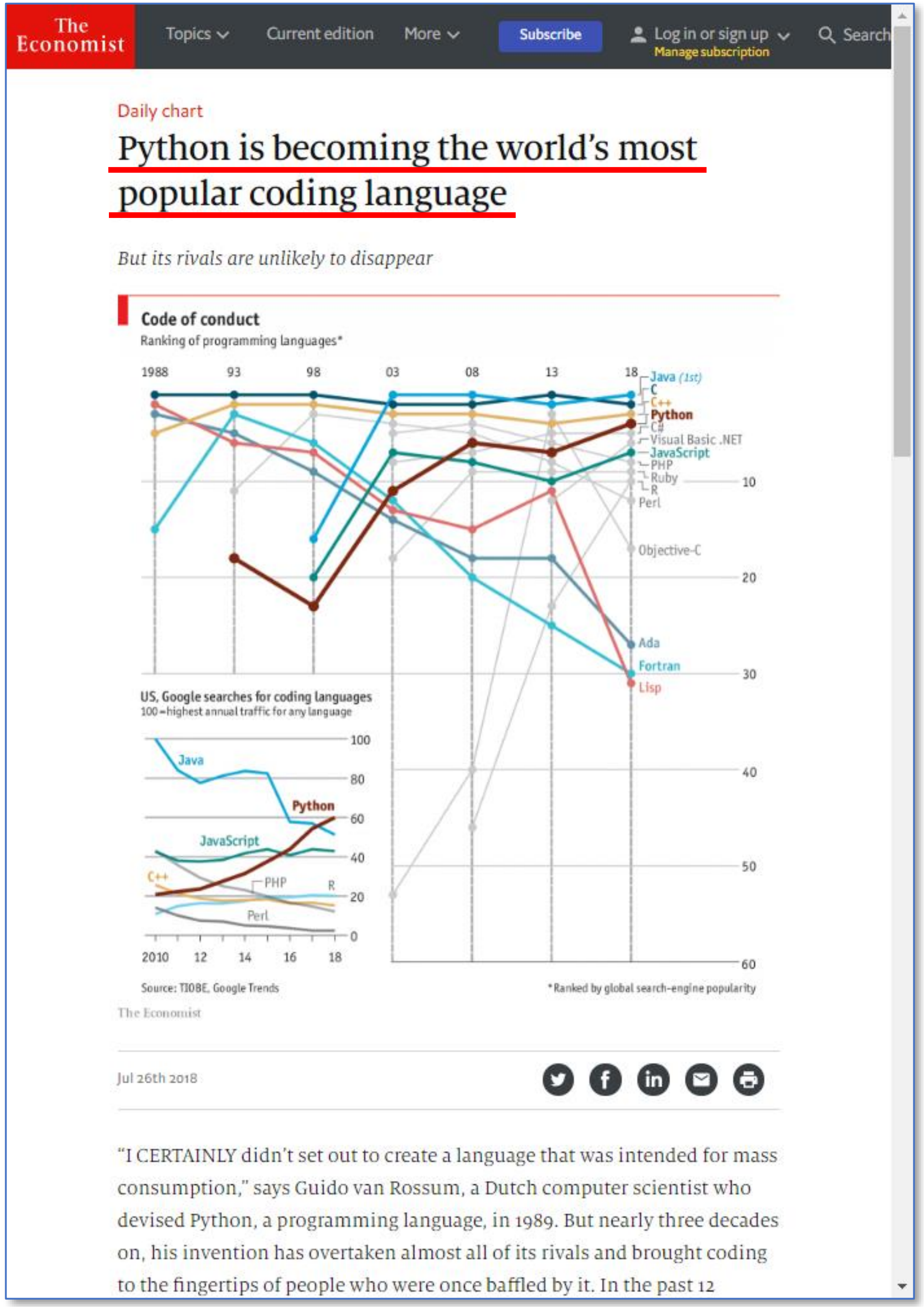
In contrast to Java, Python makes more sense for people who are writing small programs.

Another reason Guttag believes more colleges are using Python as an introductory programming language is that it has "a very large set of highly useful libraries that have been built over the years that support things … that are easy to use from language proper, and that makes Python a particularly useful language for scientists and engineers who want to take advantage of those libraries."

Python is also very good for "letting you teach conceptual material without getting in the way," observes Guttag. "So I don't find myself spending all my time explaining Python to the students. I get to spend a lot of time explaining what I think are more long-lived concepts," like algorithmic complexity.

Not everyone agrees Python is the be-all-end-all as an introductory programming language. Shriram Krish-

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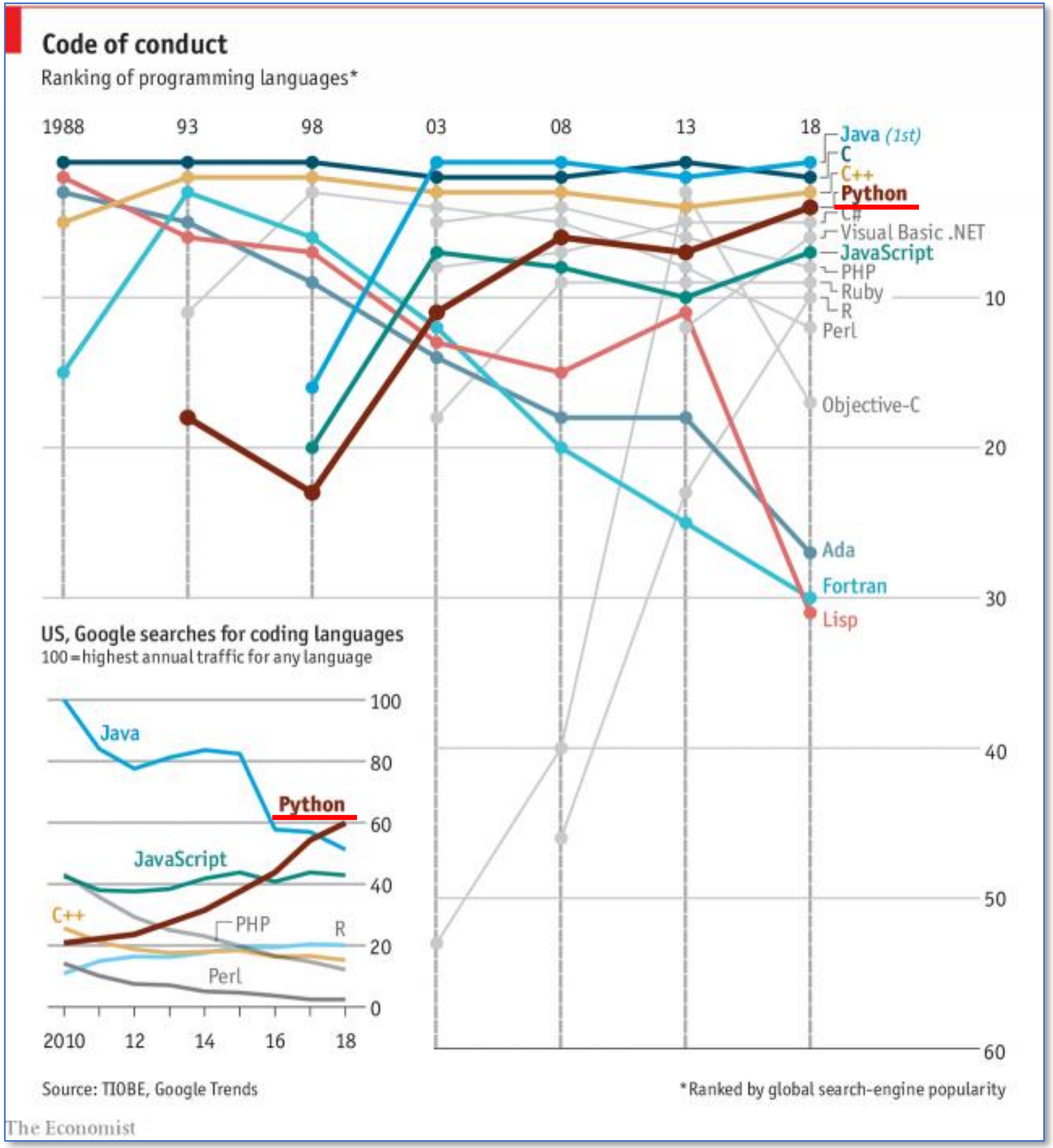
Daily chart

Python is becoming the world's most popular coding language

But its rivals are unlikely to disappear

Jul 26th 2018

"I CERTAINLY didn't set out to create a language that was intended for mass consumption," says Guido van Rossum, a Dutch computer scientist who devised Python, a programming language, in 1989. But nearly three decades on, his invention has overtaken almost all of its rivals and brought coding to the fingertips of people who were once baffled by it. In the past 12



Two Main Lines of Action

Development & Beta Testing

Programming Basics with Python

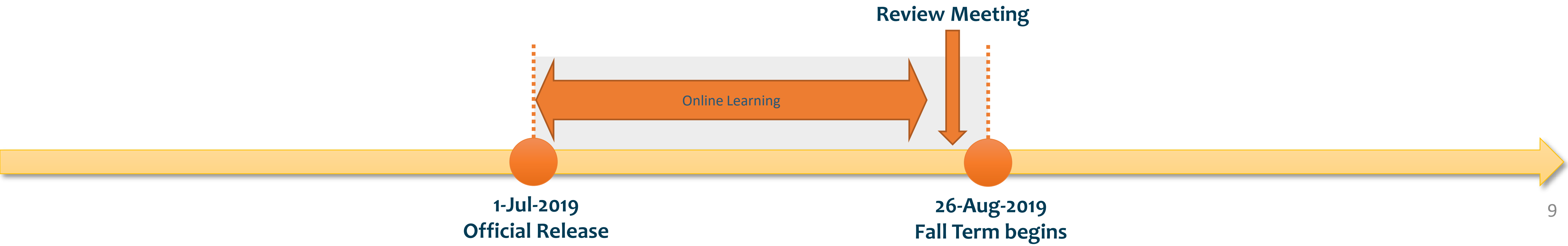
Introduction to Ocean Data Science

1-Jul-2019
Official Release

26-Aug-2019
Fall Term begins

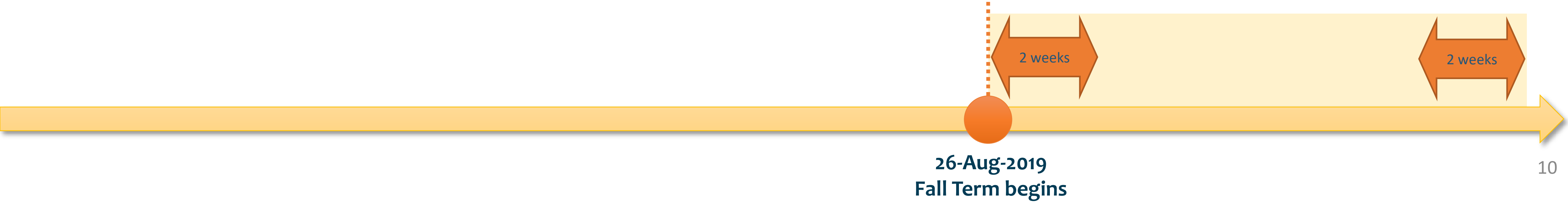
Programming Basics with Python

- Basic programming concepts **with a focus on OM applications**
- Structured in **2 phases:**
  - Asynchronous, online learning through a remotely-hosted collection of Jupyter notebooks (using JupyterHub).
  - In-person meeting during the orientation week:
    - To answer students questions
    - To evaluate their understanding of the concepts
    - To stimulate collaboration among students



INTRODUCTION TO OCEAN DATA SCIENCE

- A **connector** to the OM courses
- 2 modules in ESCI/OE 872 – Applied Tools for OM
  - Module #1 → First 2 weeks:
    - Data analysis/visualization (e.g., *numpy*, *matplotlib*)
    - Algorithms and data formats (e.g., *scipy*, *GDAL*, *PyProj*)
  - Module #2 → Last 2 weeks:
    - How to develop research code (e.g., *git*, *Pydro*)



Development & Beta Testing

- Current solution for *Programming Basics in Python* based on **JupyterHub:**
  - A Python environment that runs on a multi-user server
  - All the students have an identical computing environment
  - No need to install Python and third-party libraries on local machine
  - **Students only need a modern browser and an Internet connection!**

1-Jul-2019
Official Release

JUPYTERHUB AT THE ESS. AN INTERACTIVE PYTHON COMPUTING ENVIRONMENT FOR SCIENTISTS AND ENGINEERS

L. Fernández, R. Andersson, H. Hagenrud, T. Korhonen, E. Laface,
European Spallation Source, ERIC, Lund, Sweden
B. Zupanc, Cosylab, Ljubljana, Slovenia

Abstract

The European Spallation Source [1] will be the world's most powerful neutron source, once its construction is finished. In order to design, build and operate this complex machine many different software components and frameworks will be needed. One of those is Jupyterhub, a scripting environment for data analysis, scientific computing and physics simulations. Jupyterhub is a multiuser version of the IPython notebook (Jupyter) [2] that can be deployed in a centralized server; provides centralized authentication, centralized deployment, promotes collaboration and provides access to the most advanced libraries for data cleaning and transformation, simulation and statistics. At the Integrated Controls System Division a customized version of Jupyterhub was deployed, providing sandboxed environments to users using Docker [3] containers. Among other characteristics of this installation we can find: clustering, load balancing, A/B testing, Amazon Web Services integration, nbviewer and OpenXAL integration.

INTRODUCTION

During commissioning and operation of the ESS accelerator, physicists and engineers will need to develop a big amount of scripts. Many of those scripts will involve data analysis and in many cases they will make use of physics simulators and emulators of physical devices. The Integrated Controls System Division (ICS) at ESS is making an effort in standardization of the development of such scripts. The goal is to provide a common approach, ESS wide, regarding the development of scripts and the development of data analysis software.

The standardization of the scripting platform will bring many benefits to ESS, such as:

- Keep control on the quality of the software produced by physicists and engineers. The use of a common framework and the use of a centralized storage for scripts will facilitate the integration and the testing of the software produced. Most of the tests will be static analysis of the code and completely automated. ICS will guarantee as well that scripts follow code conventions among other parameters.
- Avoid the proliferation of scripting languages. It will be impossible for ESS to maintain software written in any possible language.
- Setup of a centralized repository for scripts. Having a central storage system for scripts, will make it possible to backup all the software and also to facilitate the integration with the Git version control system provided by ICS.
- It will also bring the possibility of creating a shared space where users can publish their scripts and make them public to the rest of the ESS users and in-kind collaborators.

The scripting environment selected by ICS was Jupyter, in particular the Jupyterhub solution was the one finally deployed. Some languages will be officially supported among others: Python, R and Julia.

JUPYTER AND JUPYTERHUB

Jupyter is an open source initiative for interactive data science and scientific computing. Jupyter is language agnostic and provides support for many different scripting languages. Jupyter Notebook is the tool selected by ICS for scripting standardization. Jupyter Notebook is a web application that will let the user create documents containing code and documentation, such as: equations, plots, videos and text. Among the different domains where Jupyter Notebook has successfully been used is worth to mention: data cleaning, data transformation, numerical simulation, statistical modelling and machine learning. Figure 1 shows an example of a notebook using OpenXAL.

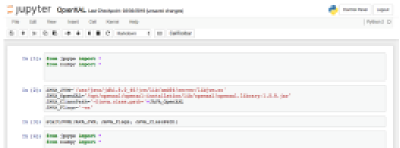


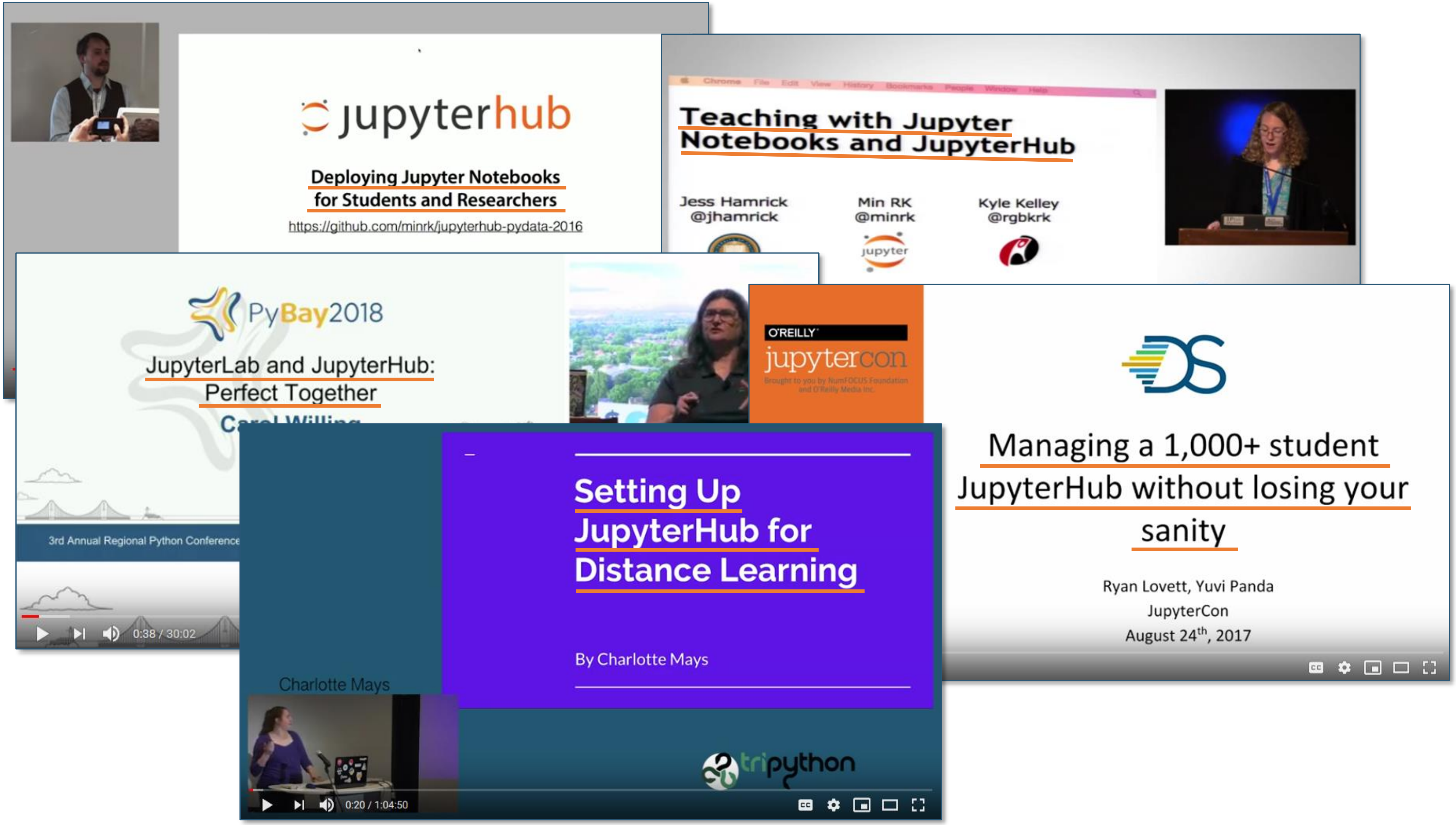
Figure 1: Screenshot of a Jupyter notebook

The use of Jupyter Notebook at ESS will bring the possibility of keeping code and documentation together in the same file. This will be extremely interesting for the ESS staff used in commissioning and developed not only by ESS staff but also in-kind contributors. It will also be possible to organize effectively all the scripts developed, so they can be easily searched and also audited.

Jupyter and Jupyter Notebook can be run in standalone mode in the user's machine. But, ICS wants to provide that service from a centralized server hosted at the ESS premises. The benefits of such centralization are:

- Provide automatic backups of the code. The user does not have to be worried about the backup strategy; this process will be taken in charge by ICS backing all the notebooks on a daily basis.
- Provide access to the different ICS services and databases. Access to all the ICS ecosystem will be pro-

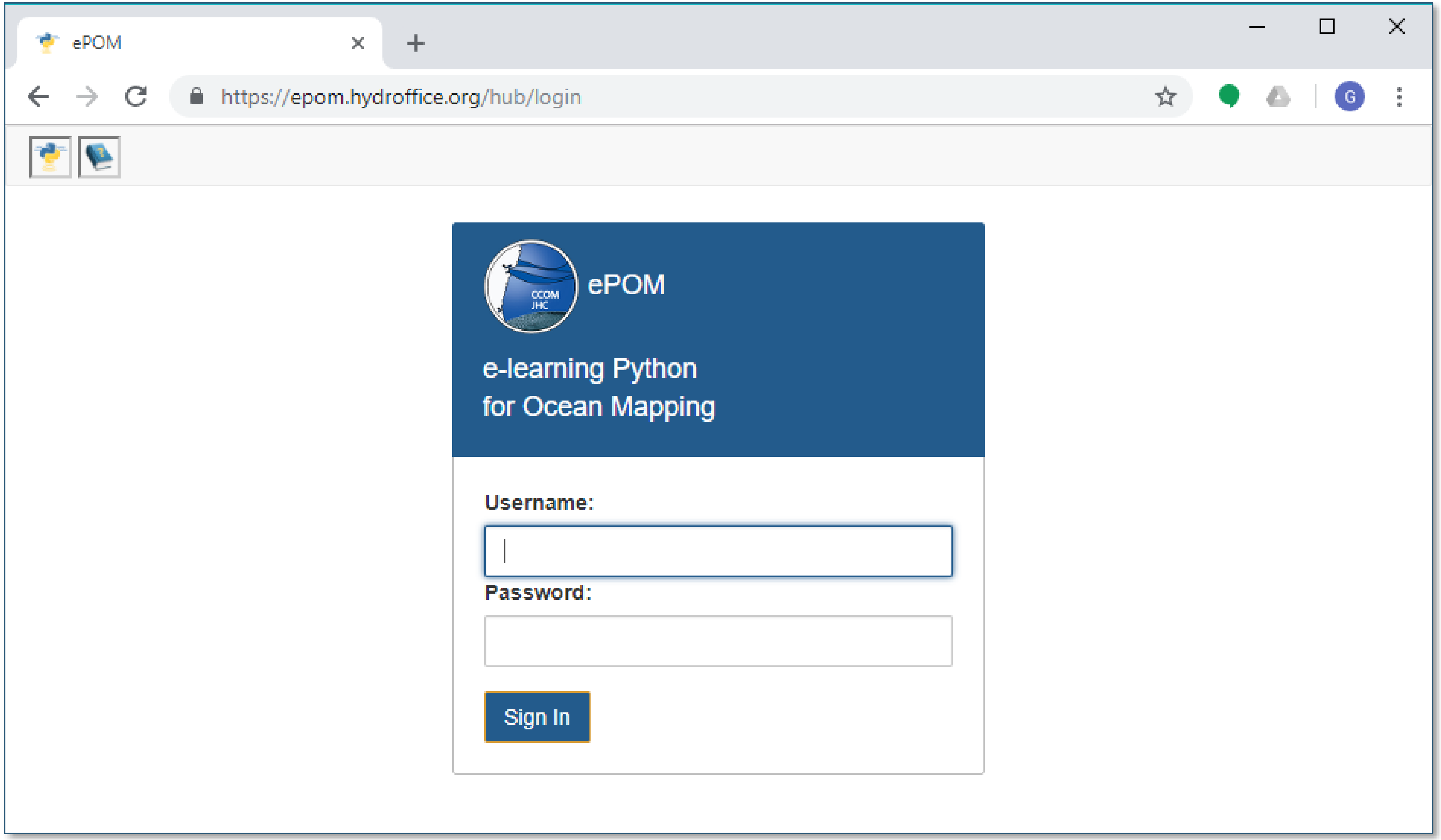
ICS provided in 2015 a custom centralized infrastructure for Jupyter notebooks. This infrastructure was recently moved and ported to the community-supported project Jupyterhub. Jupyterhub is a multiuser version of the Jupyter Notebook designed for centralized deployments. Jupyterhub is a very active project right now and many institutes and universities are intensively collaborating and deploying this solution. The UC Berkeley deployed an extremely interesting solution [4] based on Jupyterhub. ICS built its own setup based on the UC Berkeley approach.



jupyterhub
Deploying Jupyter Notebooks for Students and Researchers
https://github.com/minrk/jupyterhub-pydata-2016
Teaching with Jupyter Notebooks and JupyterHub
Jess Hamrick @jhamrick
Min RK @minrk
Kyle Kelley @rgbkrk
jupyter
PyBay2018
JupyterLab and JupyterHub: Perfect Together
3rd Annual Regional Python Conference
0:38 / 30:02
O'REILLY
jupytercon
Managing a 1,000+ student JupyterHub without losing your sanity
Ryan Lovett, Yuvi Panda
JupyterCon
August 24th, 2017
Setting Up JupyterHub for Distance Learning
By Charlotte Mays
Charlotte Mays
tripython
0:20 / 1:04:50

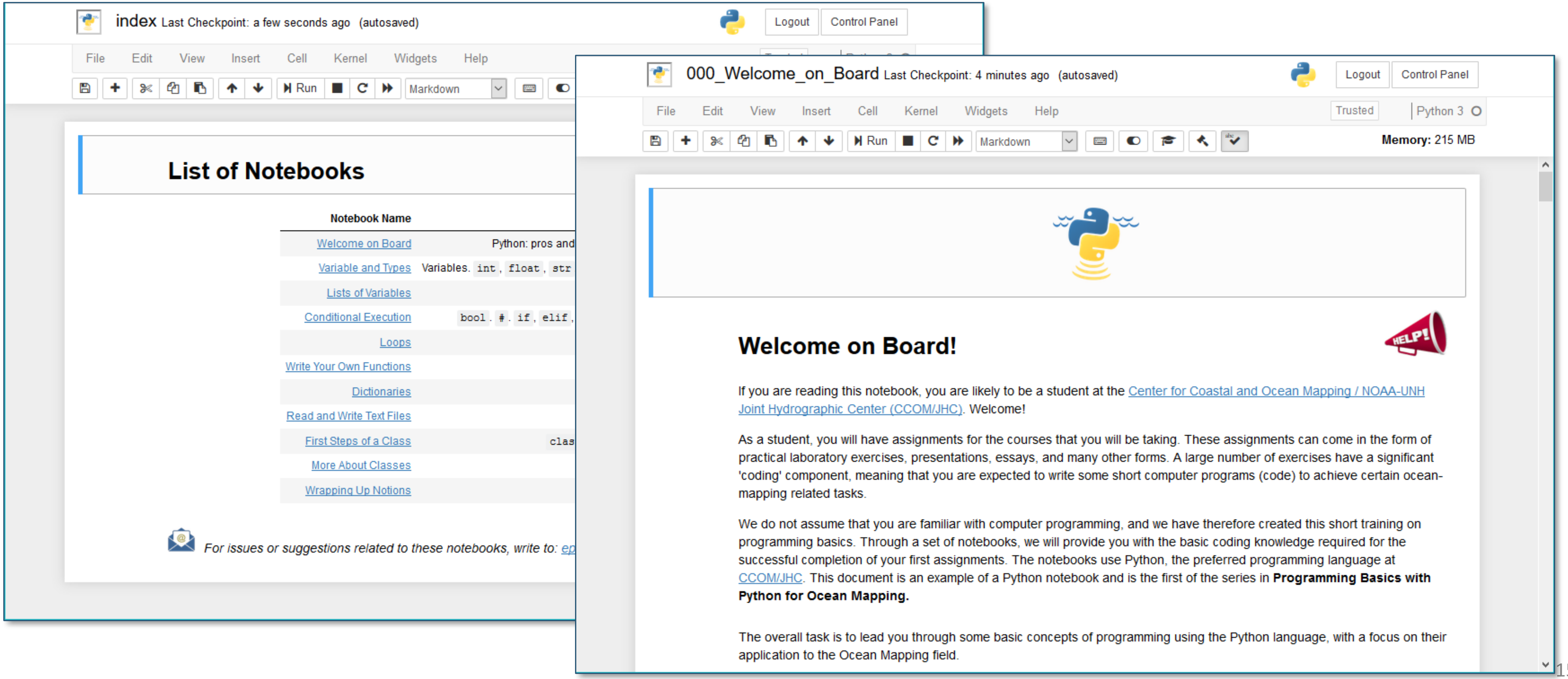
Development & Beta Testing

- Server currently hosted at: https://epom.hydroffice.org



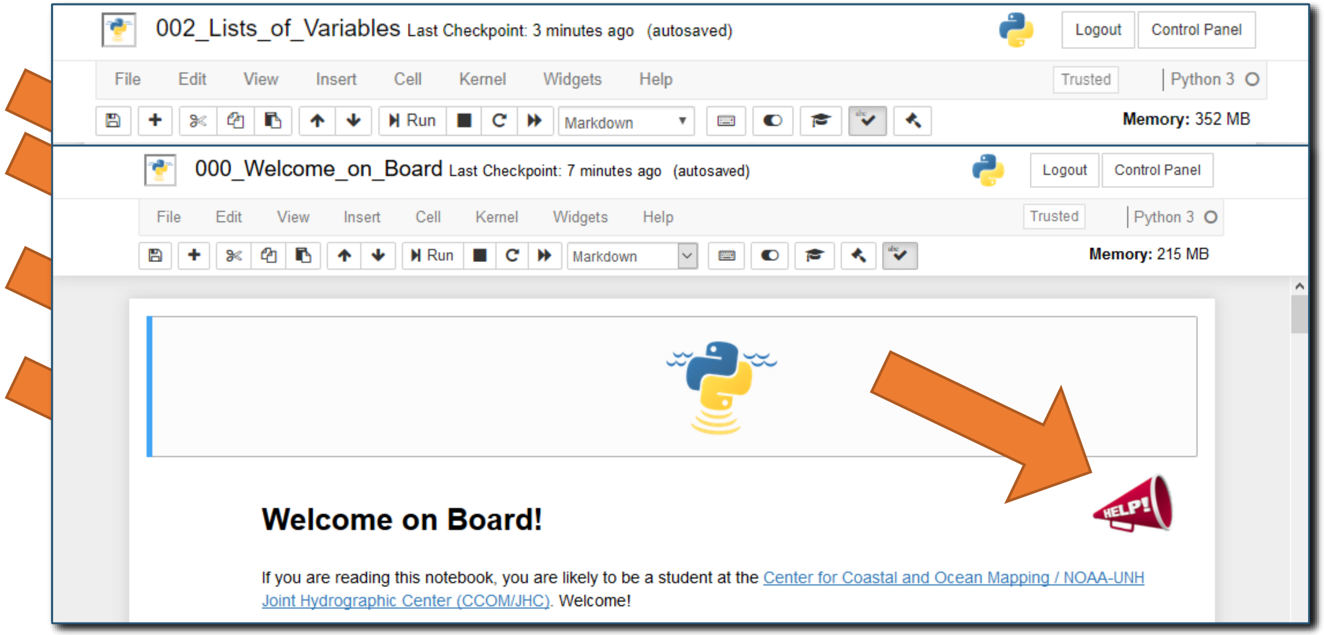
Development & Beta Testing

- An initial collection of notebooks:

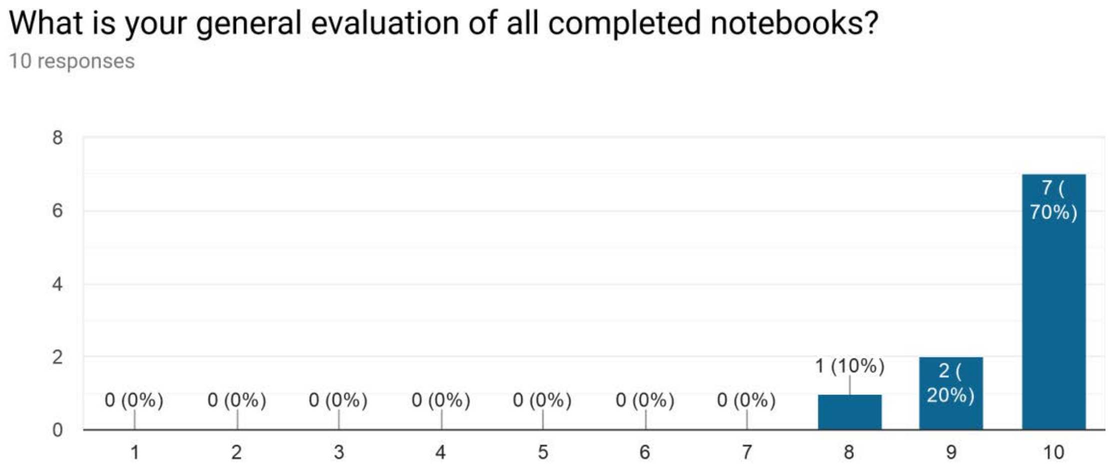


Development & Beta Testing

- An initial collection of notebooks:
  - Key concepts
  - Supplementary info
  - Exercises with solutions
  - A virtual room on Piazza.com where students:
    - Ask (and answer) questions
    - Interact with instructors
    - Start to build a community



CURRENT FEEDBACK



"I think these are a great place to start."

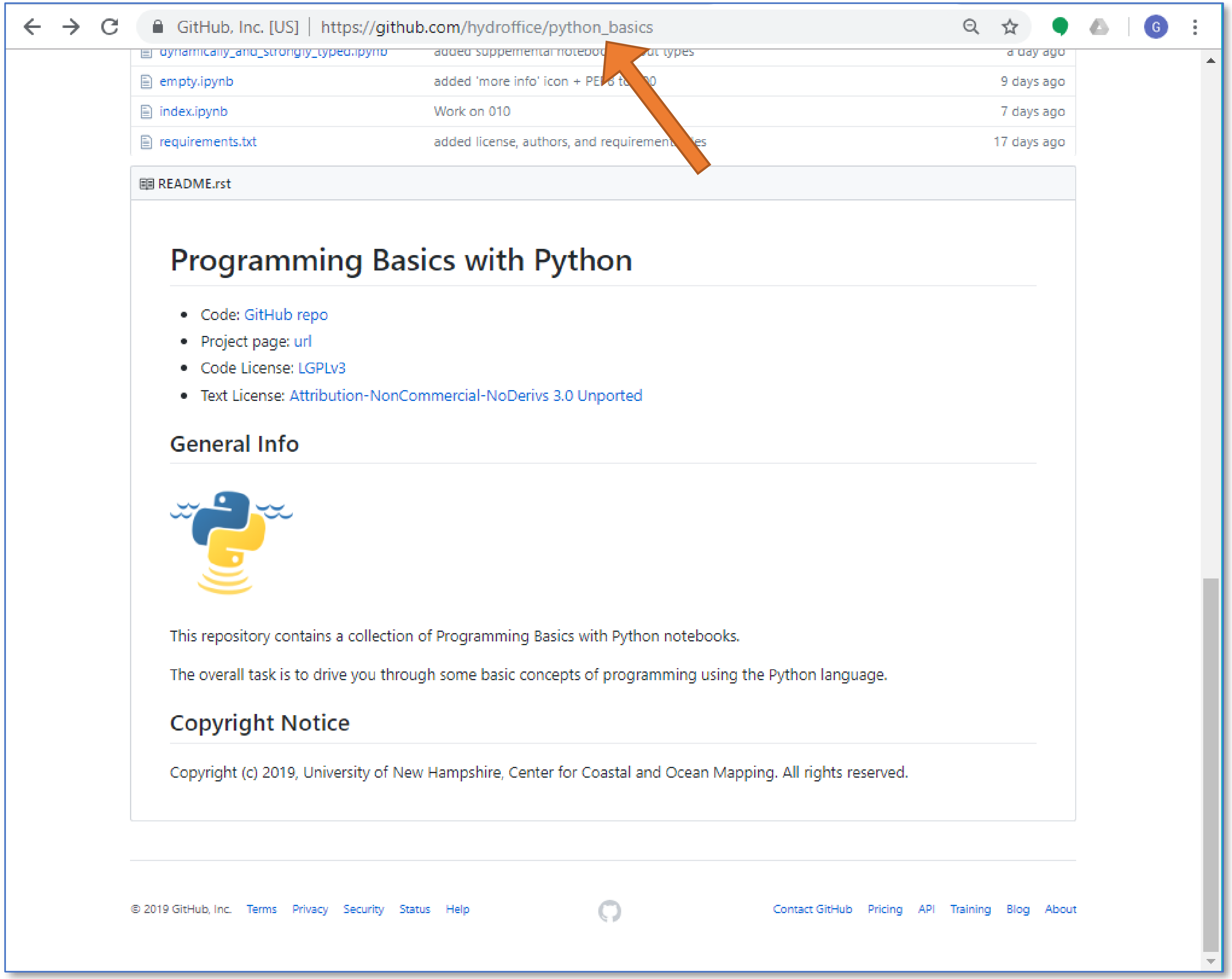
"Very nicely done!"

"Nope this is pretty neat!"

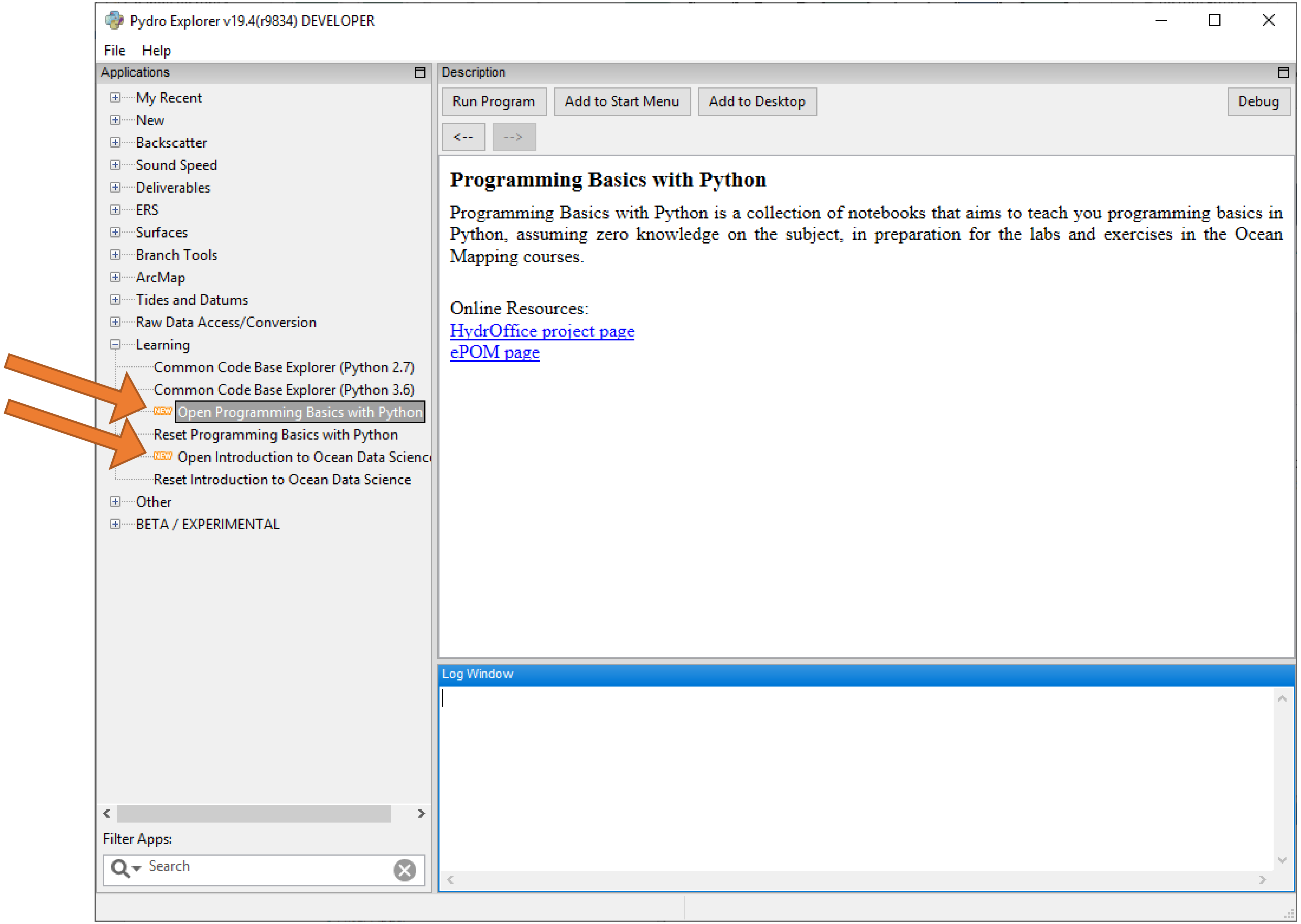
"I really like how I can do this from home without having to install any software.

"All the text is very readable and easy to comprehend."

ePOM → Publicly Available



ePOM → Available in Pydro 2019



THANKS!

Contact us at: gmasetti@ccom.unh.edu, tyanne.faulkes@noaa.gov

V0

HydrOffice - Development

G. Masetti & T. Faulkes

Canberra, June 18-20 2019

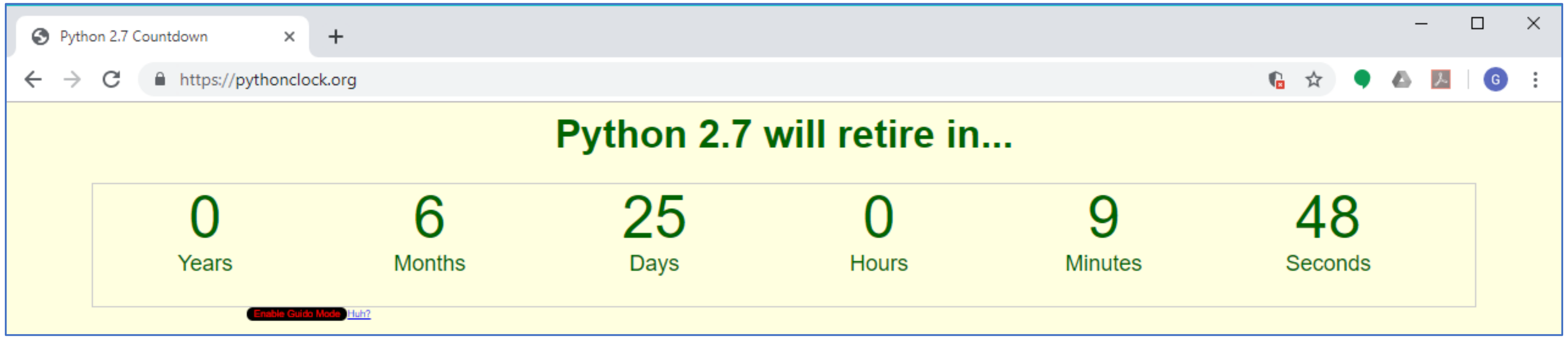
In Brief

- Apps, Libs, and Dependencies
- Packaging
- Distribution & Licensing
- Governance & Maintenance

Apps, Libs, and Dependencies

HydrOffice → Key Concepts

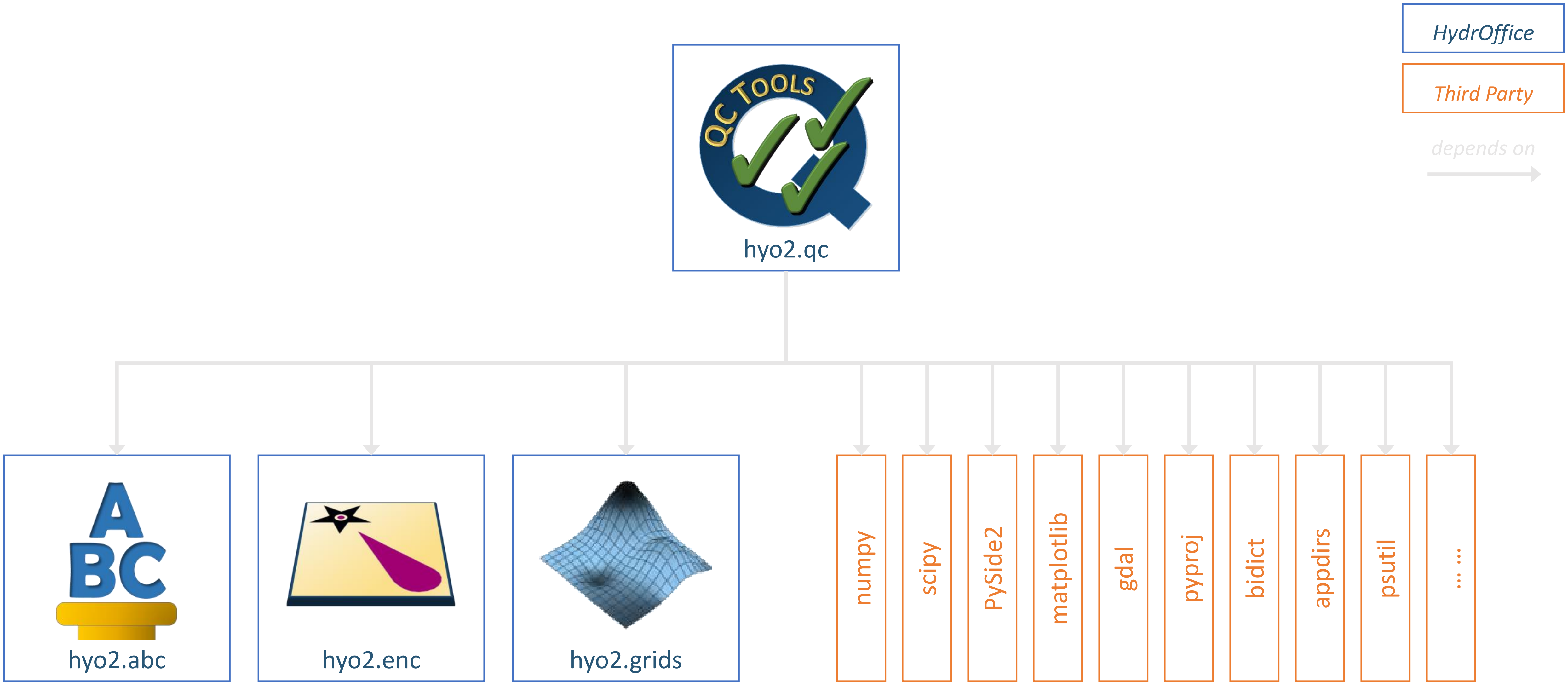
- All the Python code is in **Python 3.6+**
  - No code in Python 2: https://pythonclock.org/



  - No need to use: `from future import division, print function, …`

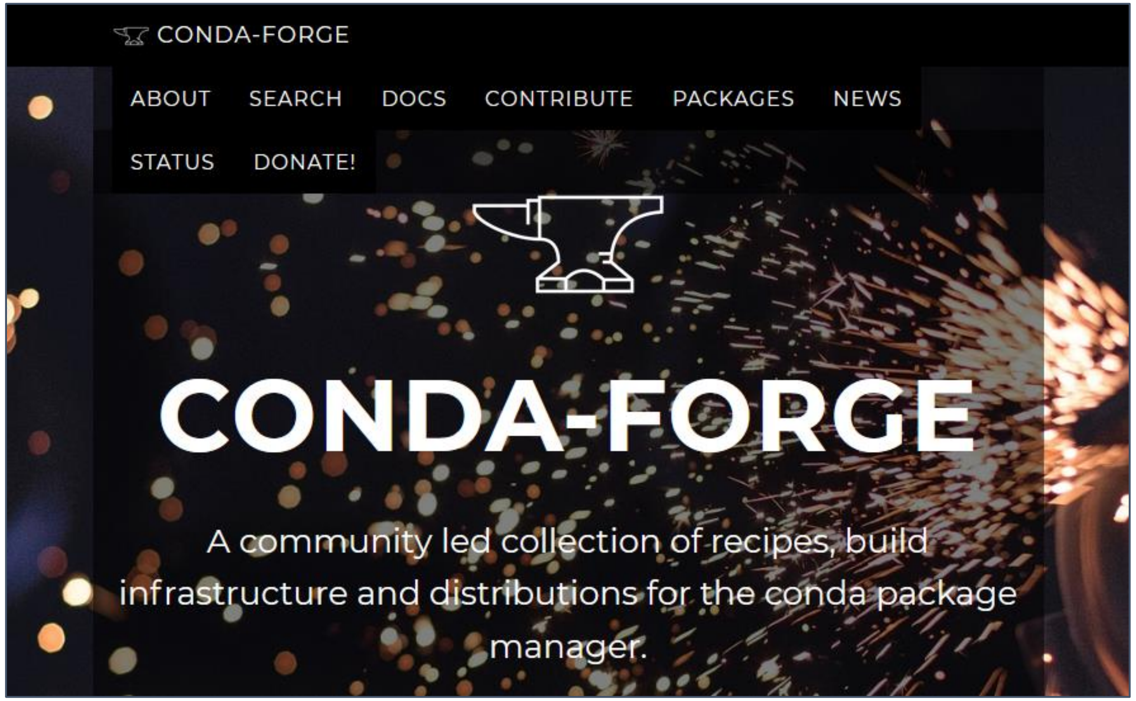
- All the Python packages are under **a common namespace: hyo2**
  - For instance, QC Tools is under `hyo2.qc`

INSTALLATION REQUIREMENTS



HydrOffice → Development Environment

- Package ecosystem: https://anaconda.org/
  - Cross-platform: **Windows, Linux, Mac**
  - Language-agnostic
    - Python
    - C++
    - ..
  - Package manager: **conda**
  - Channel: conda-forge



HydrOffice → Development Environment

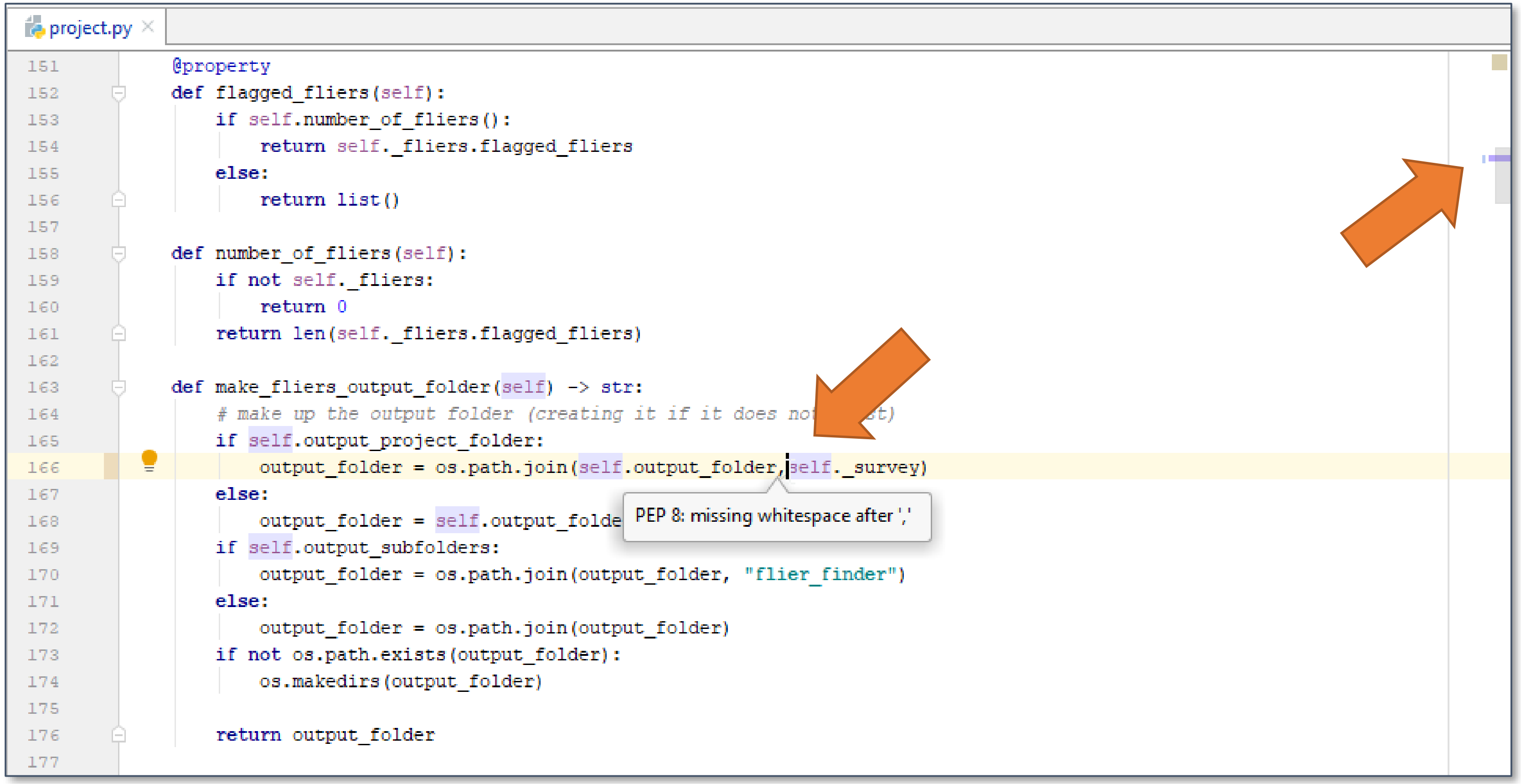
- Download and Install [miniconda 4.5.4]
  - Why 4.5.4? Last installer based on Python 3.6
  - Why Python 3.6? Selected Python version for current field season
- Add conda-forge channel:
  - Run: `conda config --add channels conda-forge`
- Install all the required packages:
  - Run: `conda install matplotlib scipy gdal …`
  - Run: `pip install PySide2 …`
- Clone and Install HydrOffice packages:
  - Run: `pip install -e .`
- Test the app:
  - Run: `python -m hyo2.qc.qctools`

HydrOffice → Development Environment

- Suggested Code Editor (IDE):
  - [PyCharm]
    - Community Edition is fine
    - Cross-platform
- Suggested GIT Client:
  - **Sourcetree**
    - Free
    - Support Windows and Mac
- To compile C++/C code:
  - **CMake**
  - **Visual Studio 2015** (Windows)

HYDROFFICE → CODING STYLE

- The HydrOffice's Python code follows:
  - [PEP 8 – Style Guide for Python Code]
    - PyCharm (and modern IDEs) simplifies PEP8 fulfillment



PACKAGING

Packaging → Key Concepts

- Based on:
  - Python Packaging User Guide by the Python Packaging Authority (PyPA)
- Python-pure Packages vs. Extension Packages
  - We need extension packages to:
    - Speed-up the code execution
    - Call code written in other languages

Packaging → Bindings

- Based on:
  - [ctypes] for hyo2.bag
    - *"a foreign function library for Python"* → part of the standard library
    - Allow to call functions in shared libraries from pure Python.
  - Cython for QC Tools, CA Tools, SSM, etc.
    - *"an optimising static compiler for the Python programming language"*
    - A superset of the Python language that supports:
      - Calling C functions
      - Declaring C types on variables and class attributes
  - SWIG for hyo2.grids, hyo2.enc, etc.
    - A tool to call C/C++ code from a variety of high-level programming languages
    - Parse C/C++ interfaces and generate the *"glue code"*
  - Numba for OpenBST(?)
    - *"JIT compiler that translates a subset of Python and NumPy code into fast machine code"*
    - Translate Python functions to optimized machine code at runtime using LLVM compiler

Packaging → Versioning

- Based on:
  - [PEP 440 – Version Identification and Dependency Specification]
    - *"The release segment consists of one or more non-negative integer values, separated by dots"*
    - Examples of final release:
      - `3.1.8` → "`3`": major, "`1`": minor, "`8`": micro or fix
      - `2019.0.3` → "`2019`": major, "`0`": minor, "`3`": micro or fix
    - Examples of pre-release:
      - `2.1.0`**`b1`** → "`2`": major, "`1`": minor, "`0`": micro or fix, "`b1`": **beta release #1**
      - `4.0.0`**`rc2`** → "`4`": major, "`0`": minor, "`0`": micro or fix, "`rc1`": **release candidate #2**

PACKAGING → DOCUMENTATION

- Based on:
  - Sphinx
    - Originally created for the Python documentation
    - Multiple output formats: HTML, LaTeX, PDF, etc.
    - Hierarchical structure, cross-references, indexing, code handing, etc.
- Generate documentation is publicly available on:
  - The HydrOffice website
  - Within the apps

Packaging → Documentation → HTML

HydrOffice QC Tools 3.0.6 documentation » previous | next | index

Previous topic

1. In brief

Next topic

2.1. Installation

This Page

Show Source

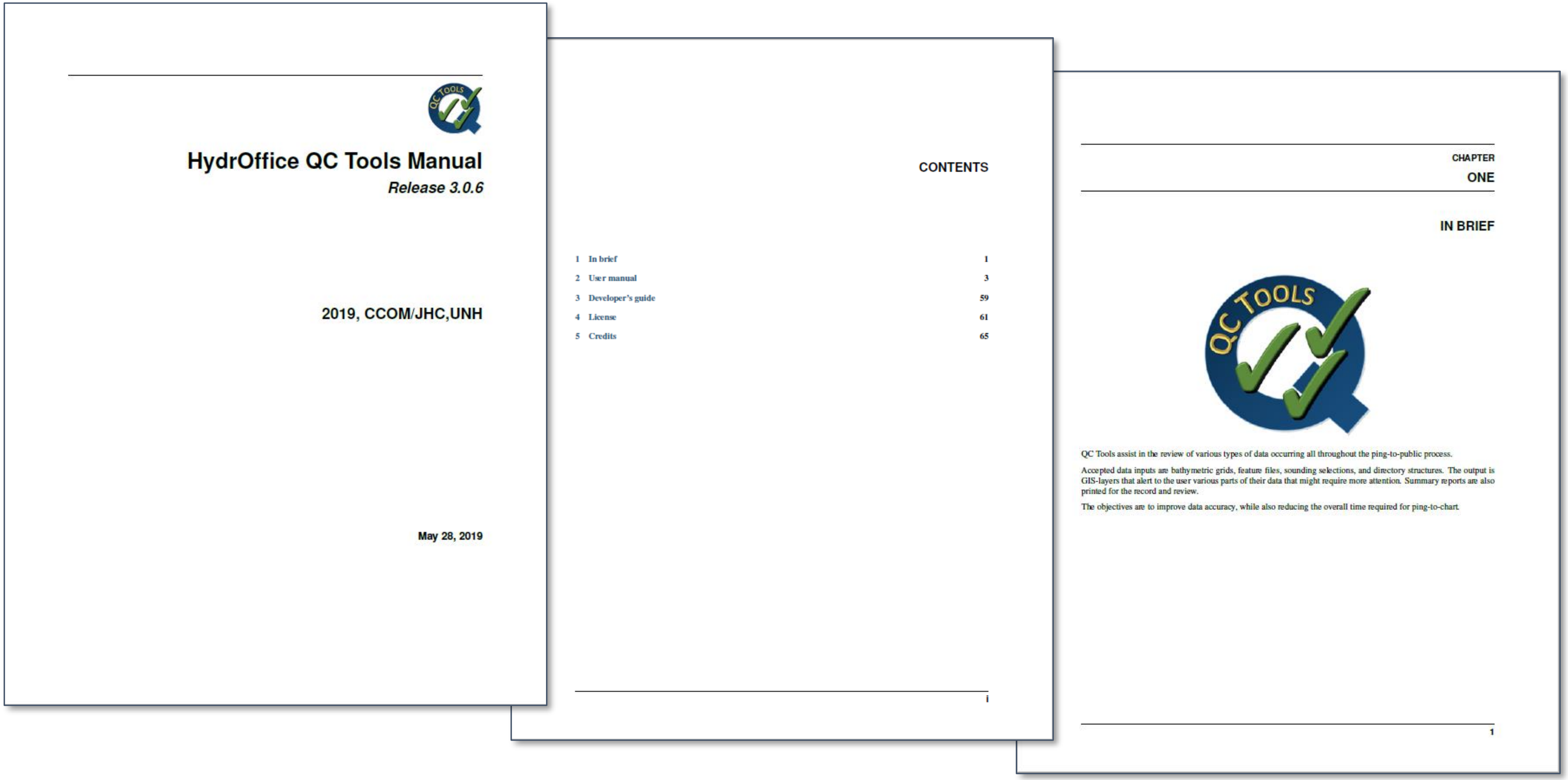
Quick search

Go

This document describes the HydrOffice QC Tools application (3.0). For the project page, go here.

2. User manual

Packaging → Documentation → PDF



HydrOffice QC Tools Manual

Release 3.0.6

2019, CCOM/JHC,UNH

May 28, 2019

CONTENTS

i

CHAPTER

ONE

IN BRIEF

QC Tools assist in the review of various types of data occurring all throughout the ping-to-public process.

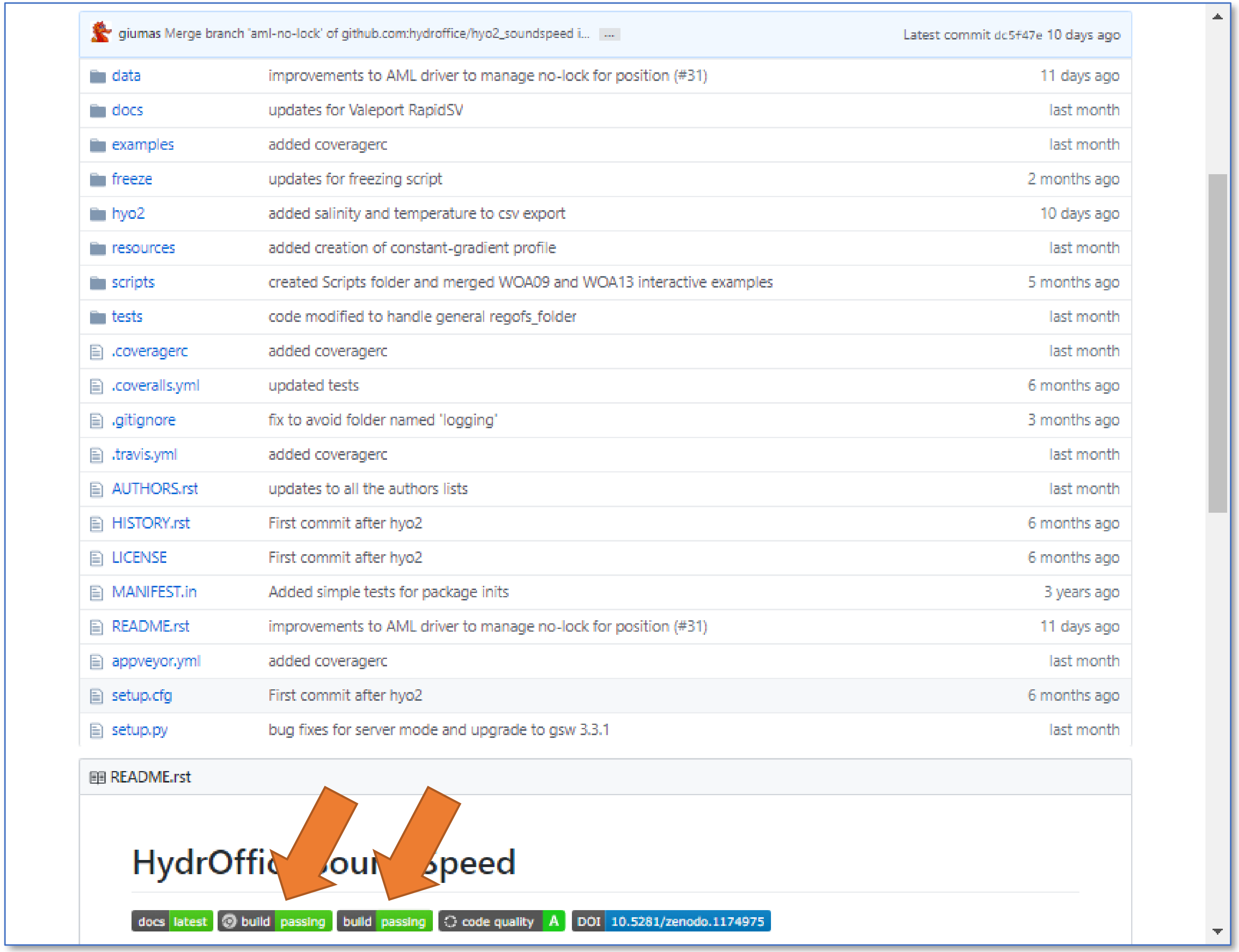
Accepted data inputs are bathymetric grids, feature files, sounding selections, and directory structures. The output is GIS-layers that alert to the user various parts of their data that might require more attention. Summary reports are also printed for the record and review.

The objectives are to improve data accuracy, while also reducing the overall time required for ping-to-chart.

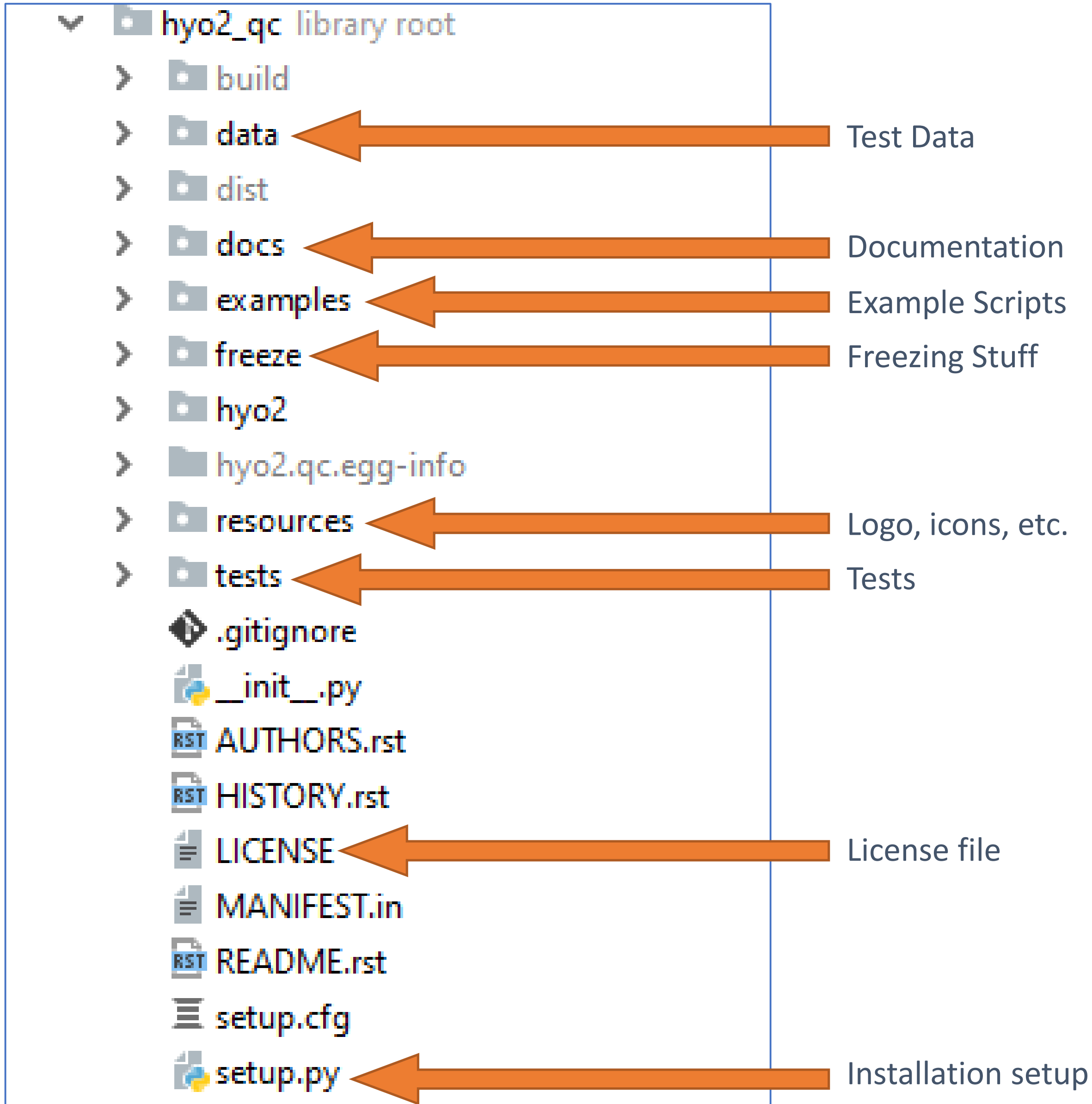
1

Packaging → Continuous Integration (CI)

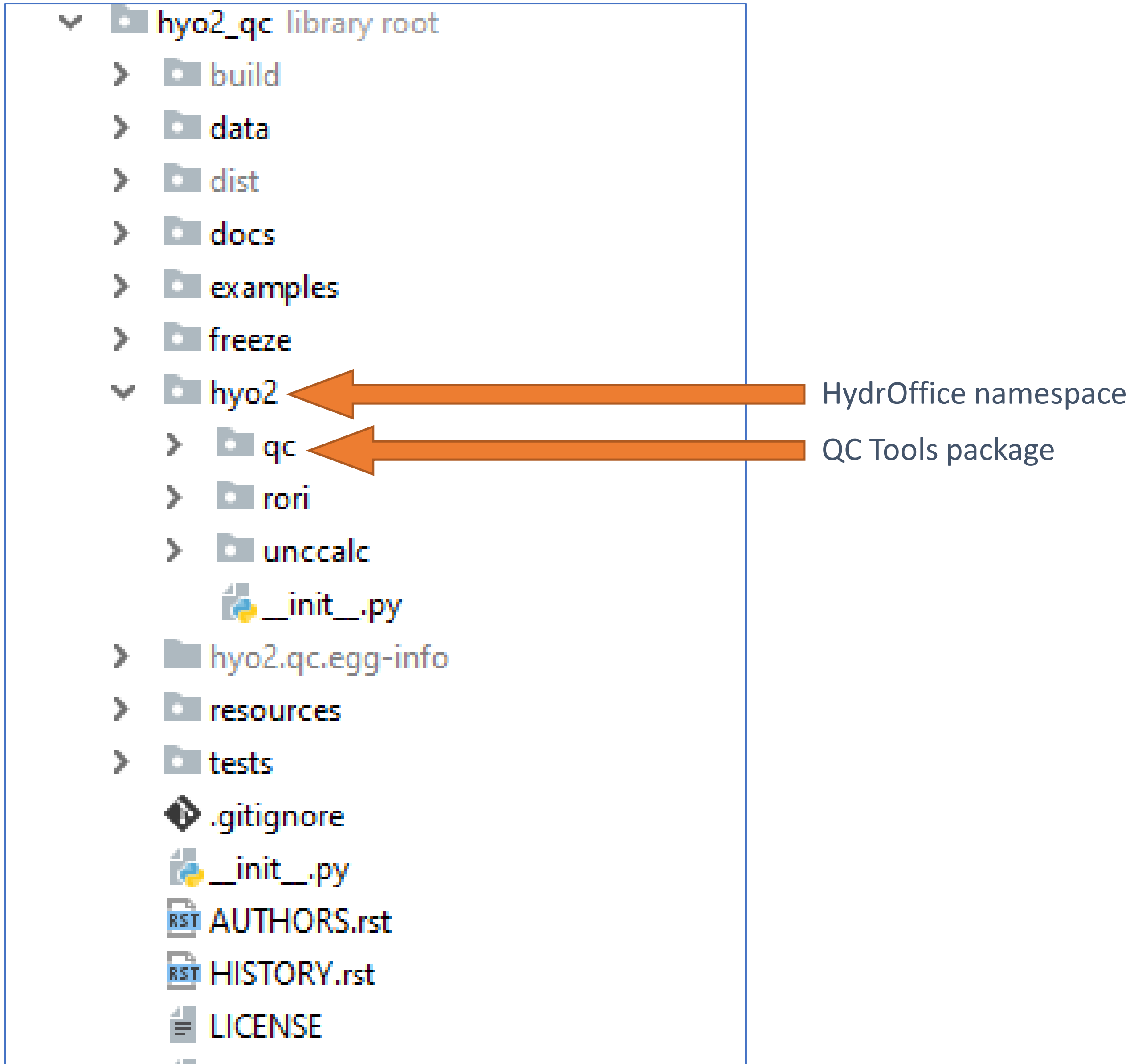
- Based on:
  - [AppVeyor]
    - Windows
  - [Travis-CI]
    - Linux
    - Mac



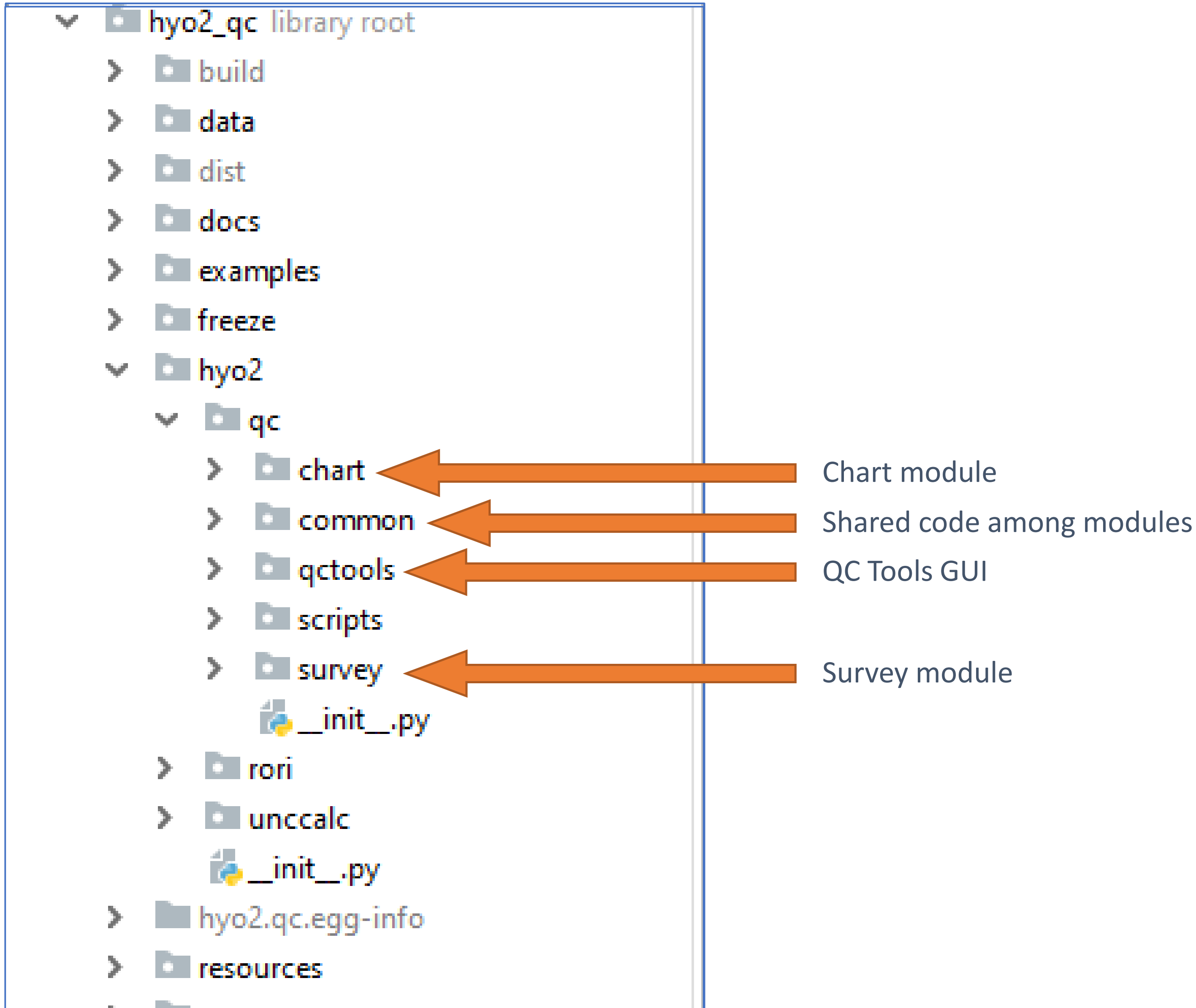
PACKAGING → REPOSITORY STRUCTURE



Packaging → Repository Structure



Packaging → Repository Structure



Distribution & Licensing

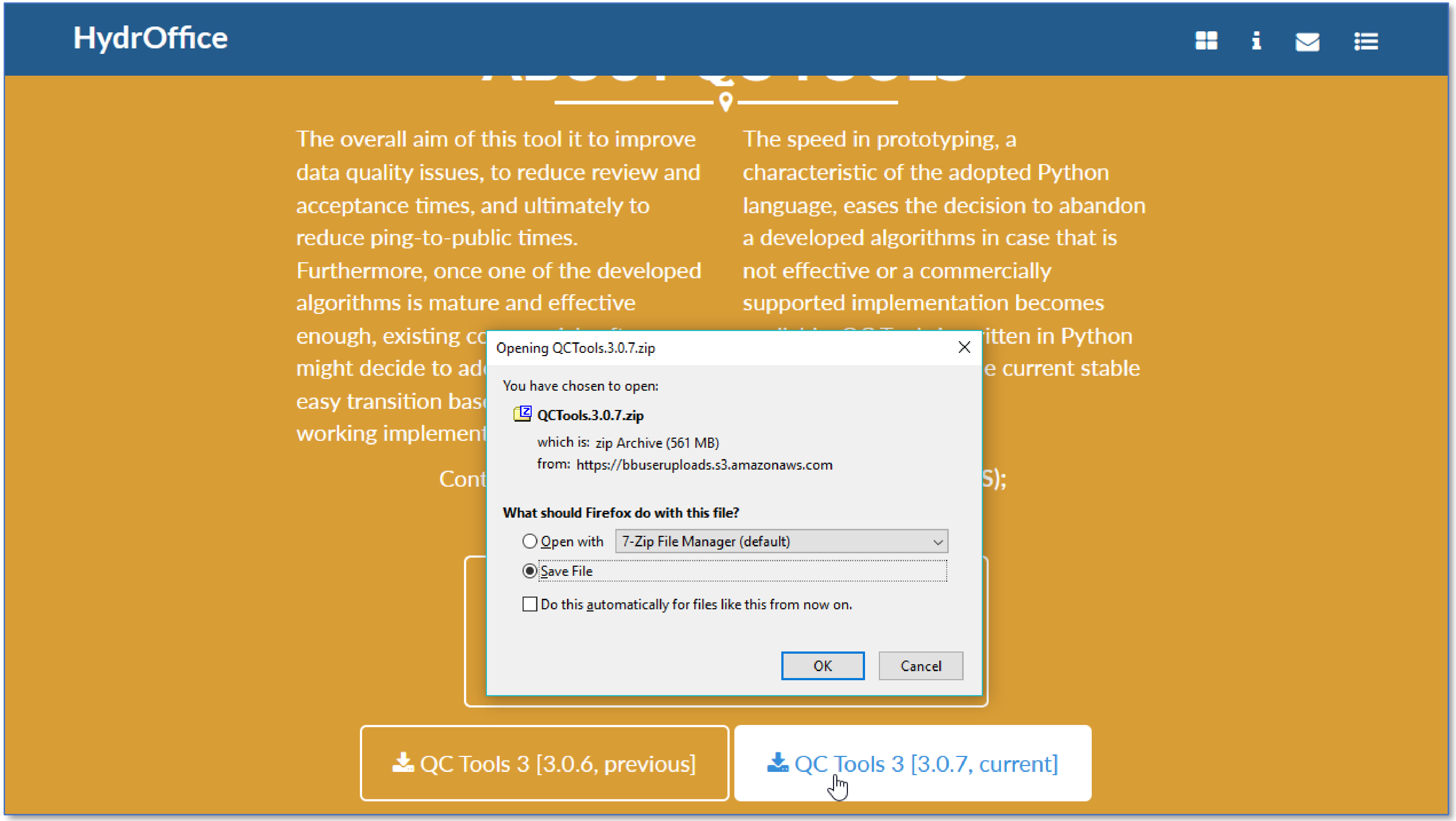
DISTRIBUTION

- User-installed packages
  - “`pip install -e .`”
  - Users that want to improve/contribute to the code base
- As part of the Pydro Distribution
  - Automatic updates (e.g., through Pydro Explorer/NOAA Pydro Server)
- Stand-alone apps

DISTRIBUTION → STAND ALONE

- Python freezer: **pyInstaller**
  - Cross-platform
  - Large community
- App-required code and libraries collected into a single folder
- No “installation”, just unzip and run it!

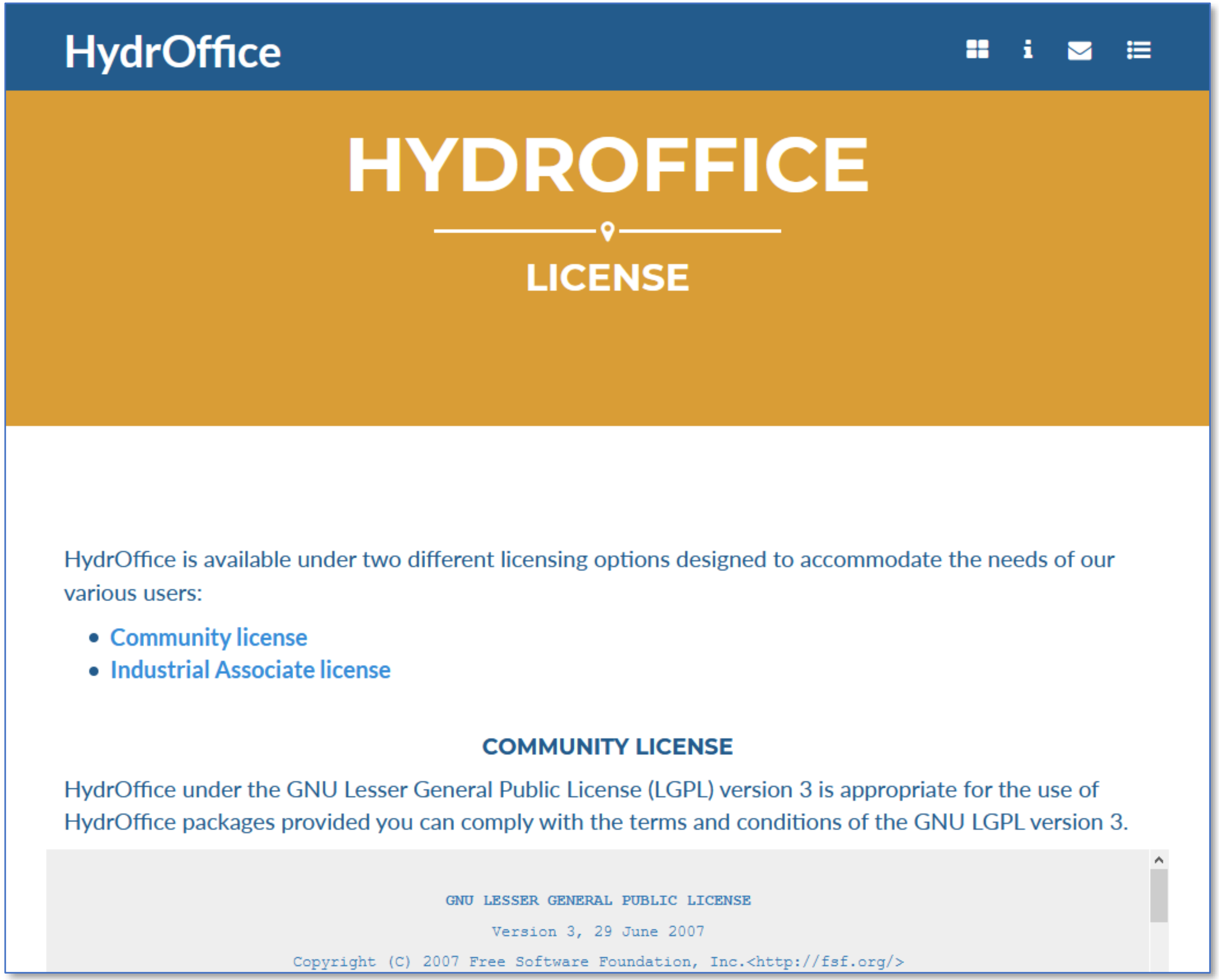
DISTRIBUTION → STAND ALONE



Licensing

- Dual License
  - Community license → GNU LGPL
  - Industrial Associate license
  - Public domain for NOAA contributions:
    - *"Portions of this project were developed under a cooperative agreement with NOAA Coast Survey Development Laboratory, and contain* ***NOAA-developed code in the public domain."***

LICENSING


HydrOffice

HYDROFFICE

LICENSE

HydrOffice is available under two different licensing options designed to accommodate the needs of our various users:

- Community license
- Industrial Associate license

COMMUNITY LICENSE

HydrOffice under the GNU Lesser General Public License (LGPL) version 3 is appropriate for the use of HydrOffice packages provided you can comply with the terms and conditions of the GNU LGPL version 3.

GNU LESSER GENERAL PUBLIC LICENSE

Version 3, 29 June 2007

Copyright (C) 2007 Free Software Foundation, Inc.<http://fsf.org/>

Governance & Maintenance

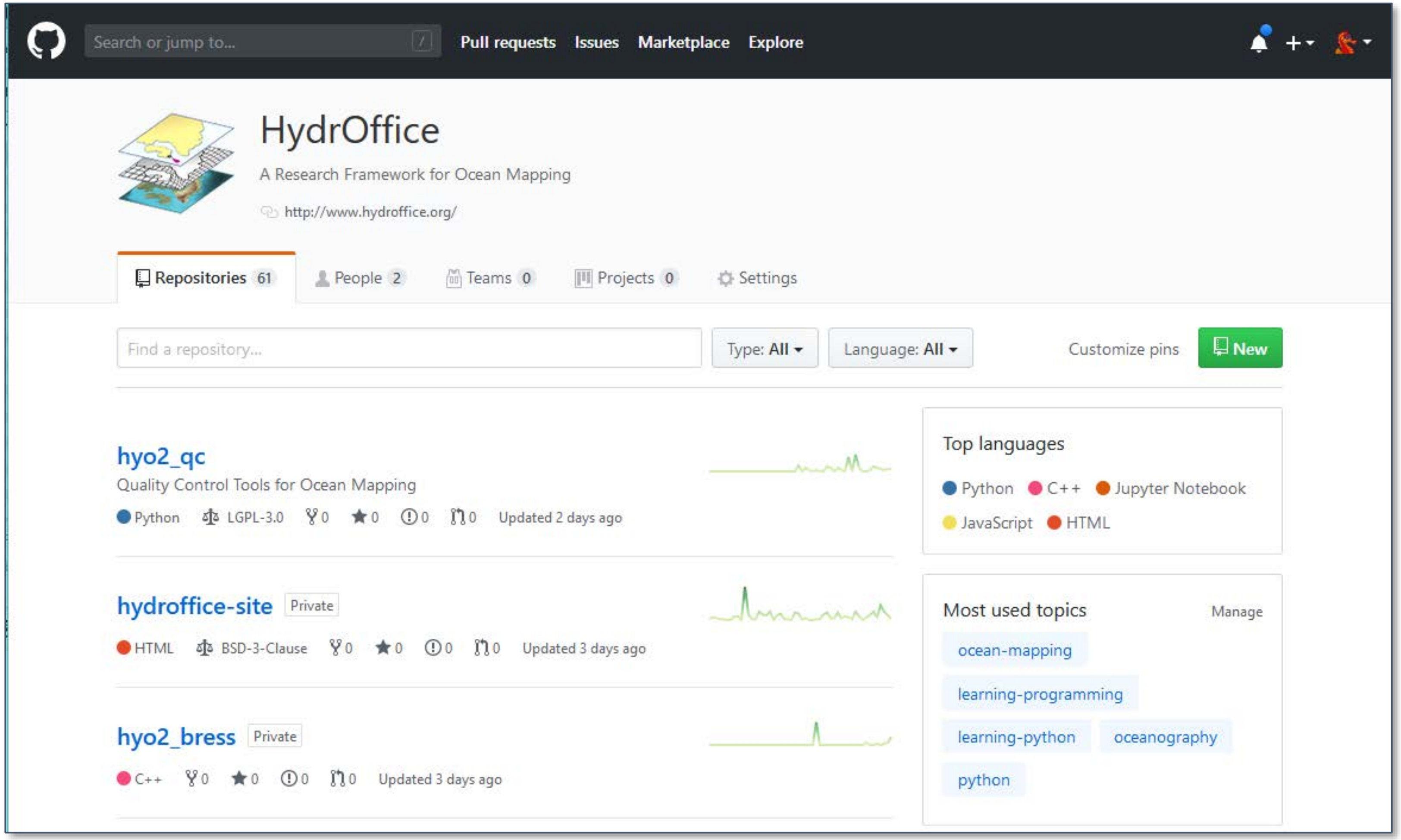
Governance & Maintenance

- Similar to other open-source projects (e.g., GDAL, matplotlib)

- Based on well-known **GitHub mechanisms**:
  - Pull Requests (PR)
  - Issues/Labels
  - Milestones/Projects

HYDROFFICE → GITHUB ORGANIZATION

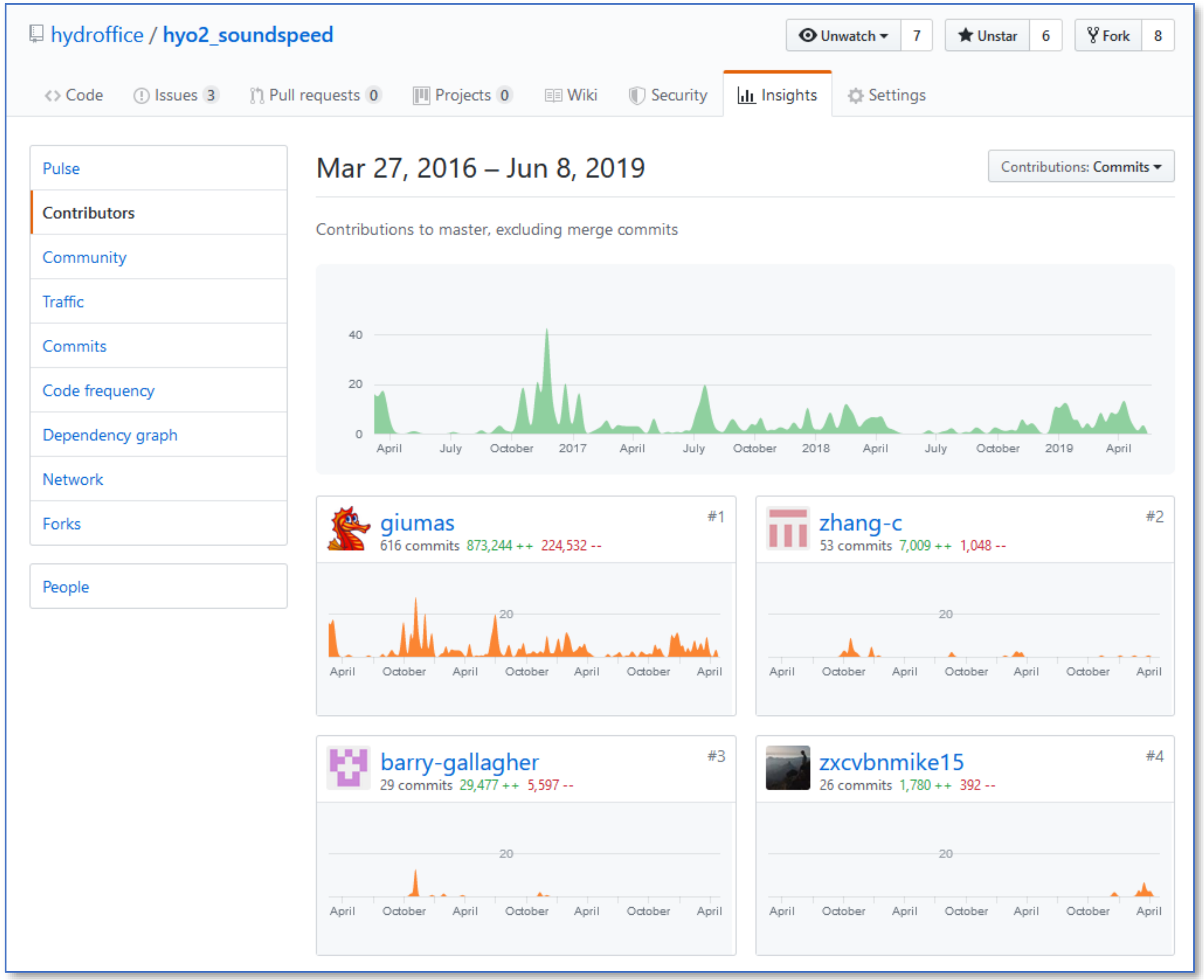
- https://github.com/hydroffice



GOVERNANCE & MAINTENANCE

- Different roles based on code contributions:
  - Issues fixed
  - Features added
  - Workload & time availability

- 3 main roles:
  - Core Developers
  - Code Contributors
  - Testers



THANKS!

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