Quality Level Measurements and Considerations

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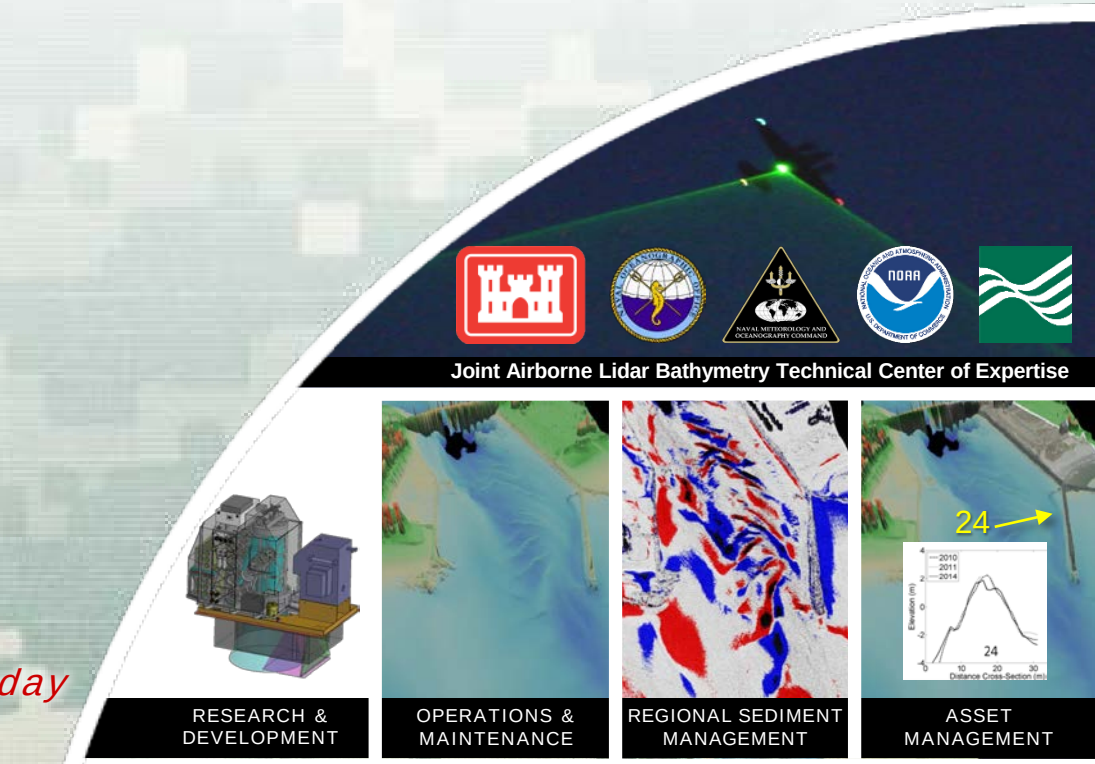
Physical Scientists

Silver Spring, MD

July 21, 2016



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QL Introduction and Intent

National Coastal Mapping Strategy (NCMS) by Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM)

- Component 1 - Aspirational Strategy and Agency Responsibilities
- Component 2 - Annual Coordinated Planning of Coastal Mapping Activities
- **Component 3 - Establishing Common Standards for U.S. Coastal Mapping**
- Component 4 -Establishing Cooperative Data Management
- Component 5 - Research and Development to Improve U.S. Coastal Mapping

http://iocm.noaa.gov/iwg/

Establishing Common Standards for U.S. Coastal Mapping

“ Having QLs defined consistently by all agencies facilitates comparing specifications across agencies, coordinating acquisition to meet cross-agency needs,and determining whether data collected for one purpose will meet requirements for other uses.”

Approach to defining Bathy QLs considered:

- 3DEP Quality Levels for topographic lidar
- (IHO) hydrographic vertical uncertainty
- Existing agency specifications

QL Currently Defined

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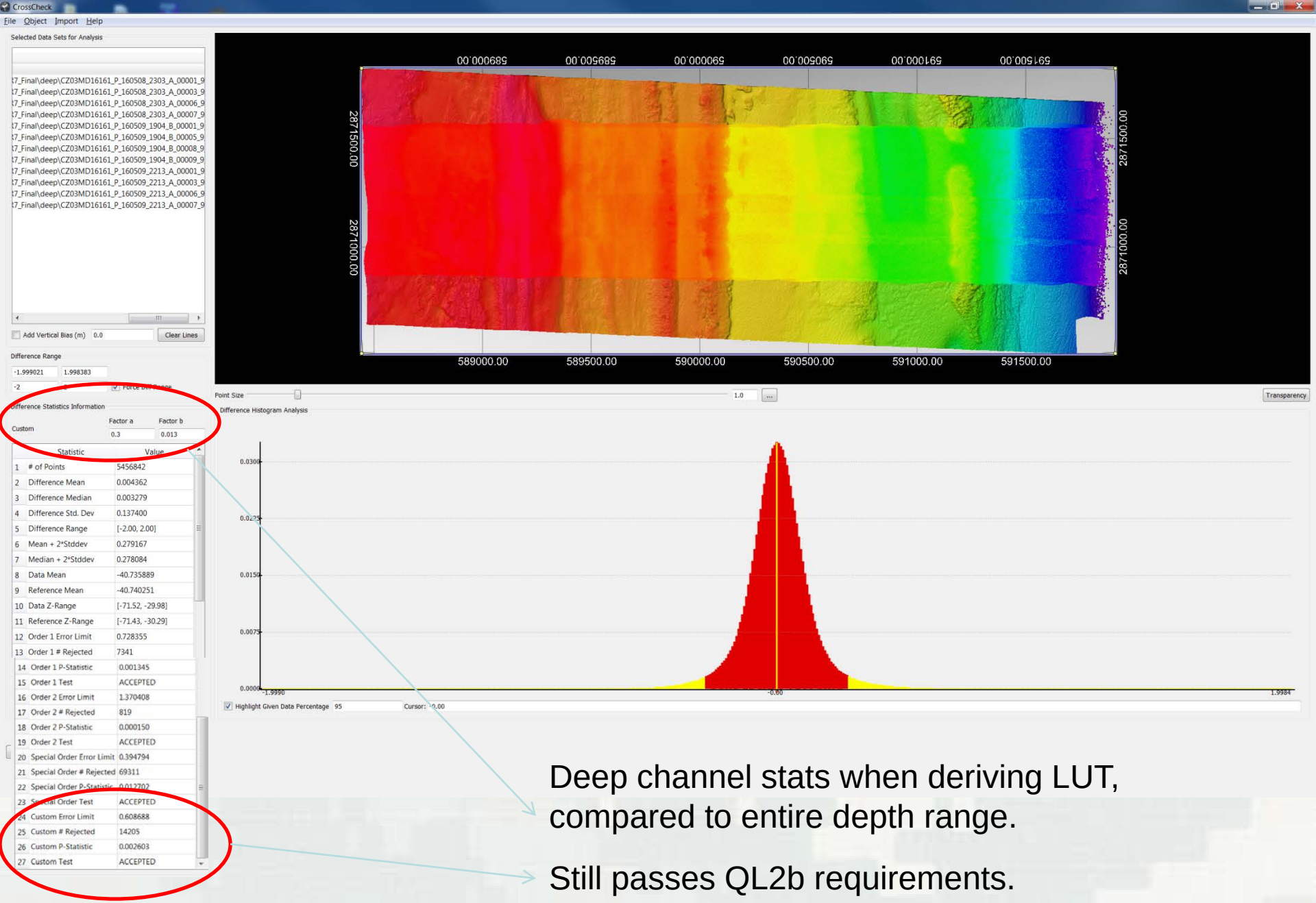
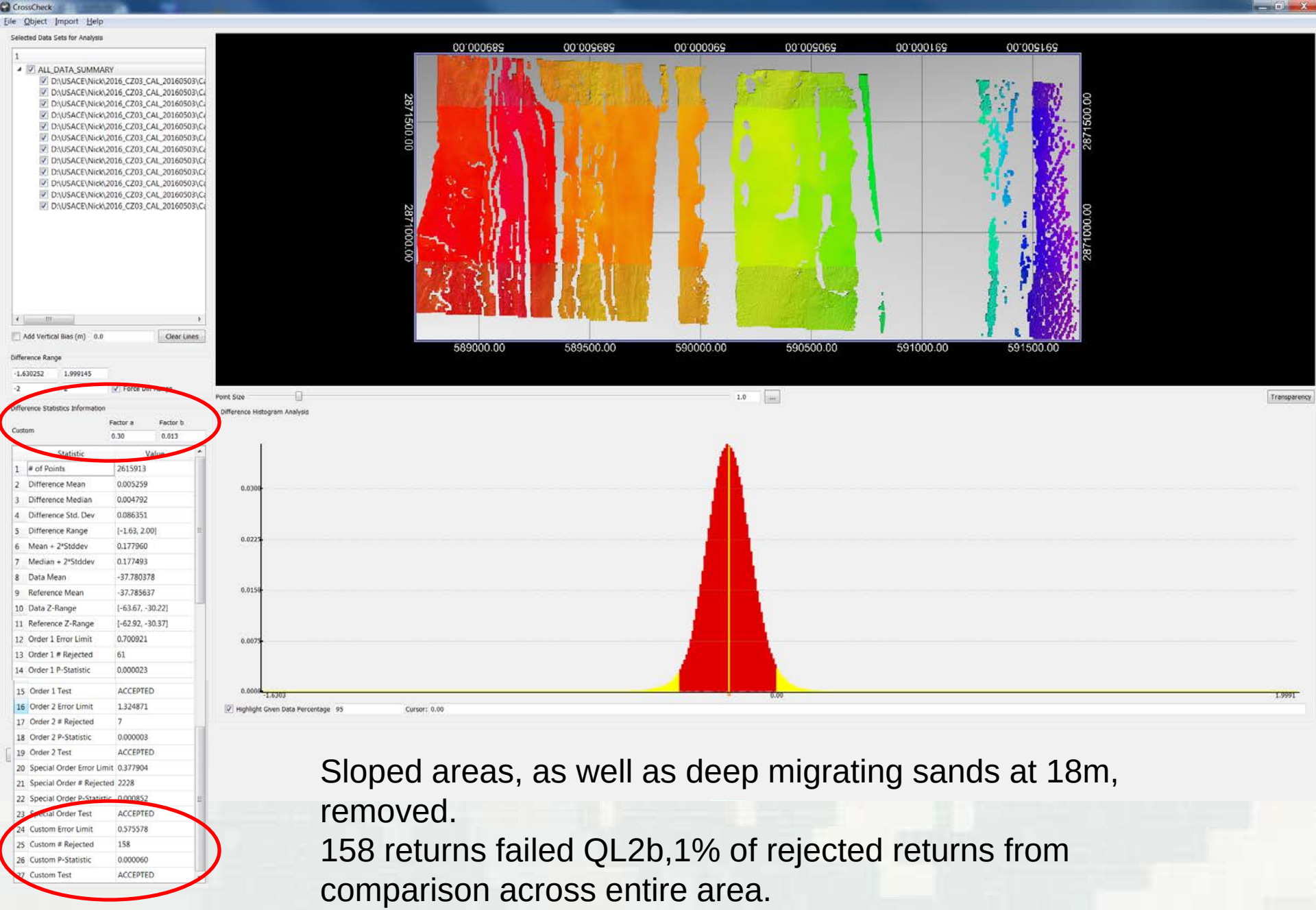
	Bathy Lidar Quality Level	Vertical uncetainty coefficients a,b	Nominal Pulse Spacing (m)	Point Density (pt/m^2)	Example Applications
IHO Special	$QL0_B$	0.25, 0.0075	≤0.7	≥2.0	Detailed site surveys, dredging and inshore engineering surveys; high-resolution surveys of ports and harbors
3DEP QL2	$QL1_B$	0.25, 0.0075	≤2.0	≥0.25	
	$QL2_B$	0.30, 0.0130	≤0.7	≥2.0	Charting surveys; regional sediment management; coastal science and management applications.
IHO 1	$QL3_B$	0.30, 0.0130	≤2.0	≥0.25	
	$QL4_B$	0.50, 0.0130	≤5.0	≥0.04	Recon/planning; all general applications not requiring higher resolution and accuracy



Deep channel stats when deriving LUT, compared to entire depth range.

Still passes QL2b requirements.



Sloped areas, as well as deep migrating sands at 18m, removed.

158 returns failed QL2b,1% of rejected returns from comparison across entire area.

2016 CZMIL Deep Channel Uncertainty

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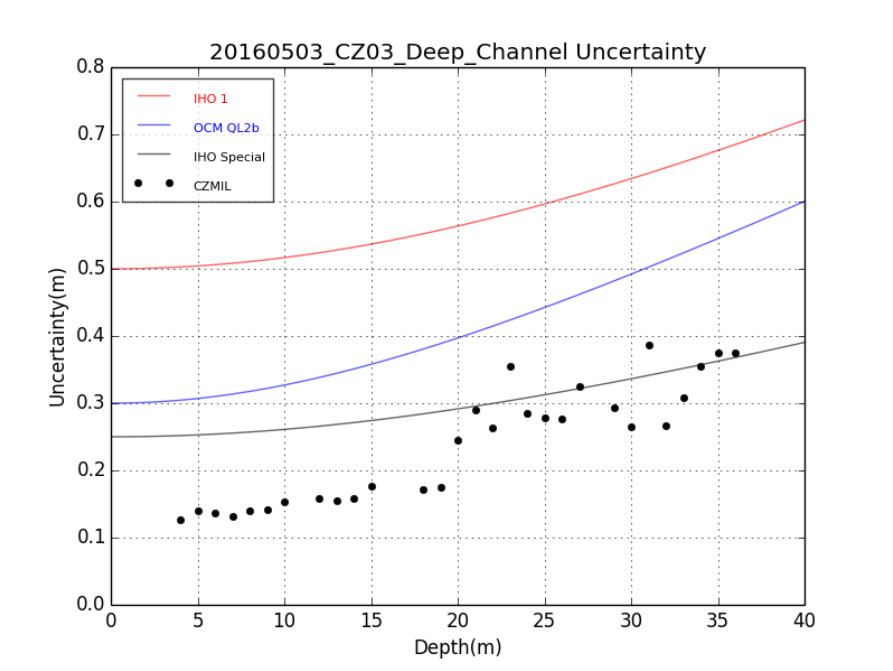

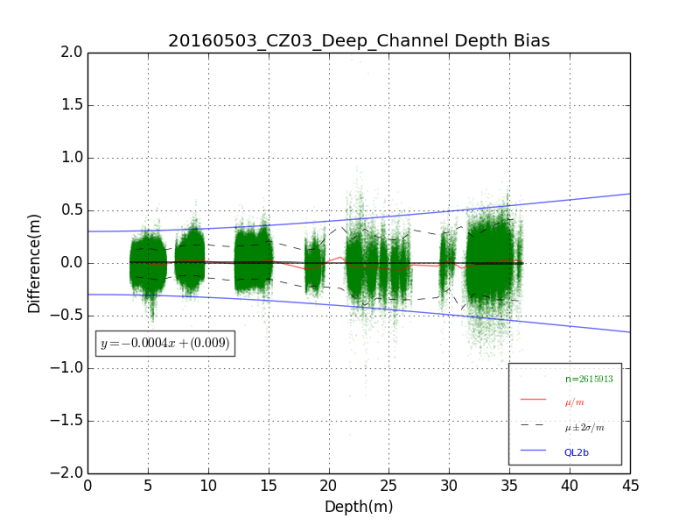

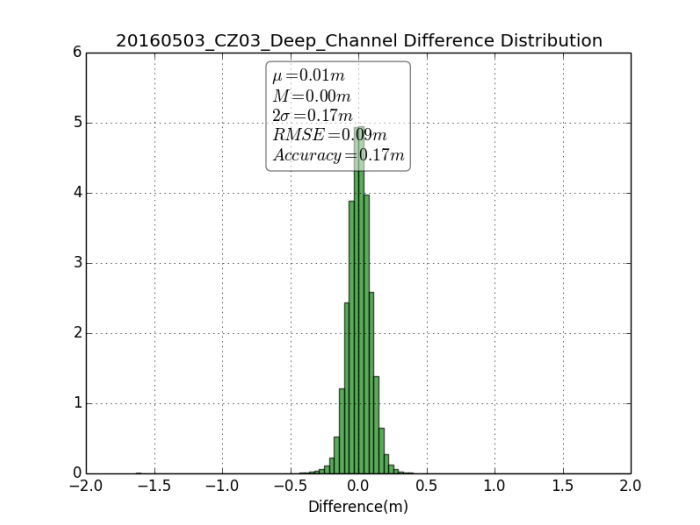

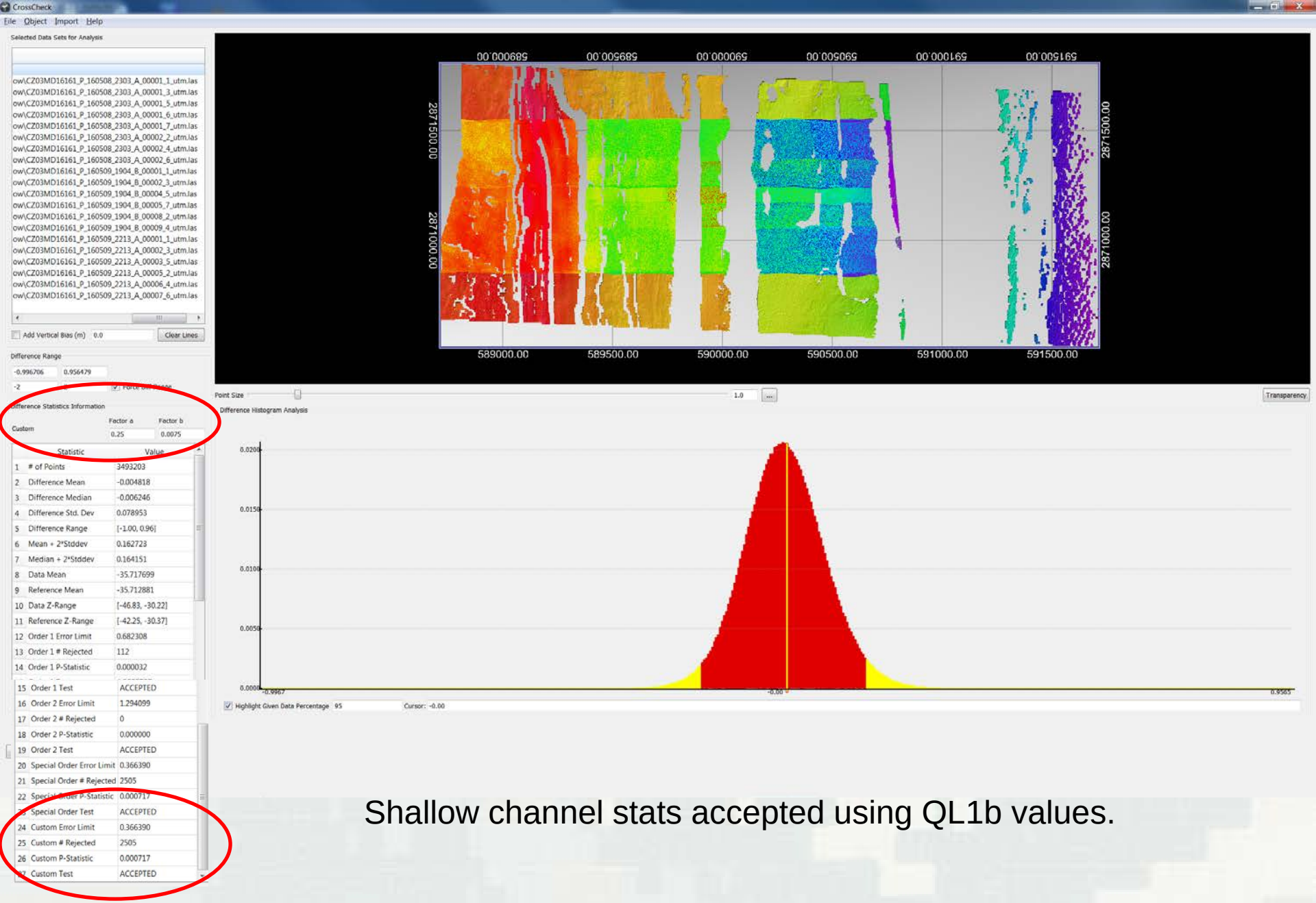

Shallow channel stats accepted using QL1b values.

2016 CZMIL Shallow Channel Uncertainty

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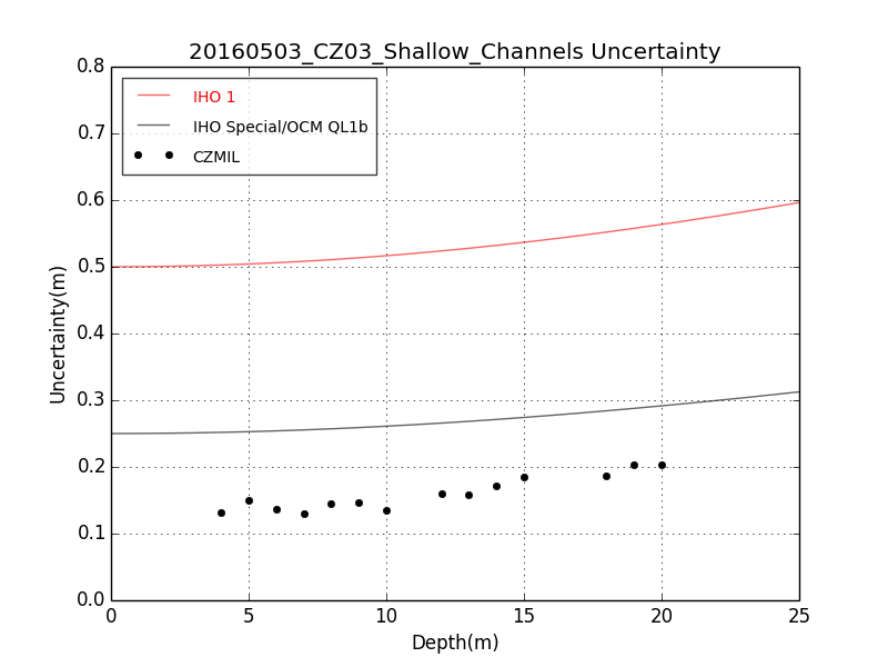

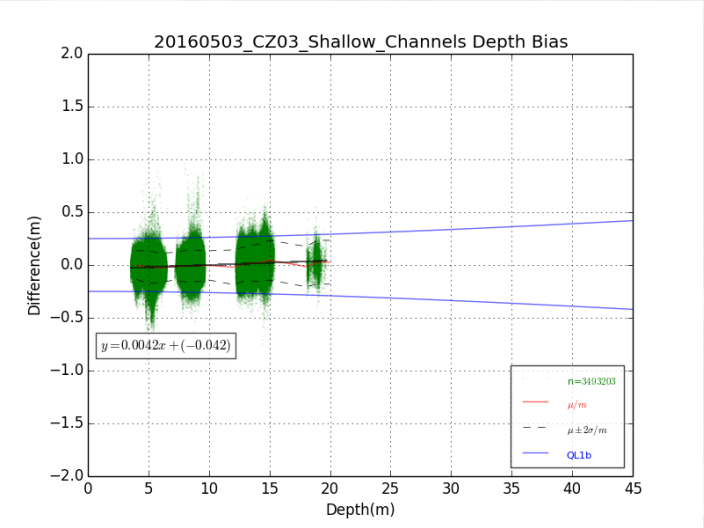

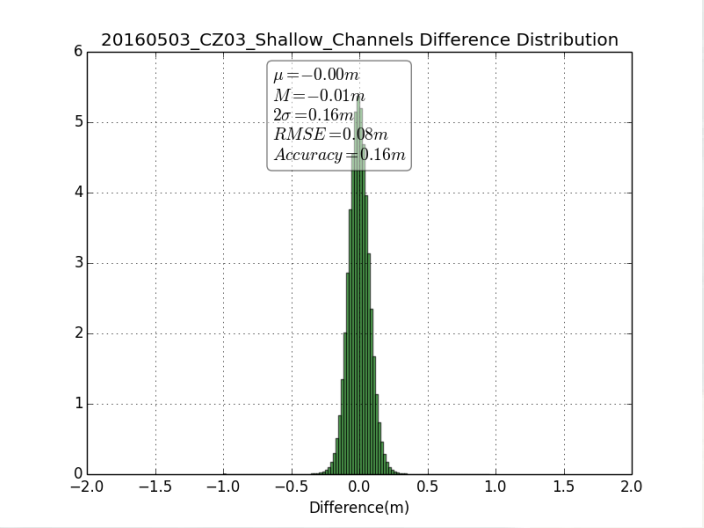

Shallow Channel Density

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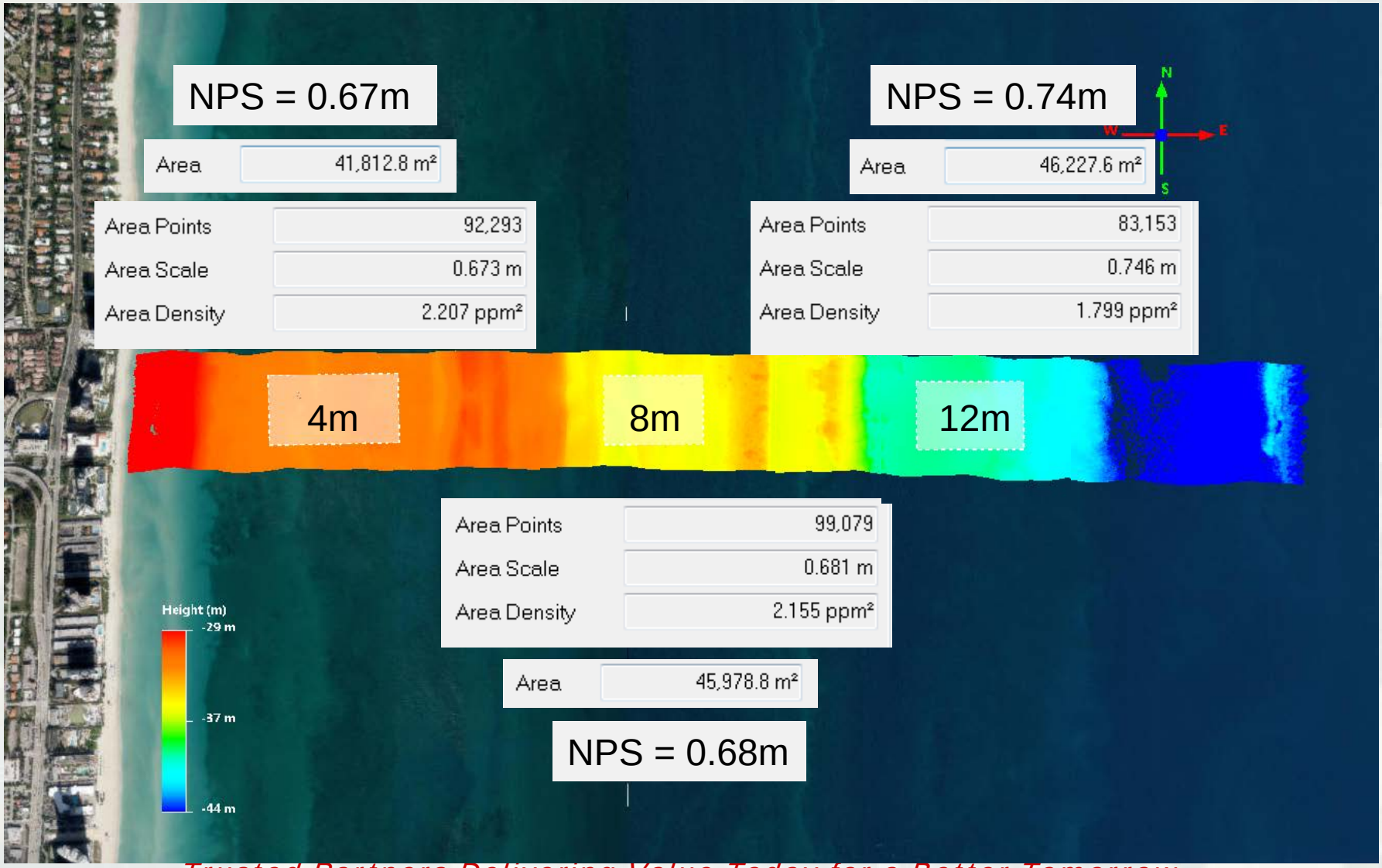

Shallow Channel Data Distribution and Regularity

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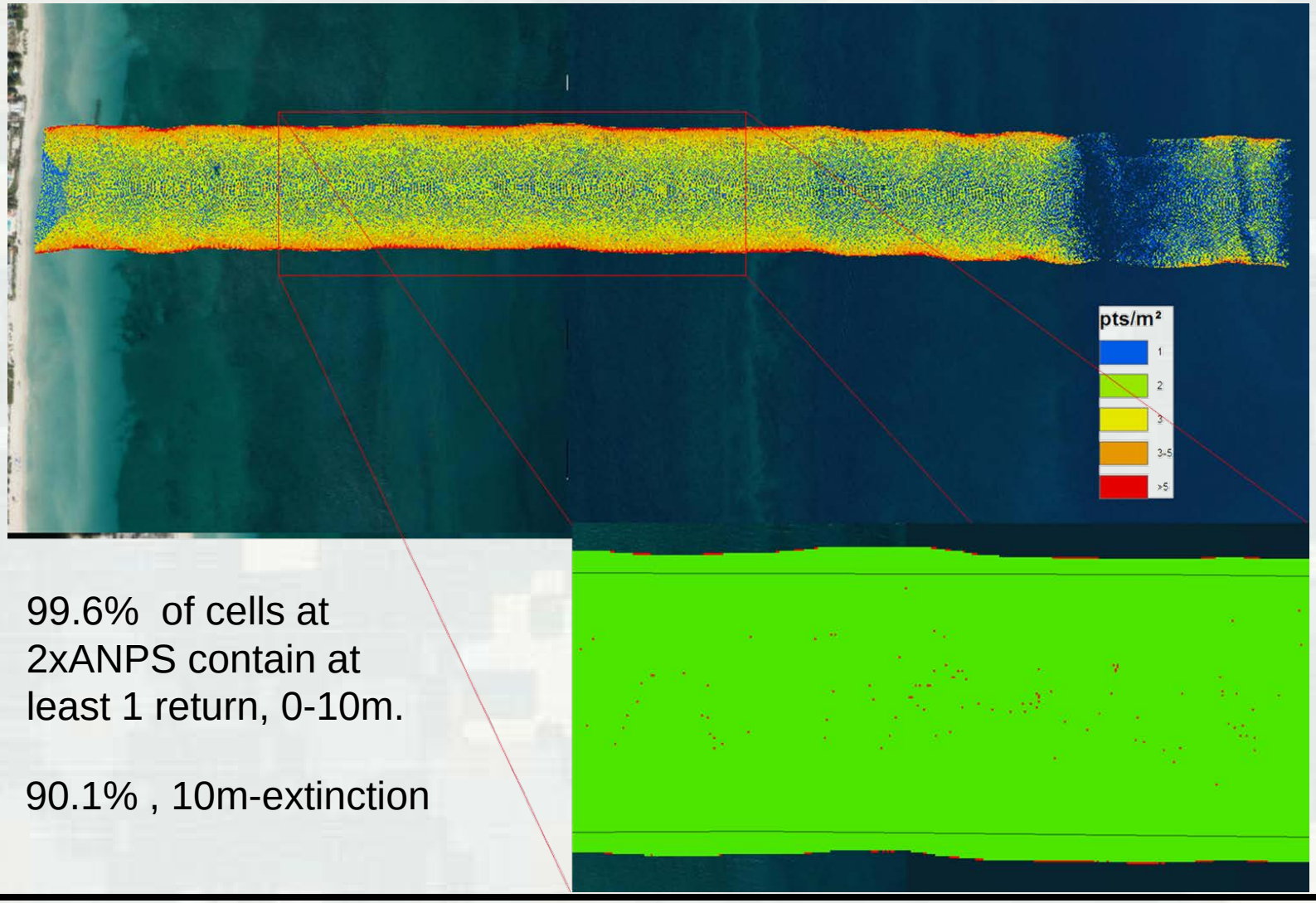

99.6% of cells at 2xANPS contain at least 1 return, 0-10m.

90.1% , 10m-extinction

Deep Channel Density

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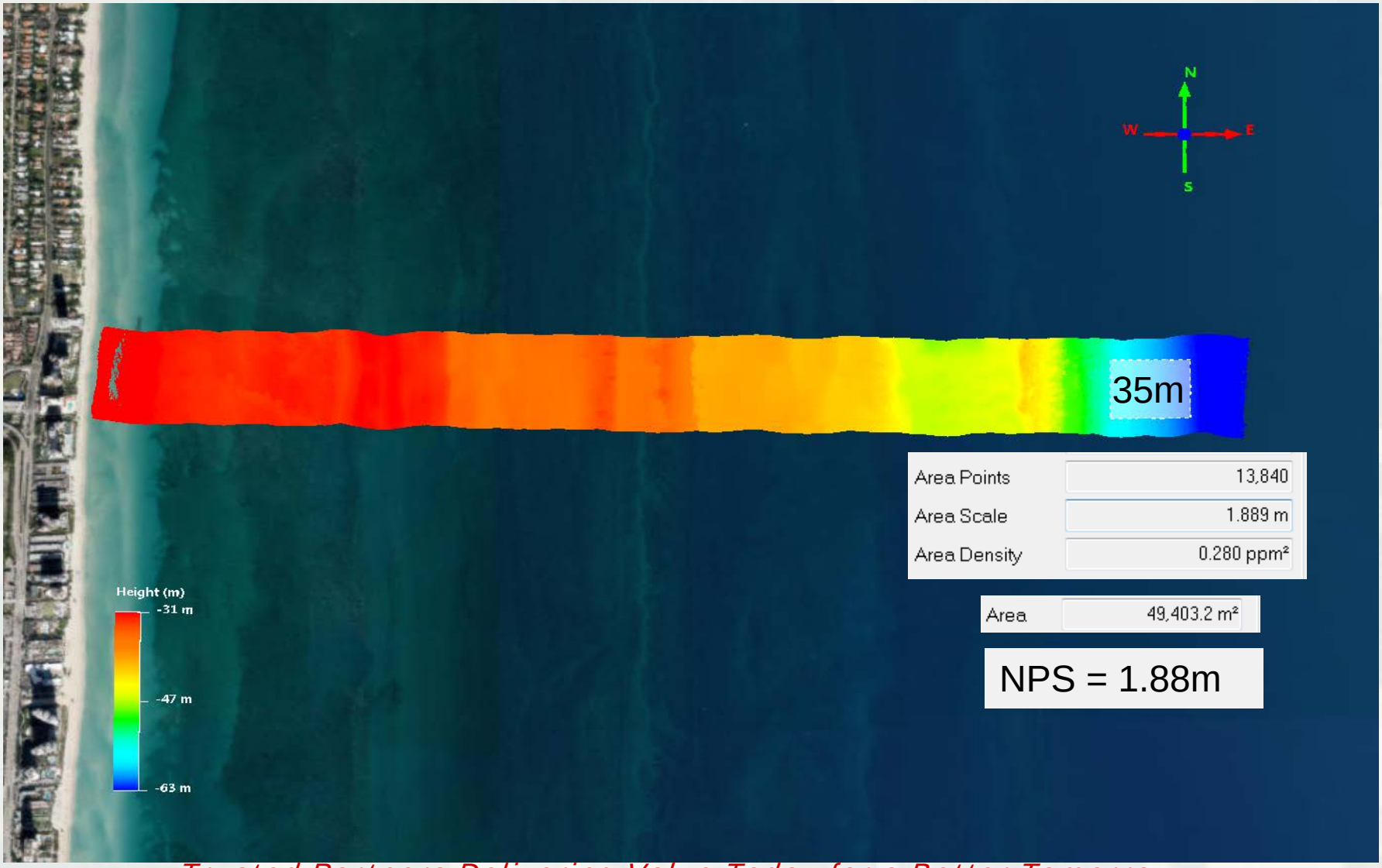

Deep Channel Data Distribution and Regularity

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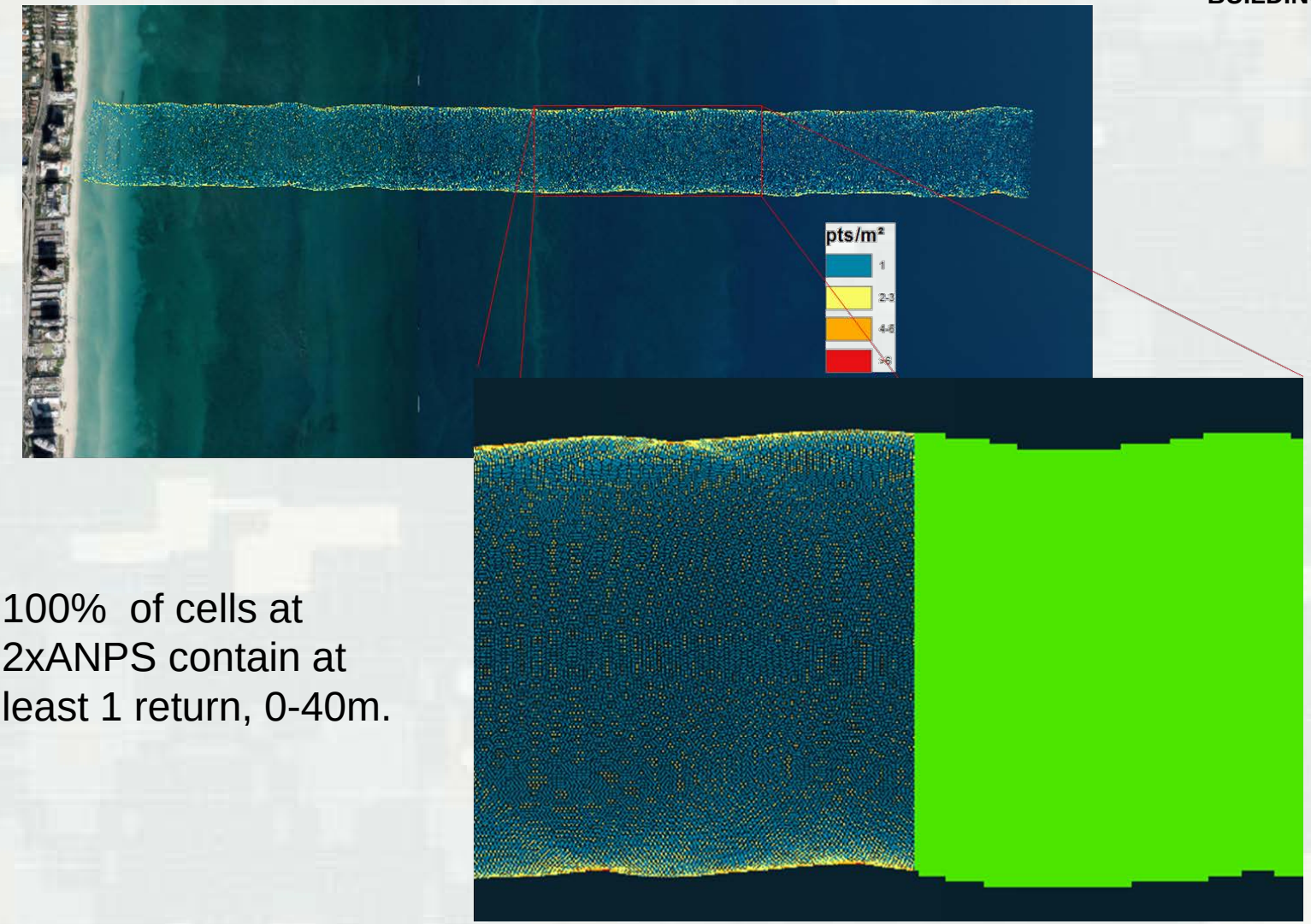

100% of cells at 2xANPS contain at least 1 return, 0-40m.

QL Considerations

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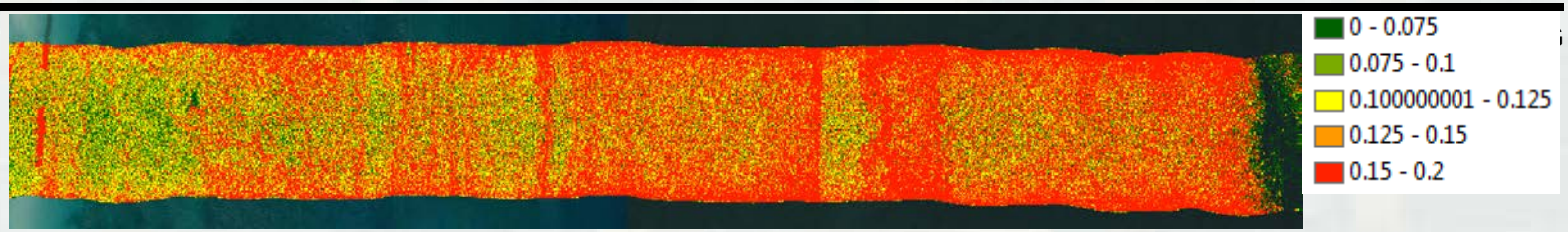
- Include smooth surface repeatability and swath overlap difference? How often do you have or need recent nearshore bathymetric GT?

Quality Level (QL)	Aggregate nominal pulse spacing (ANPS) (m)	Aggregate nominal pulse density (ANPD) (pls/m^2)	Smooth surface repeatability (cm)	Swath overlap difference, $RMSD_z$ (cm)	Swath overlap difference, maximum (cm)	$RMSE_z$ (nonvegetated) (cm)	NVA at 95-percent confidence level (cm)
QL0	≤0.35	≥8.0	≤3	≤4	±8	≤5.0	≤9.8
QL1	≤0.35	≥8.0	≤6	≤8	±16	≤10.0	≤19.6
QL2	≤0.71	≥2.0	≤6	≤8	±16	≤10.0	≤19.6
QL3	≤1.41	≥0.5	≤12	≤16	±32	≤20.0	≤39.2

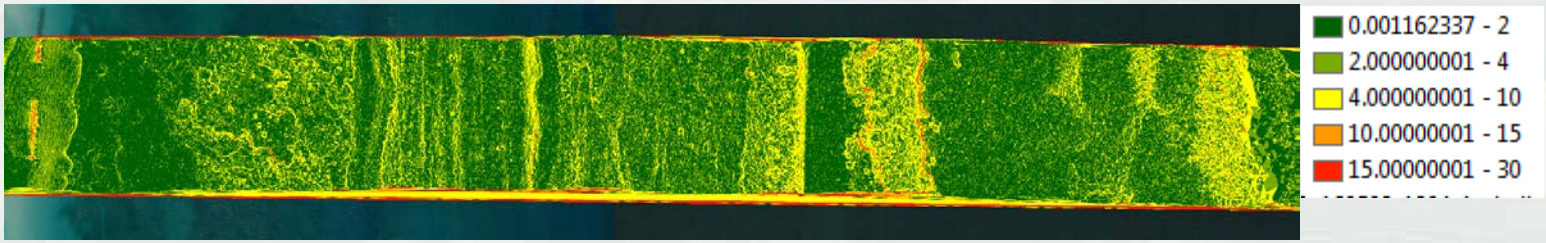
Bathy Lidar Quality Level	Vertical accuracy coefficients a,b as in sqrt(a^2+(b*d)^2)) a(m), b	Smooth surface repeatability (m) Max diff(m) , b	Swath overlap difference, Maximum (m) Diff(m), b
$QL0_B$	0.25, 0.0075	≤0.075, 0.0075	0.2, 0.0075
$QL1_B$	0.25, 0.0075	≤0.075, 0.0075	0.2, 0.0075
$QL2_B$	0.30, 0.0130	≤0.09, 0.0130	0.24, 0.0130
$QL3_B$	0.30, 0.0130	≤0.09, 0.0130	0.24, 0.0130
$QL4_B$	0.50, 0.0130	≤0.15, 0.0130	0.4, 0.0130

Shallow Smooth Surface Repeatability

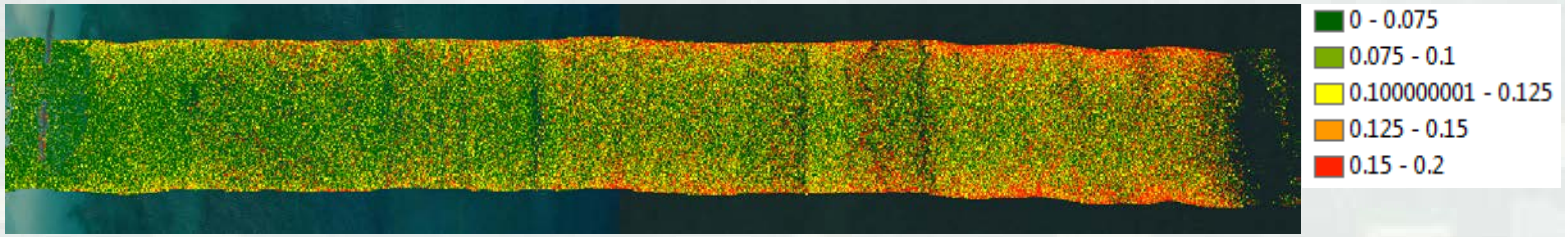
2m Difference



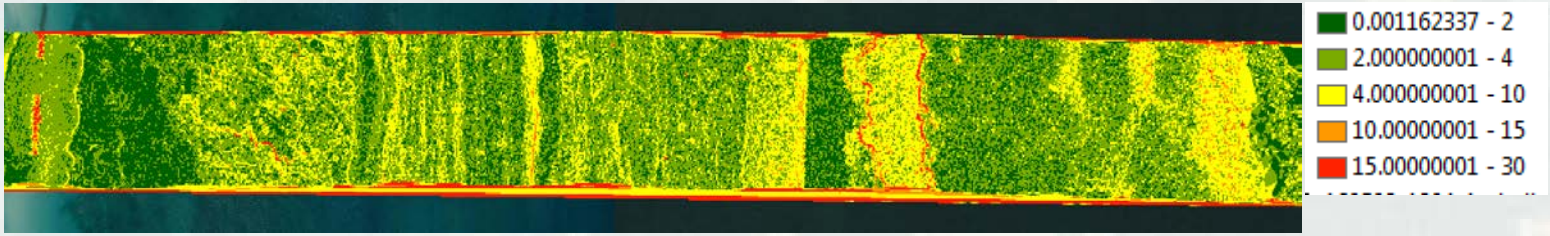
2m Slope



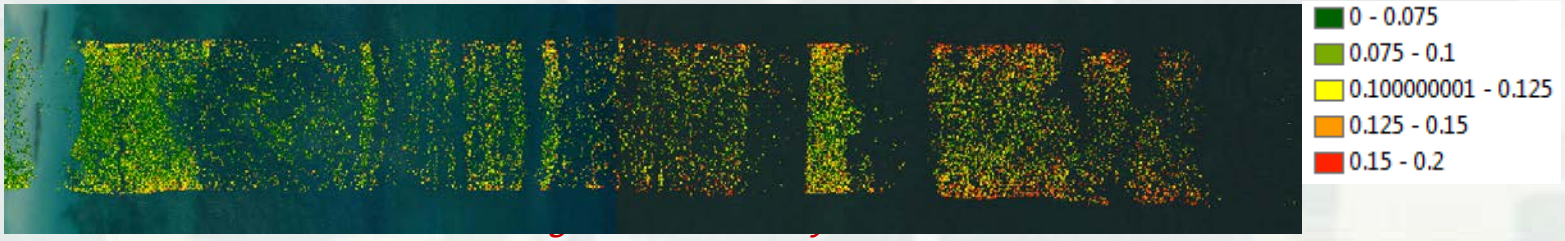
2m NDiff



2m Slope
With 1.5m neighborhood max replacement



2m Ndiff
in featureless areas



Shallow Smooth Surface Repeatability

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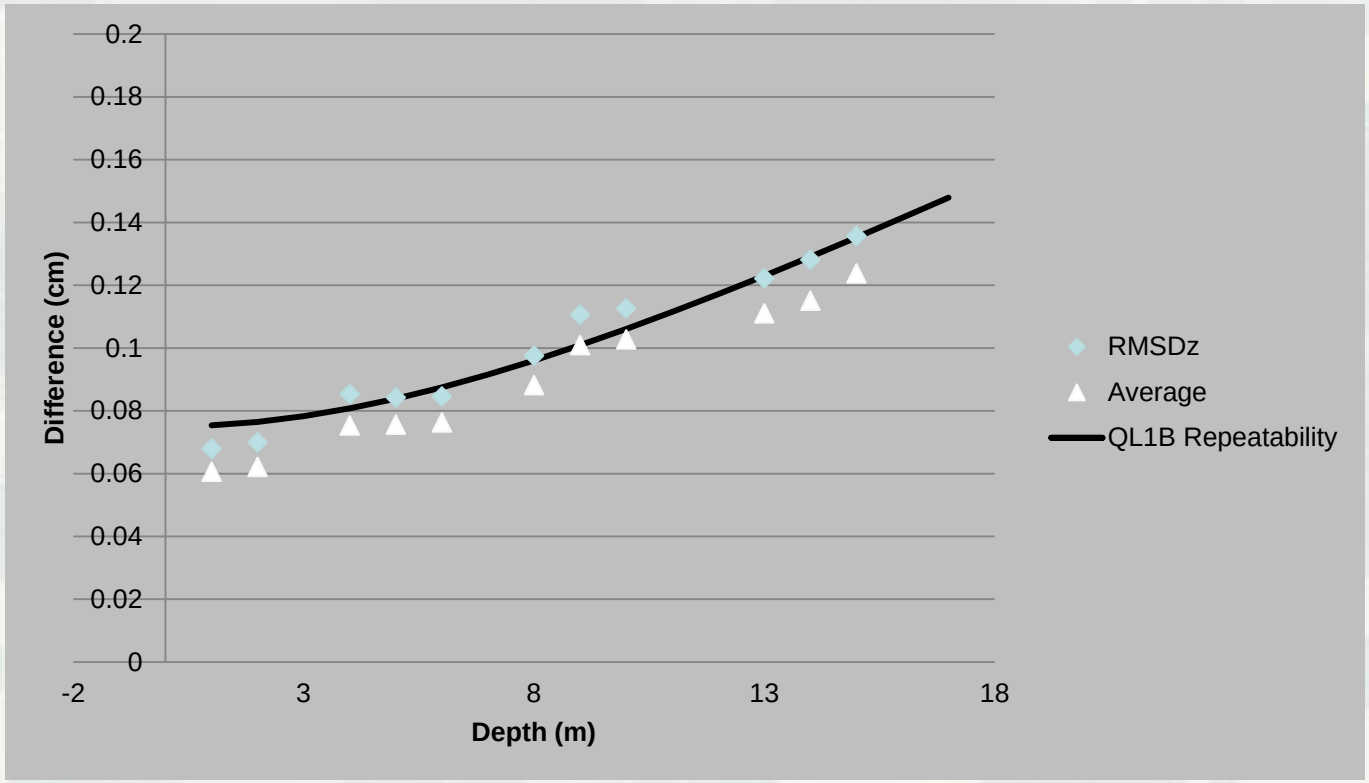
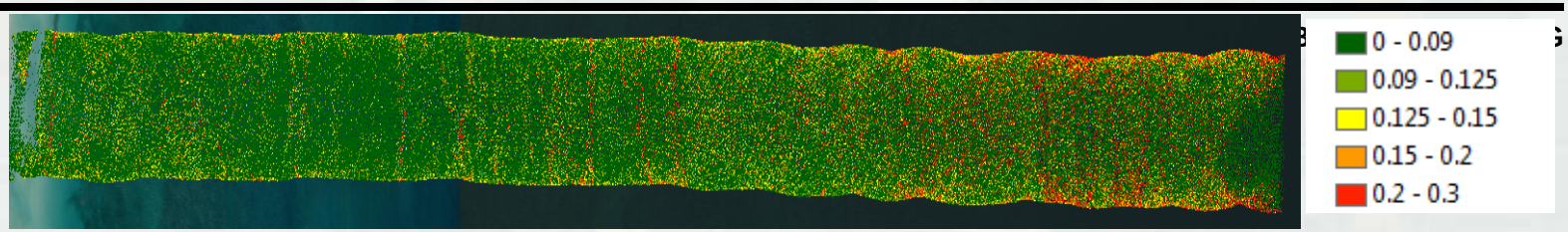


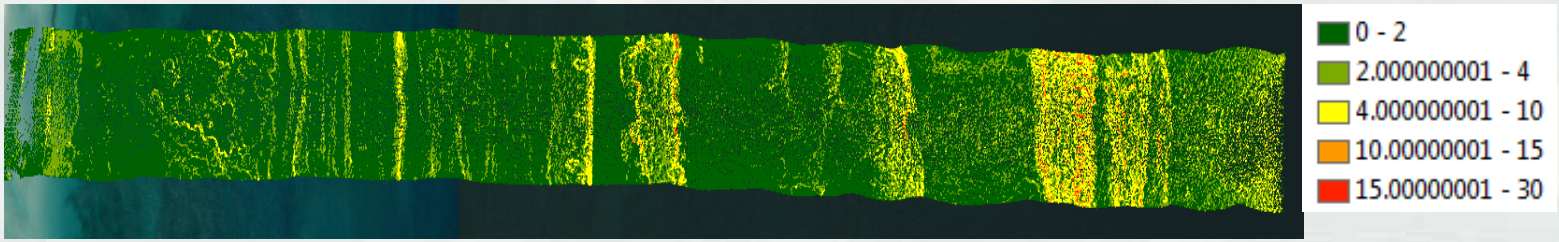
QL	Smooth surface repeatability (m),b
$QL0_B$	≤0.075, 0.0075
$QL1_B$	≤0.075, 0.0075
$QL2_B$	≤0.09, 0.0130
$QL3_B$	≤0.09, 0.0130
$QL4_B$	≤0.15, 0.0130

Deep Smooth Surface Repeatability

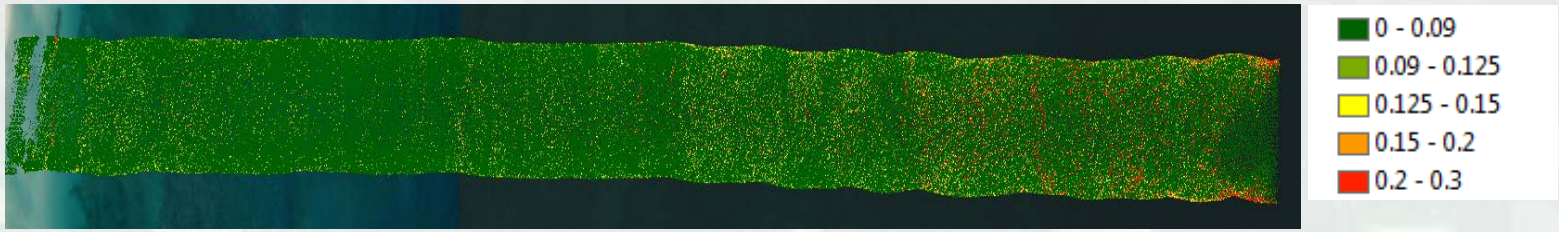
2m Difference



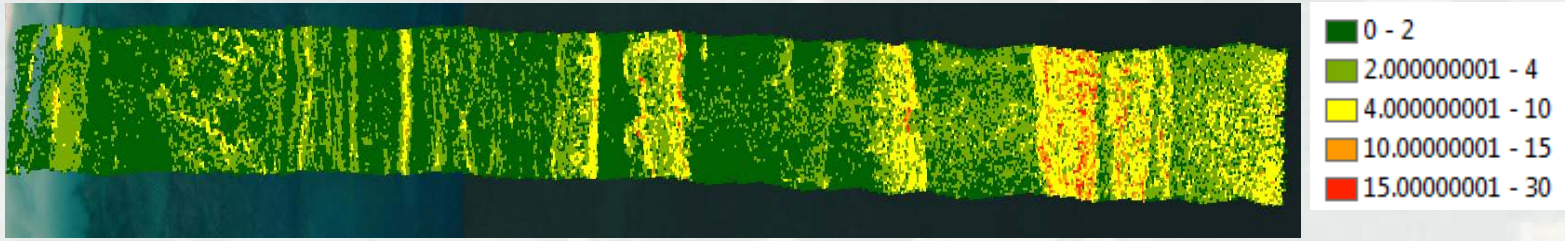
2m Slope



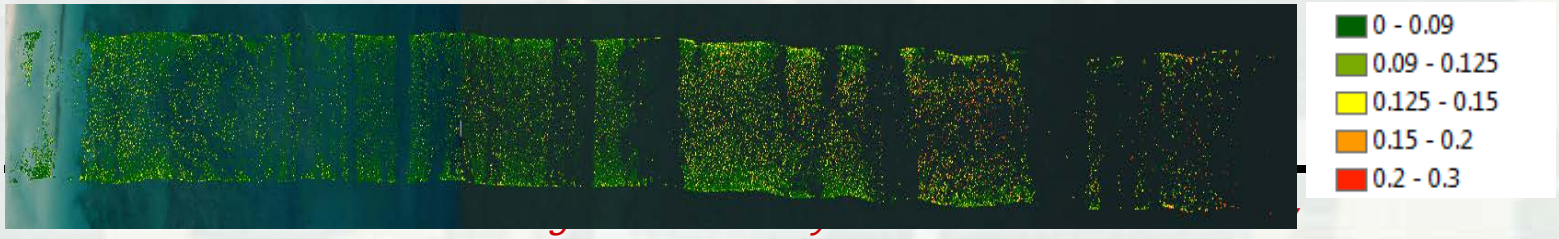
2m NDiff



2m Slope
With 1.5m neighborhood max replacement



2m Ndiff
in featureless areas



Deep Smooth Surface Repeatability

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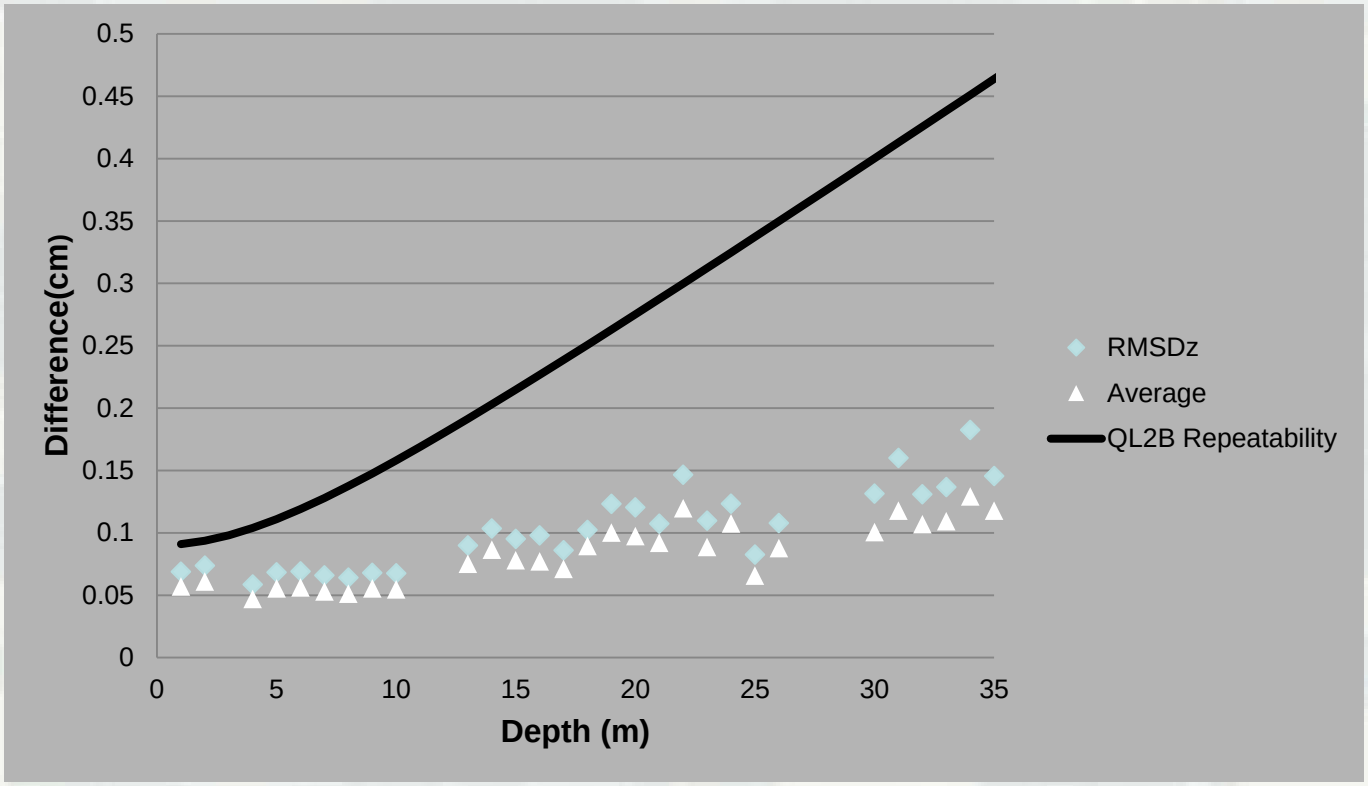

QL	Smooth surface repeatability (m),b
$QL0_B$	≤0.075, 0.0075
$QL1_B$	≤0.075, 0.0075
$QL2_B$	≤0.09, 0.0130
$QL3_B$	≤0.09, 0.0130
$QL4_B$	≤0.15, 0.0130

Shallow Swath Overlap Difference

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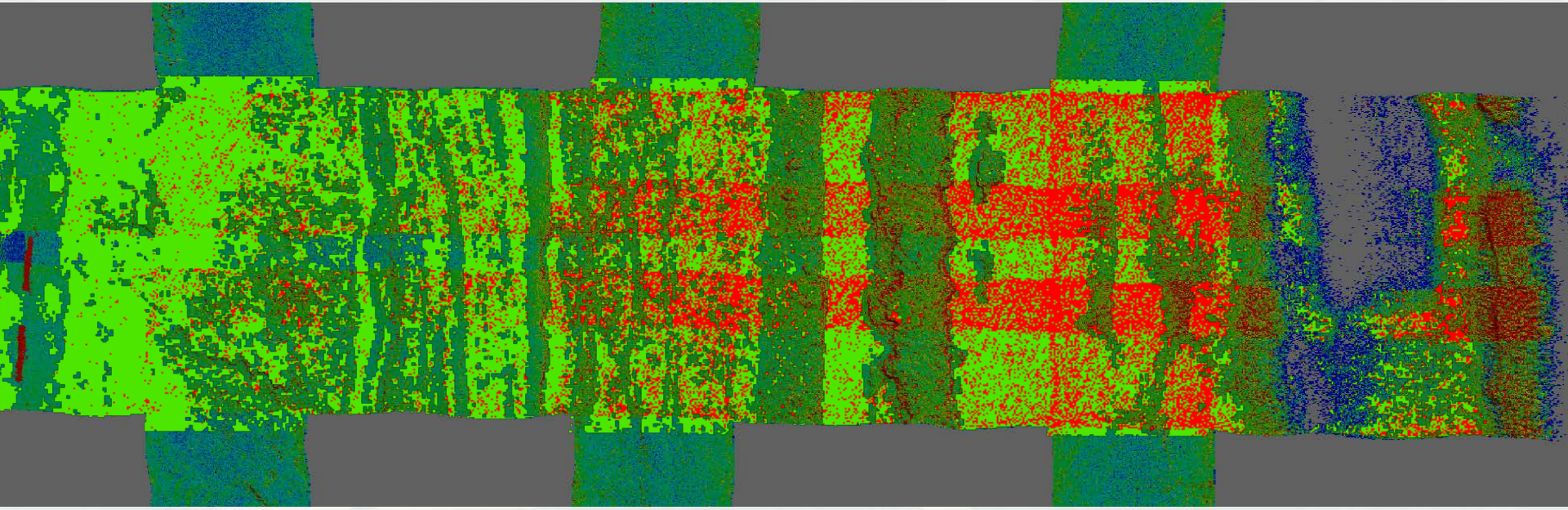

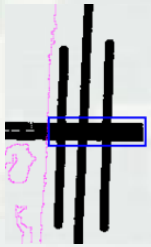

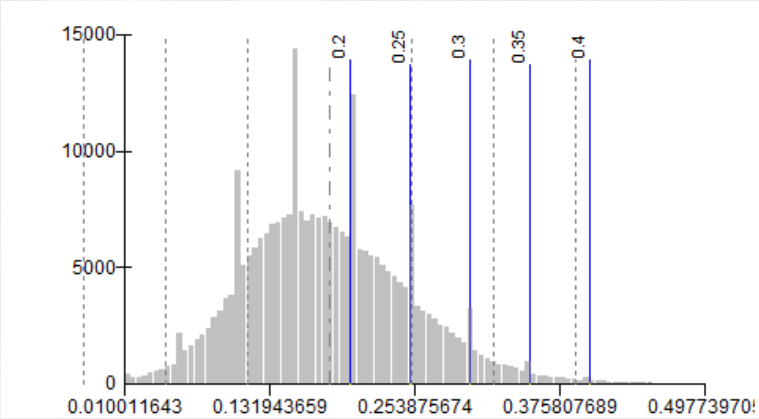

Count:	277485
Minimum:	0.010011643
Maximum:	0.497739705
Sum:	50,488.49554
Mean:	0.18195036
Standard Deviation:	0.068963144

QL	Swath overlap difference, Max (m),b
$QL0_B$	0.20, 0.0075
$QL1_B$	0.20, 0.0075
$QL2_B$	0.24, 0.0130
$QL3_B$	0.24, 0.0130
$QL4_B$	0.40, 0.0130

Deep Swath Overlap Difference

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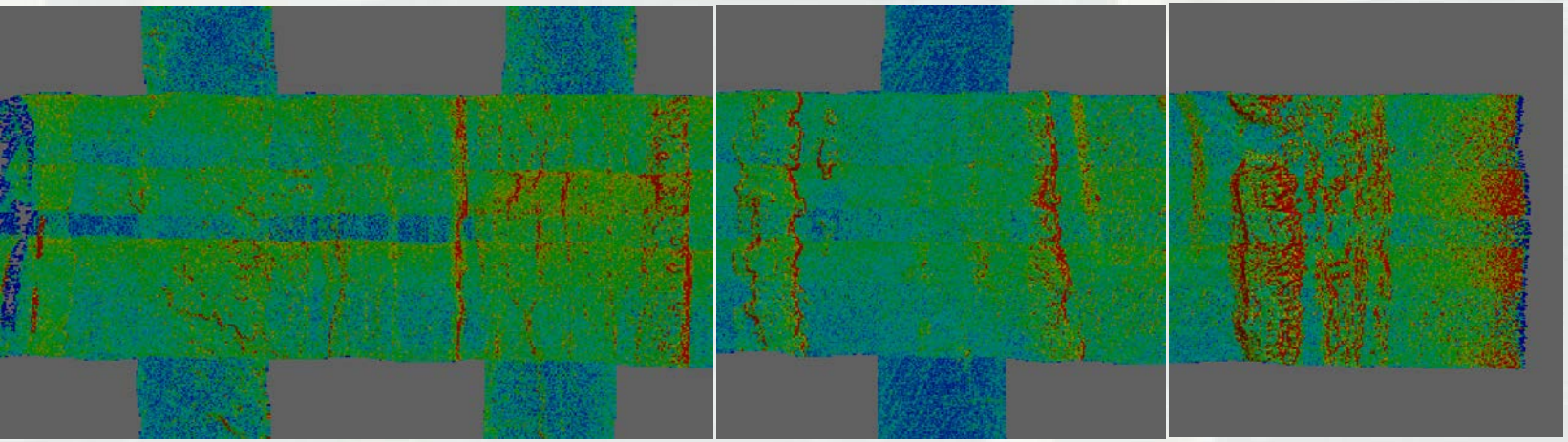
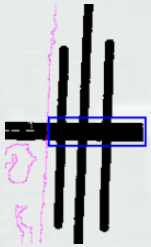
Depth 0-12m 12-20m >20m





0-12m	12-20m	>20m
~12cm	~20cm	~30cm
~ 18cm	~ 28cm	~ 37cm
> 24cm	> 35cm	> 45cm

QL	Swath overlap difference, Max (m),b
$QL0_B$	0.20, 0.0075
$QL1_B$	0.20, 0.0075
$QL2_B$	0.24, 0.0130
$QL3_B$	0.24, 0.0130
$QL4_B$	0.40, 0.0130

Hardware Improvement – Dynamic Range

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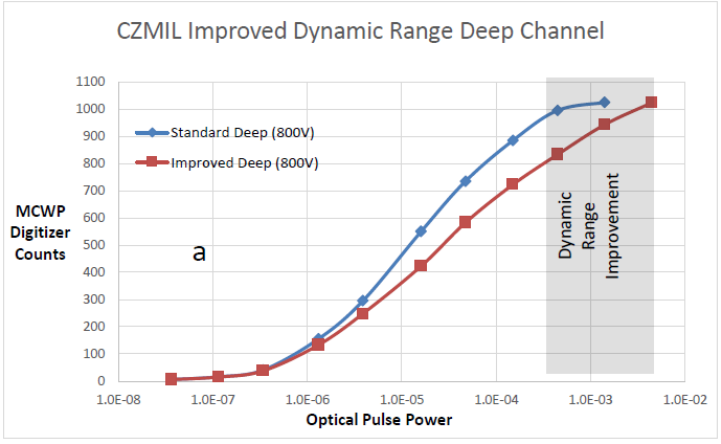

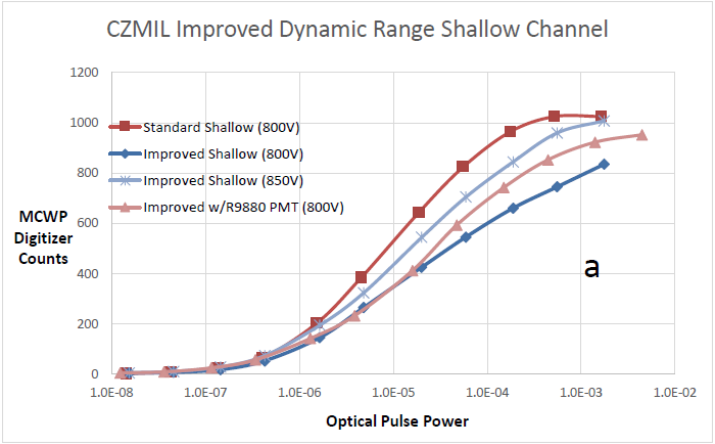

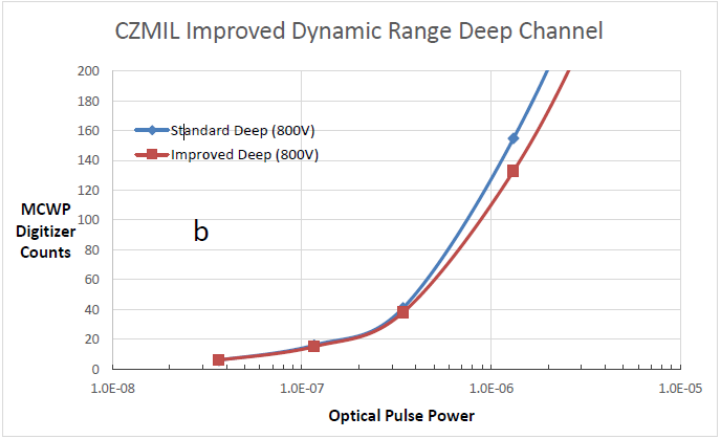

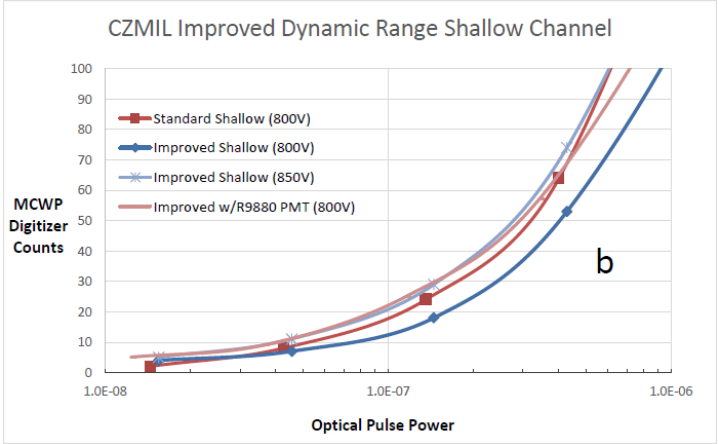

Report concluded that practically 1 extra decade or roughly 10 times more signal can arrive at the PMTs without exceeding the input range of the MCWP optimized circuit.

Hardware Improvement – Dynamic Range

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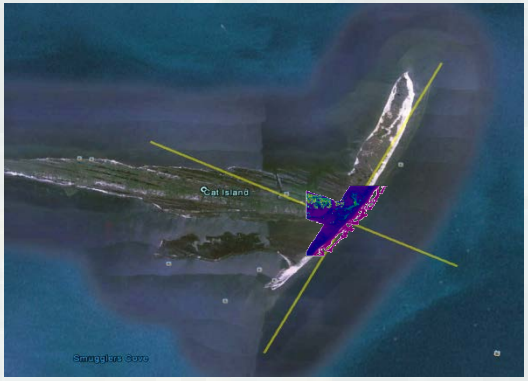
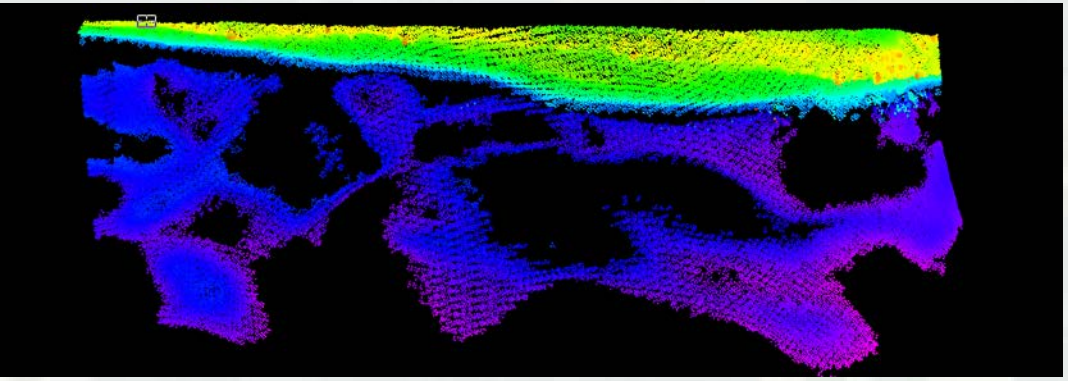
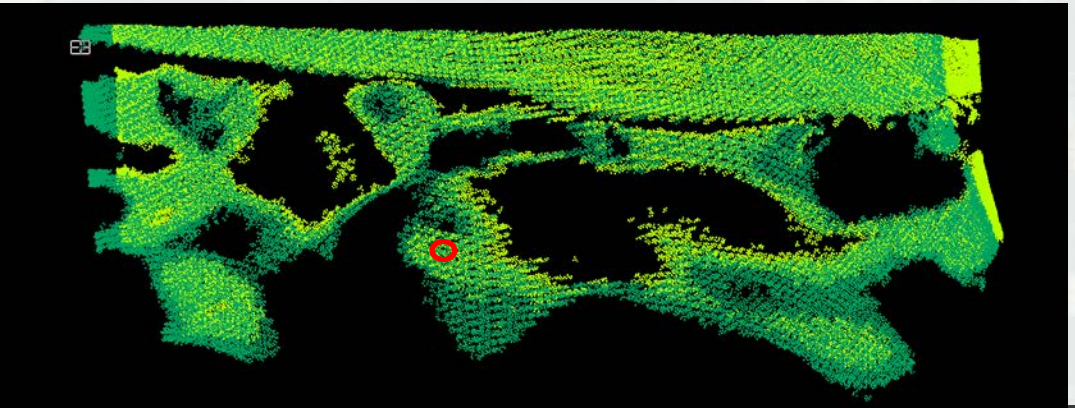
20160505 Cat Island

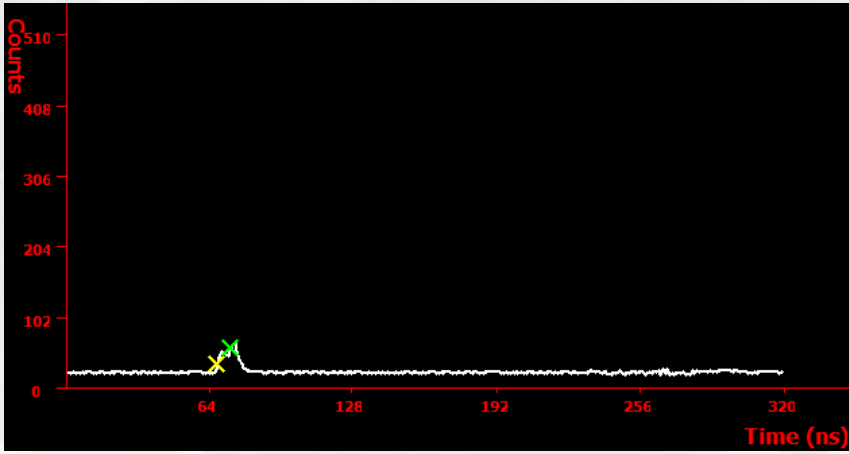
Dynamic Range/voltage settings test flight



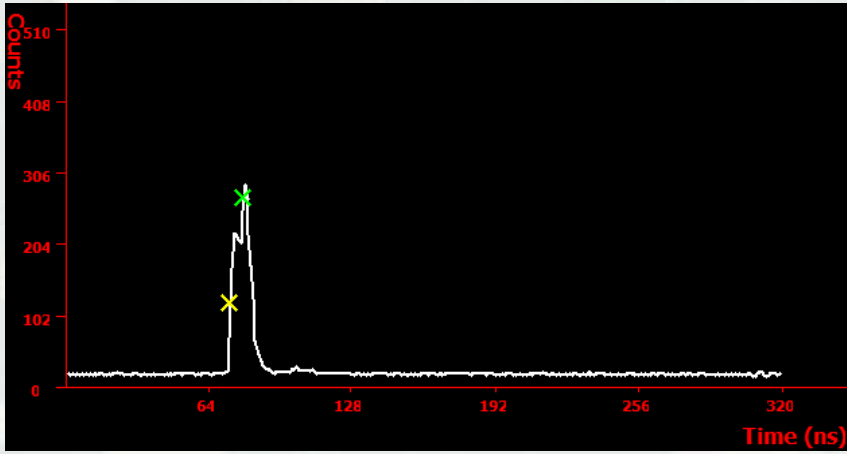




Shallow Channel 4 – original voltage



Shallow Channel 4 – increased voltage



Hardware Improvement – Dynamic Range

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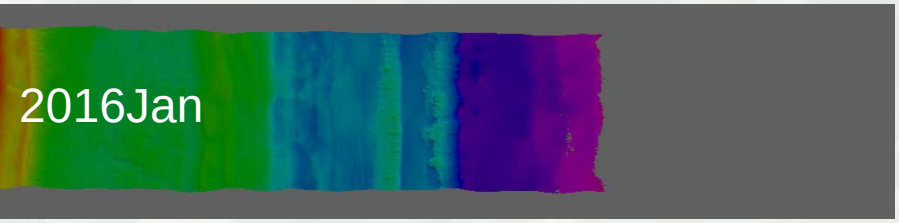
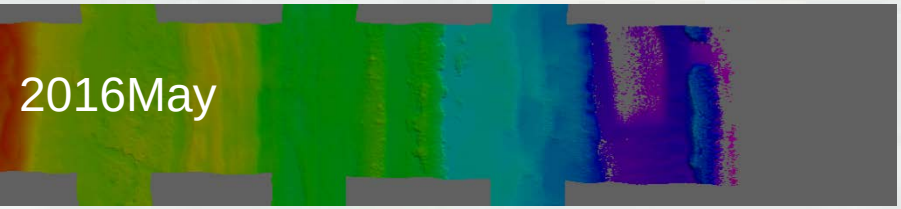
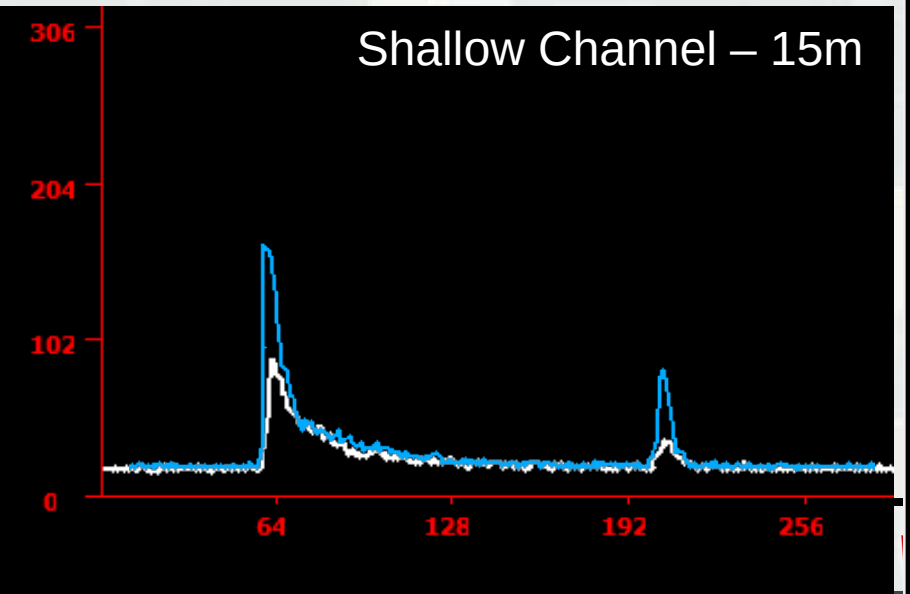
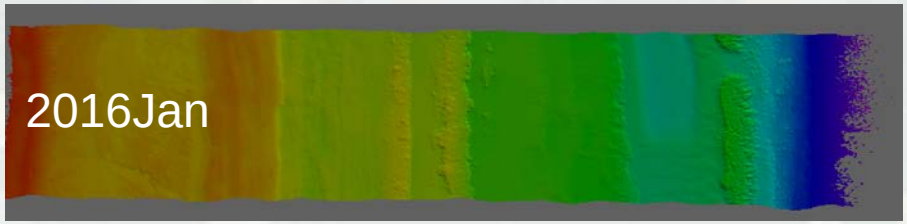
Shallow Channel Coverage

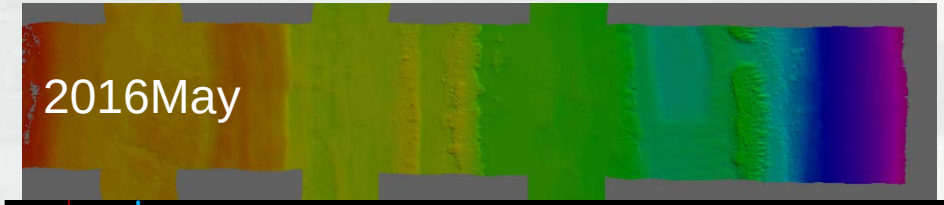


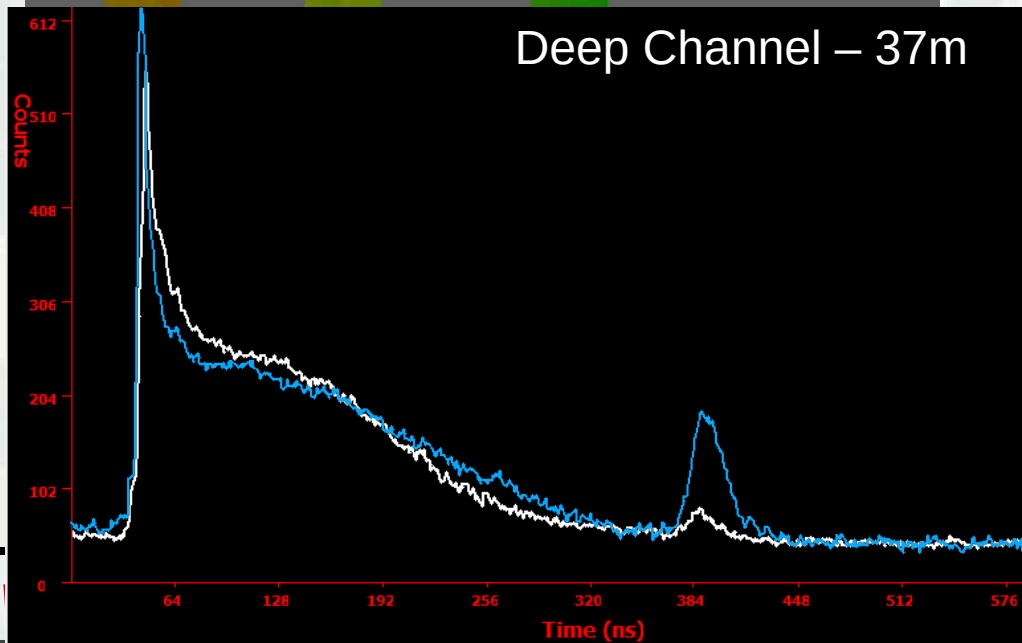




Deep Channel Coverage







Software Improvement – SWA classification logic

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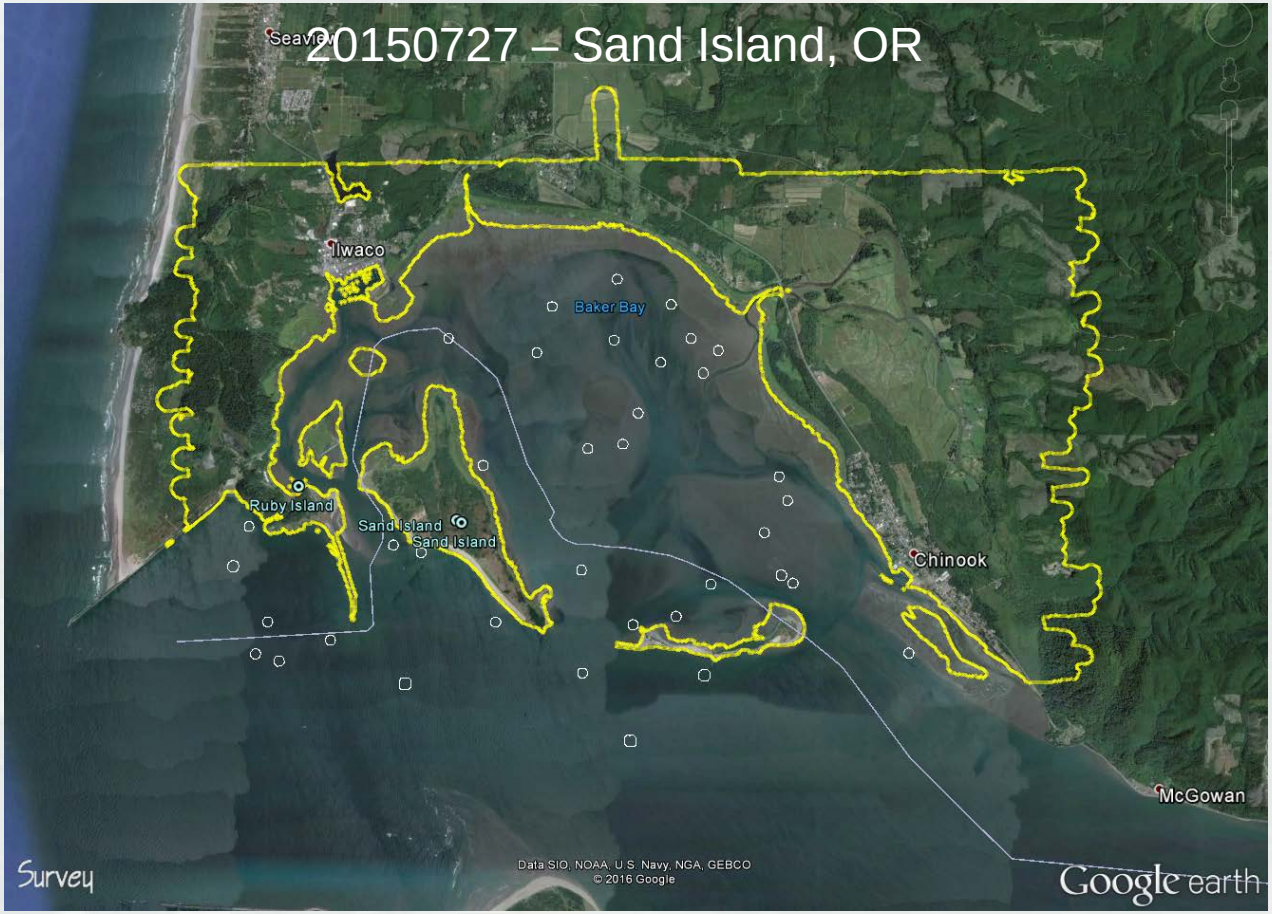
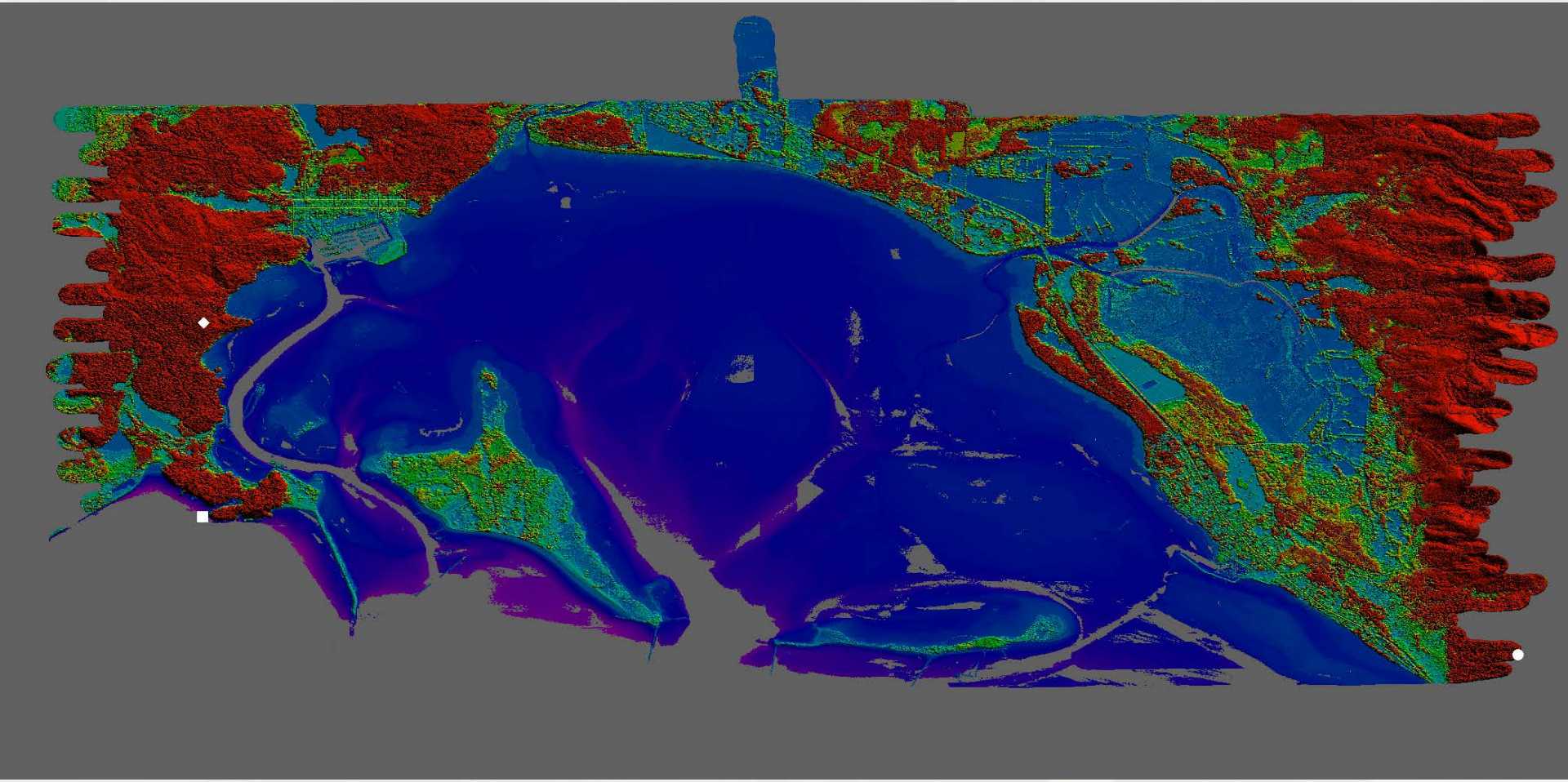
White circles – automated water ROI's for classification statistics
Yellow lines – Land/water boundary for SWA classification support.



Software Improvement – SWA classification logic

BUILDING STRONG

20150727 – Sand Island, OR



LUT – Surface and Propagation Bias

BUILDING STRONG

20160113 - 20160429	C0(b)	C1(m)
Shallow channel LUT	-0.080	0.9949
Deep channel LUT	-0.365	1.0032

20150912 - 20151231		
Shallow channel LUT	-0.107	0.9962
Deep channel LUT	-0.380	1.0065

20150708 - 20150910		
Shallow channel LUT	-0.100	0.9920
Deep channel LUT	-0.355	1.0035

20150513 - 20150707		
Shallow channel LUT	-0.080	0.9920
Deep channel LUT	-0.375	1.0045

current		
Shallow channel LUT	-0.070	0.9922
Deep channel LUT	-0.390	1.0040

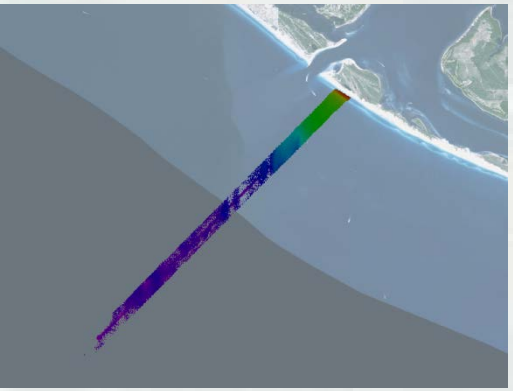
average	C0(b)	C1(m)
Shallow channel LUT	-0.087	0.9935
Deep channel LUT	-0.373	1.0043

devation		
Shallow channel LUT	0.015	0.0020
Deep channel LUT	0.014	0.0013

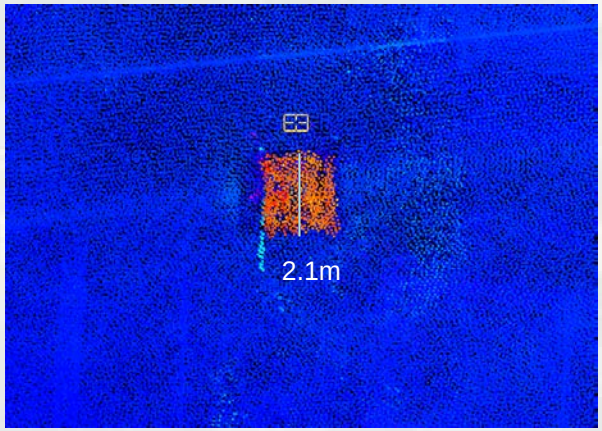
Feature Resolution

Oct 2015 – Panama City NAVO Target Test

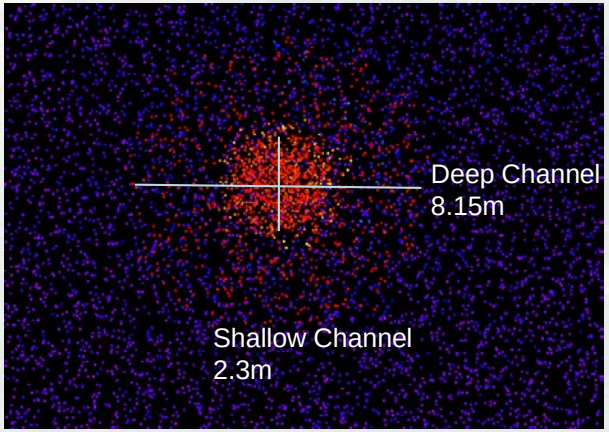
BUILDING STRONG

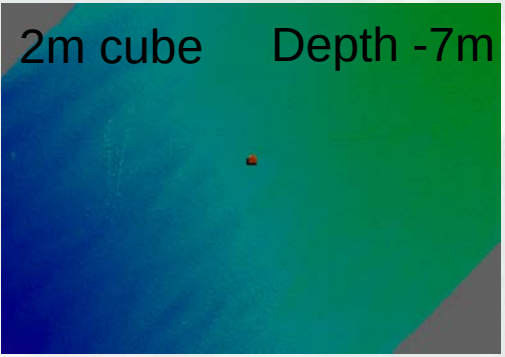


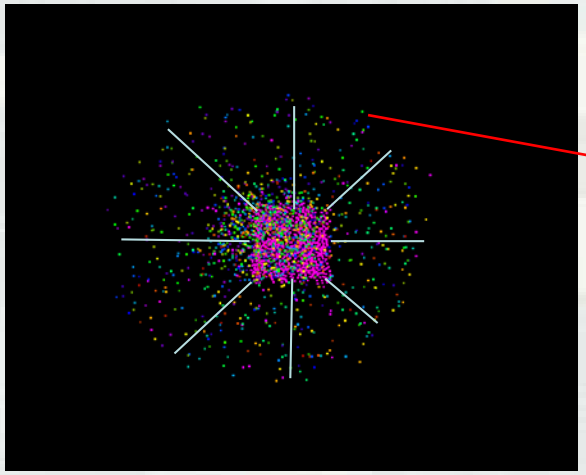
MBES

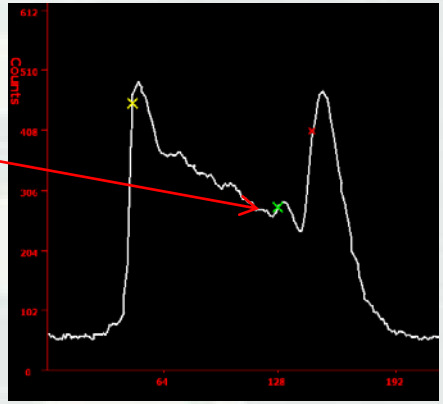


CZMIL









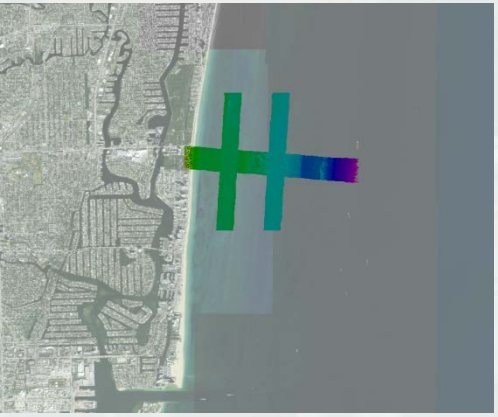
n	20
RMSD	3.335106
min	2.03
max	4.17
average	3.2965
std dev	0.519132

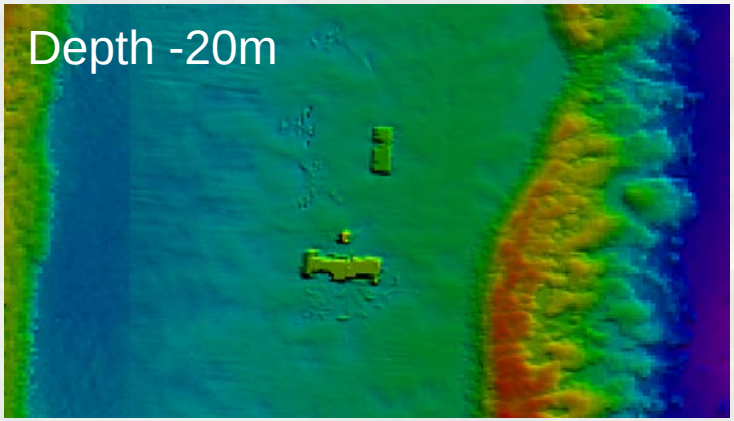
~60cm between center of cubes

Feature Resolution

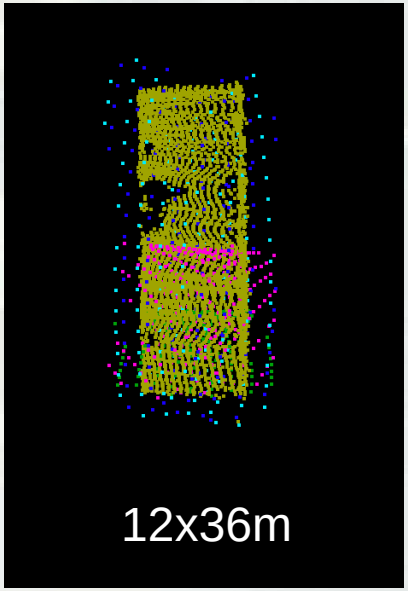
May 2016– Fort Lauderdale

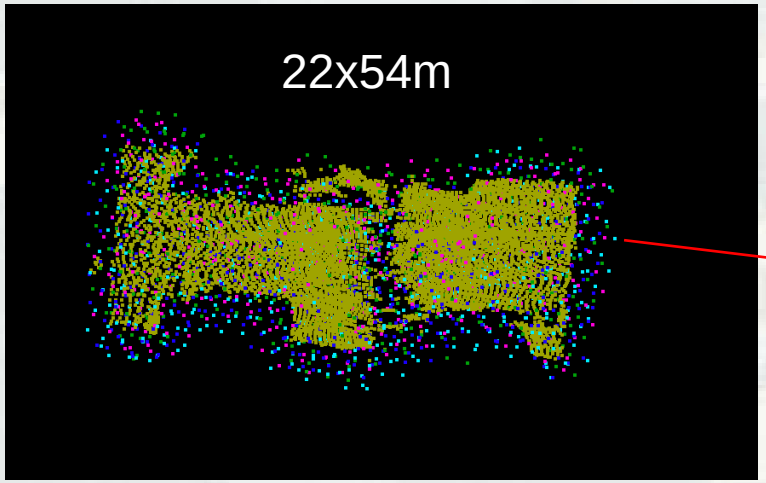
BUILDING STRONG

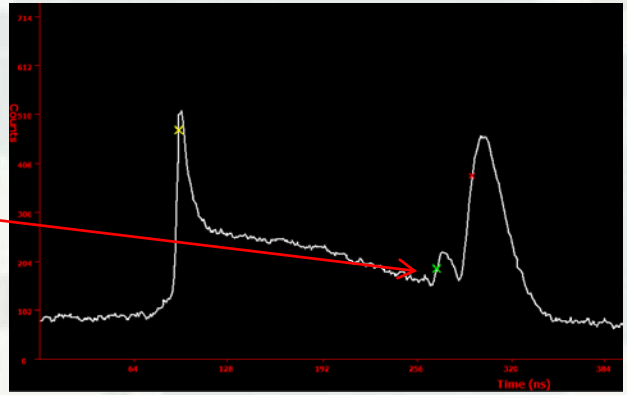




n	20
RMSD	3.124944
min	2.13
max	4.24
average	3.0775
std cev	0.556558







Bathy Comparison Considerations

- Understanding of systems, calibrations and processing methods
  - MBES or Bathy lidar systems varying in information acquired and how that information becomes a point on the seafloor.
  - Accuracy Specification data was acquired to meet.

- Management of the water surface
  - Tide application/reduction method/draft
  - Surface detection and logic

- Navigation/GPS uncertainty

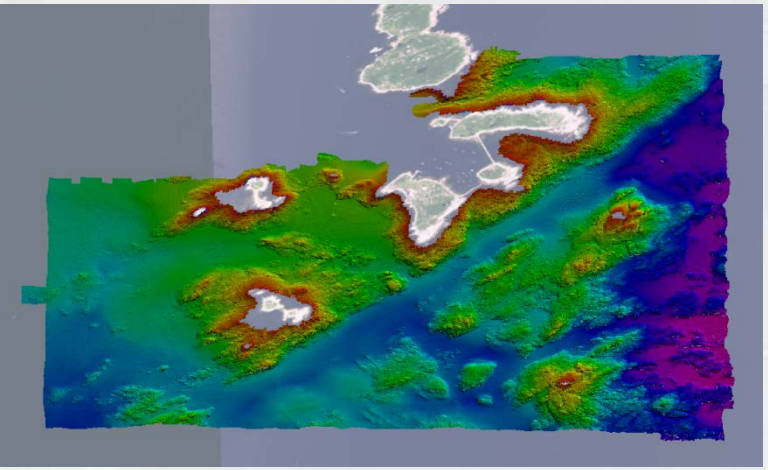
- Attitude correction methods

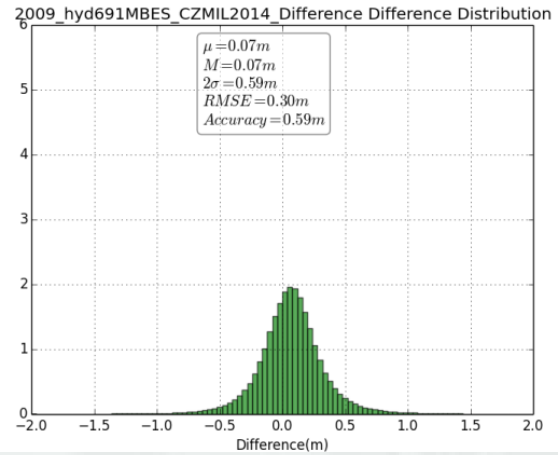
- Environmental/depth bias management

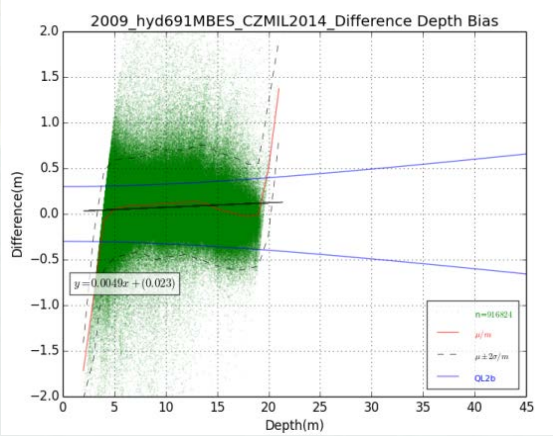
- DEM/surface methods

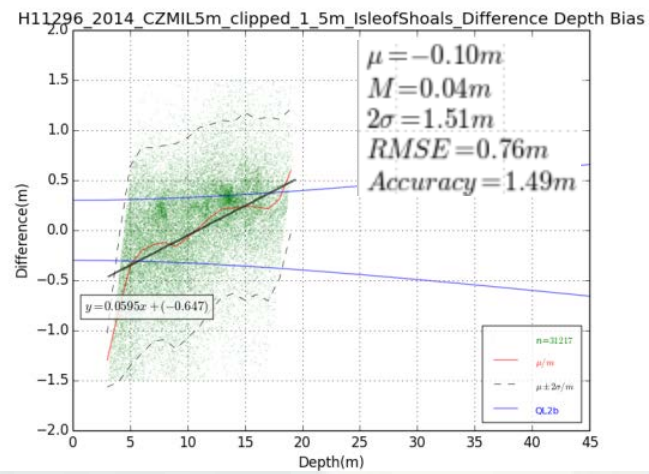
Bathy Comparison Considerations

BUILDING STRONG







All GSF Files(6days)
RMSE = 0.146m
Mean Diff = -0.069m
Range = -0.32,0.158

Excluding 20090616/20190620
RMSE = 0.077m
Mean Diff = 0.011m
Range = -0.114,0.158