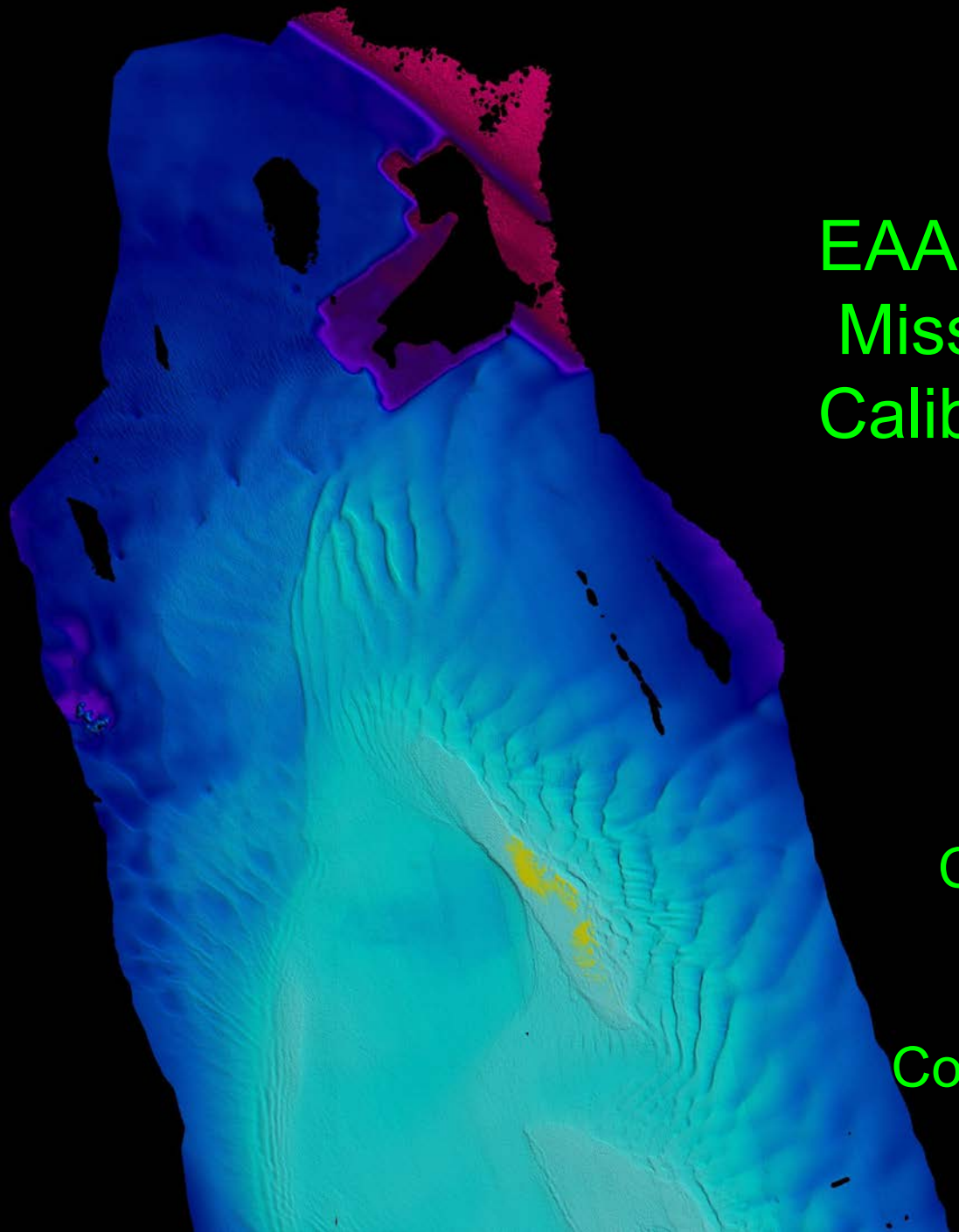


EAARL-B: Missions, Calibration & Validation

June 11, 2014

Charles Wayne Wright

USGS
Coastal & Marine Geology

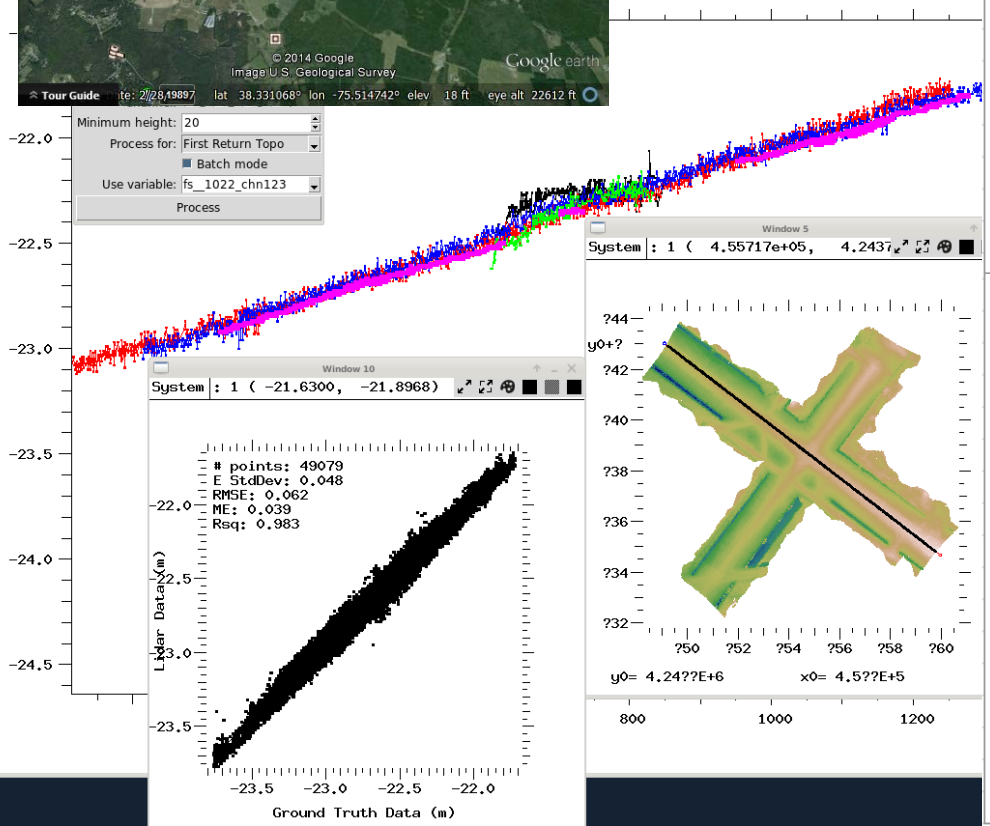
EAARL-B Revised Specs

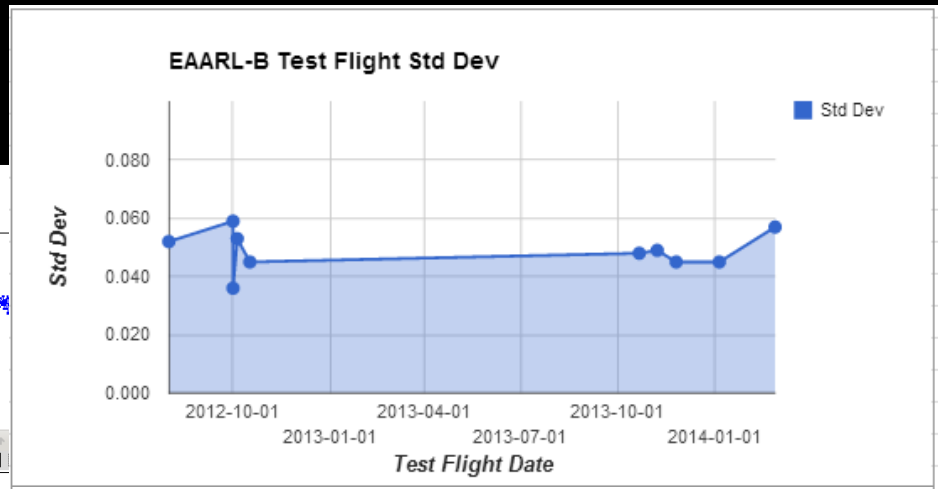
- 0 to 45m Operational depth range
- Nominal operating altitude 300-600m
- Topography & Submerged Topography
- Green only, 532nm
- 900 ps pulse width
- 4 wide dynamic range PMT receivers, waveform channels.
- One deep channel receiver
- Three small FOV receivers
- 50 deg raster scan
- 15 cm receiver telescope aperture

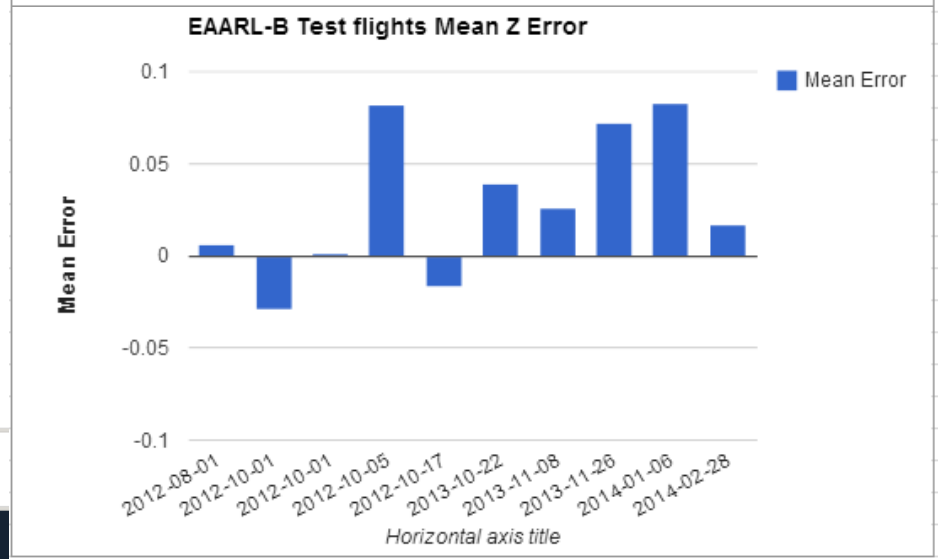
EAARL-B Calibration & Validation Sites

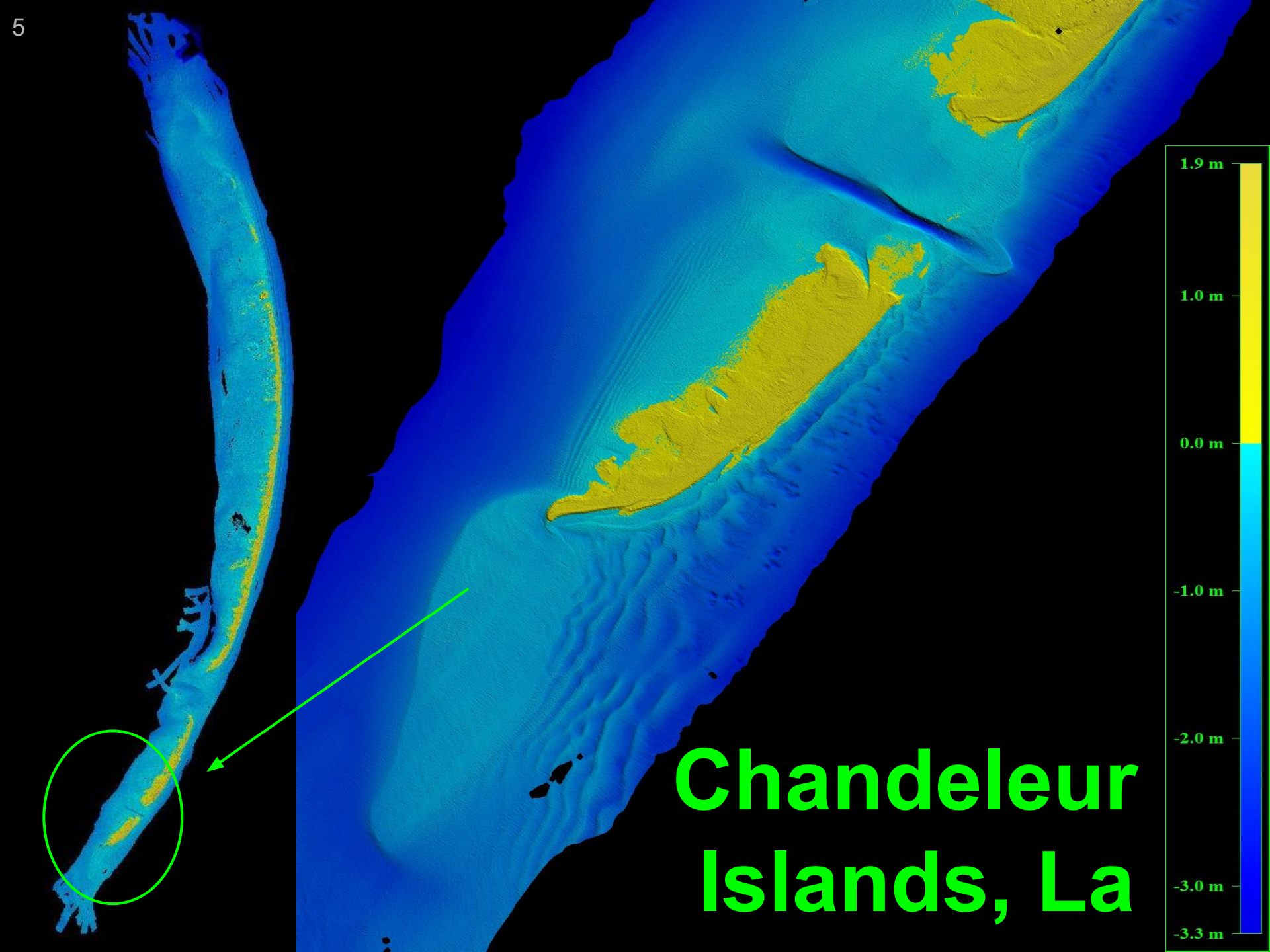
- KSBY Runway ground cal
- Chandeleur, La. (0-9.5m)
- St. Croix, USVI, Lang Bank, (10-42m),NOAA 400 kHz Multibeam SONAR
- Ft. Lauderdale, U.S. A. COE SHOALS-3000 Reference dataset (7-37m),
- Ft. Lauderdale USGS SBS (1-33m)
- Delaware River, PA, NJ, NY (0-10m)
- Lemhi River, Idaho (0-2m)
- Cape Canaveral, Fla.
- USGS Jet Ski SBS (.5-7m)
- Anna Maria Island, Fla., (1-10m), USGS Jet Ski SBS (.5-10m)
- Delmarva coastline

KSBY Runway Ground Cal



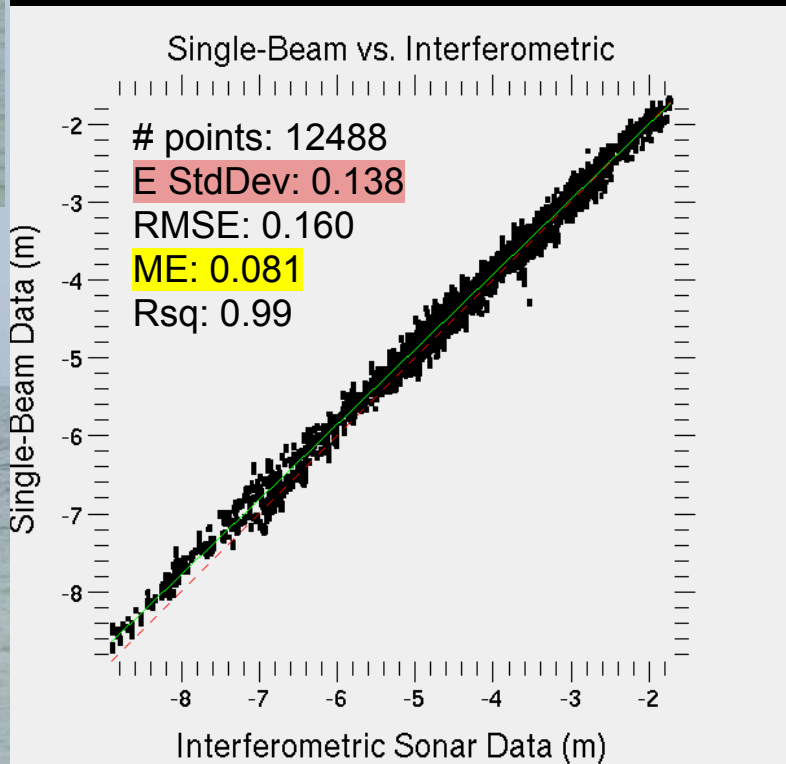




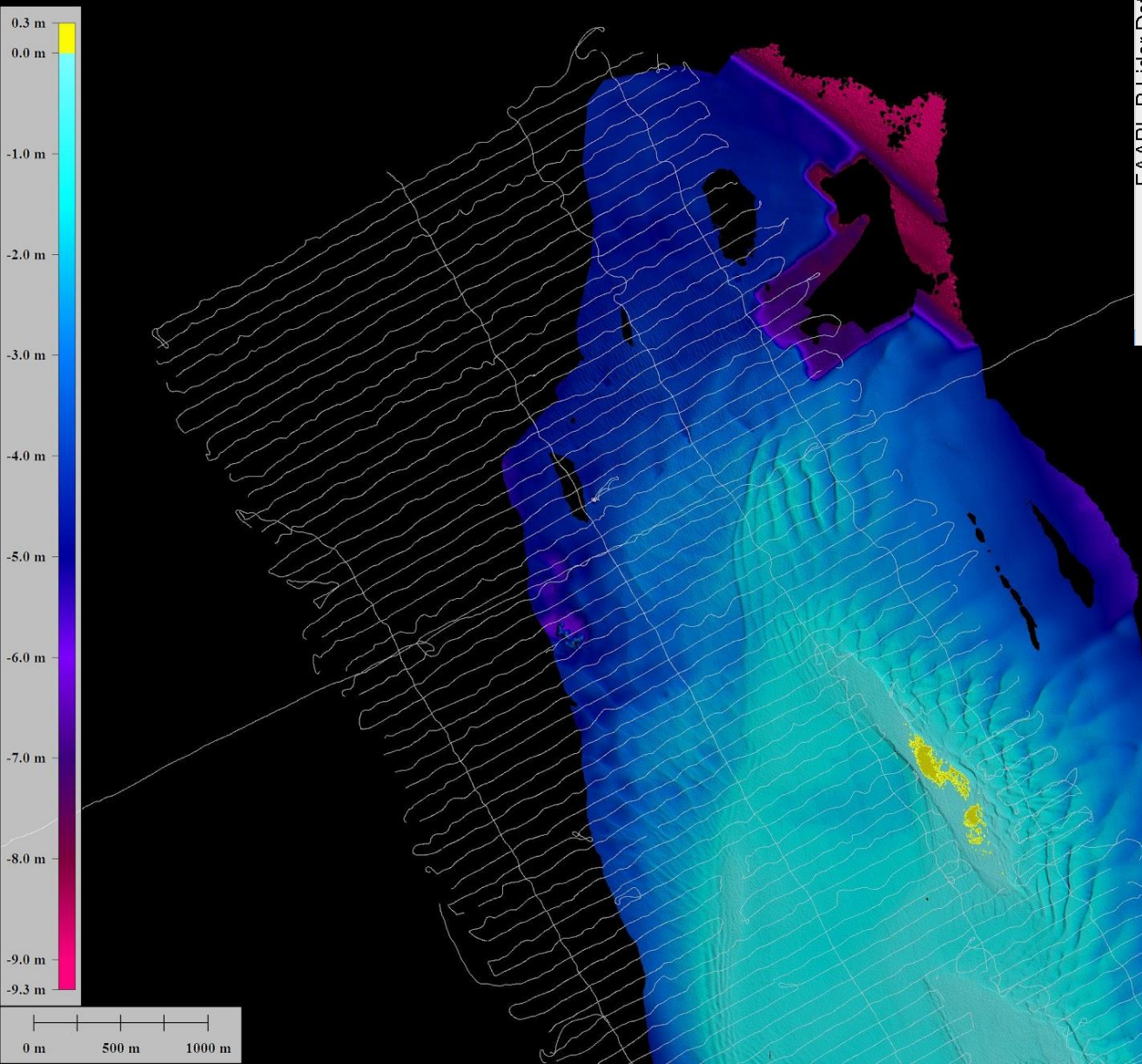

1.9 m
1.0 m
0.0 m
-1.0 m
-2.0 m
-3.0 m
-3.3 m
Chandeleur Islands, La

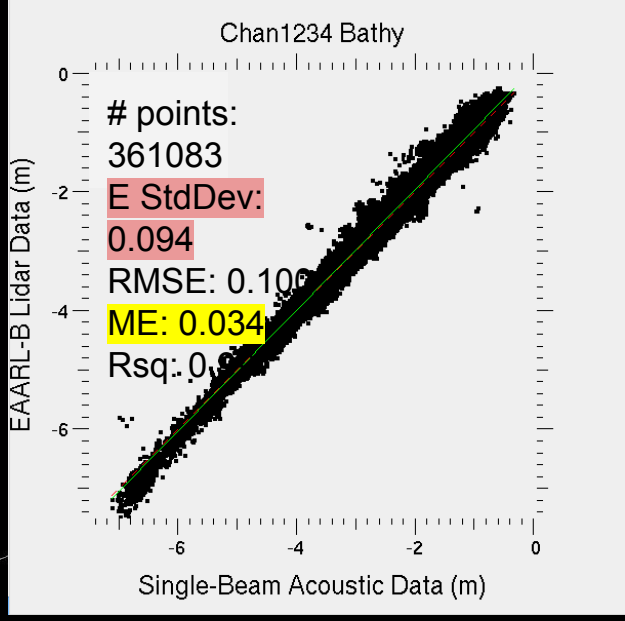
Sonar vs Sonar

Photo Credit: Dave Thompson, USGS

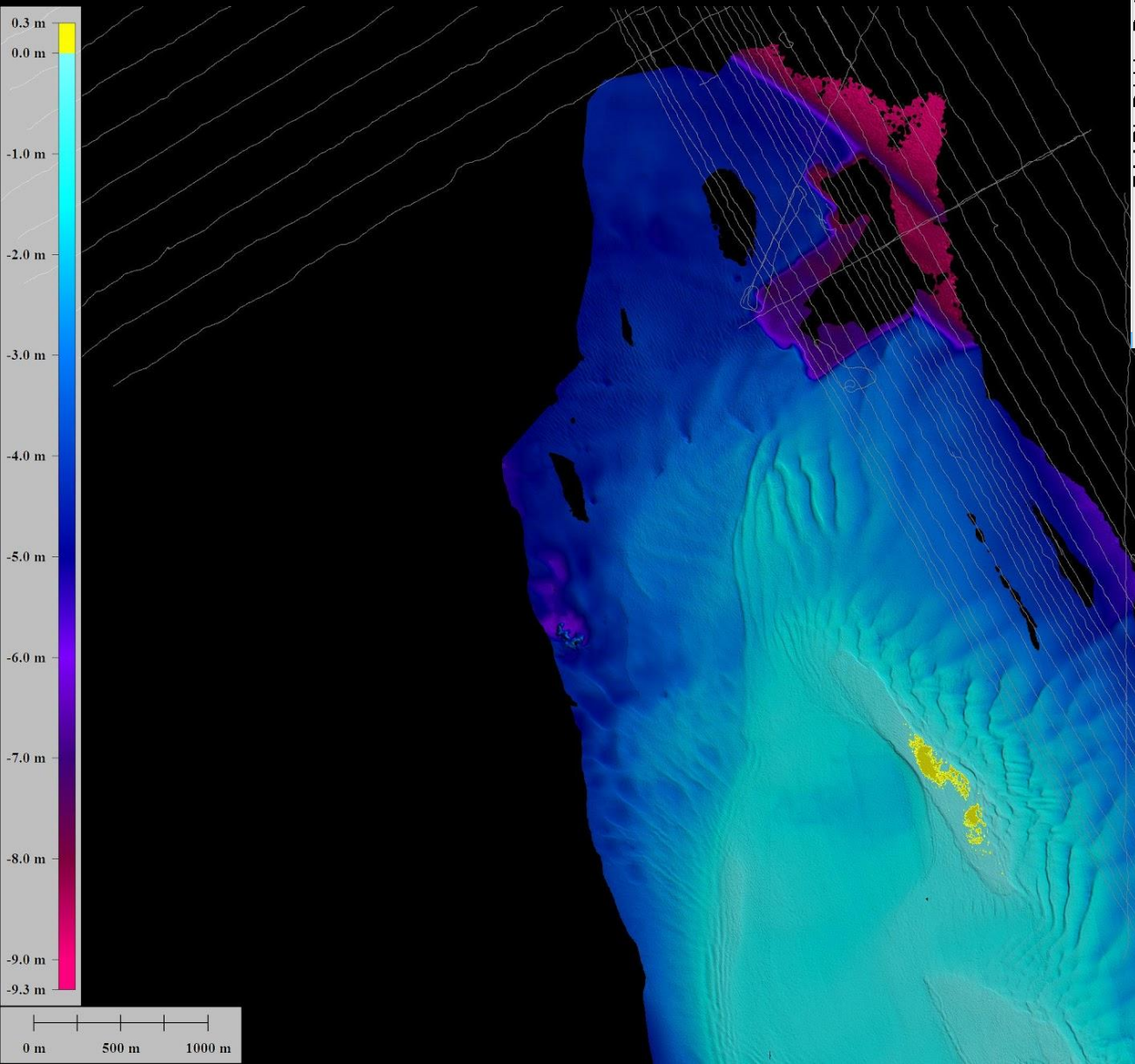


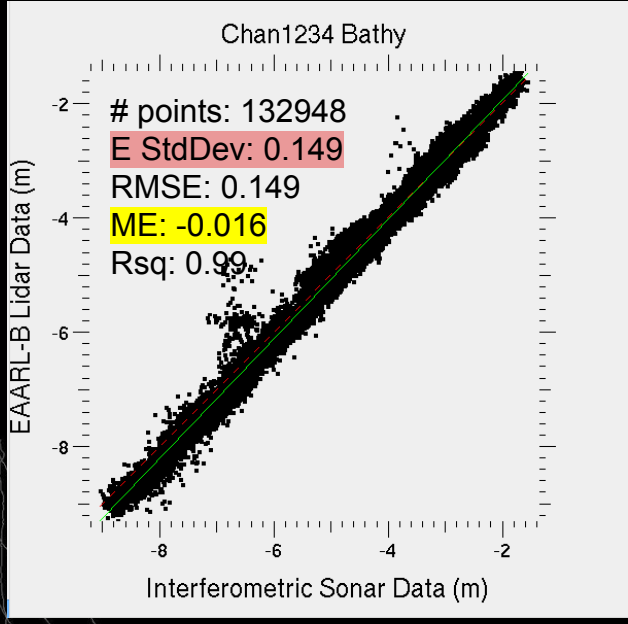
Chandeleur Island, EAARL-B vs Single-Beam SONAR





Chandeleur Island, EAARL-B LiDAR vs Interferometric SONAR

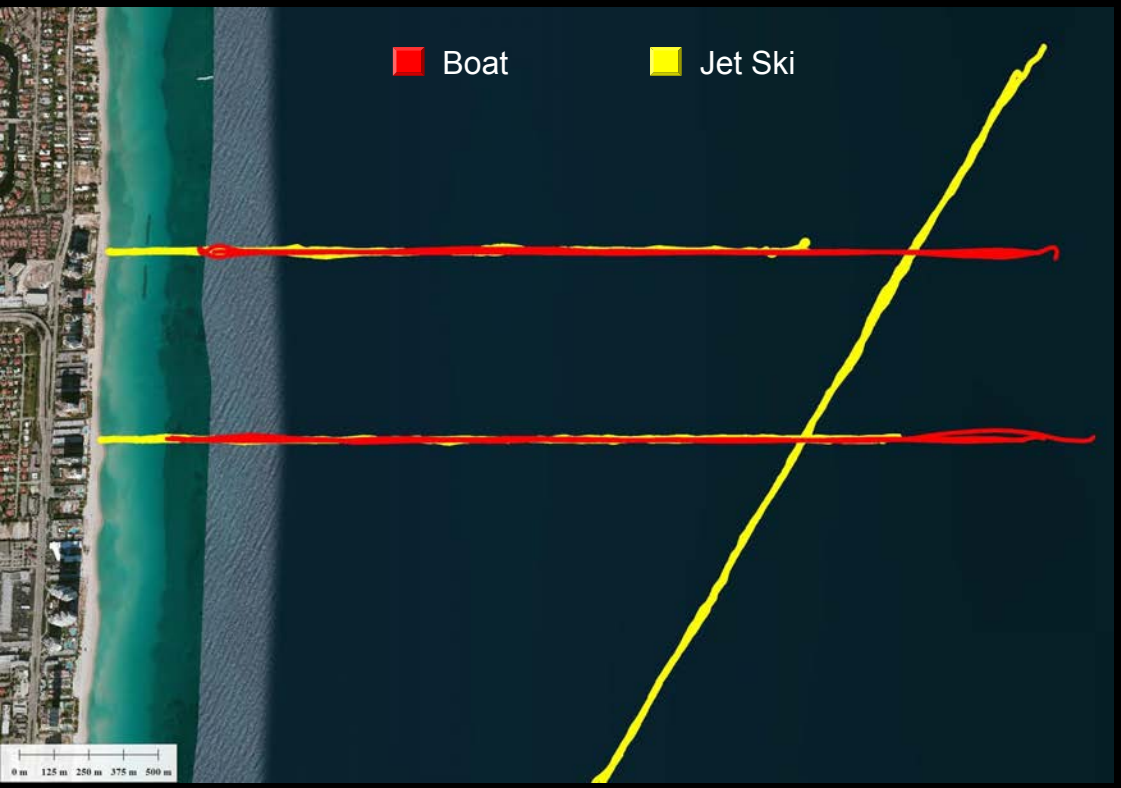


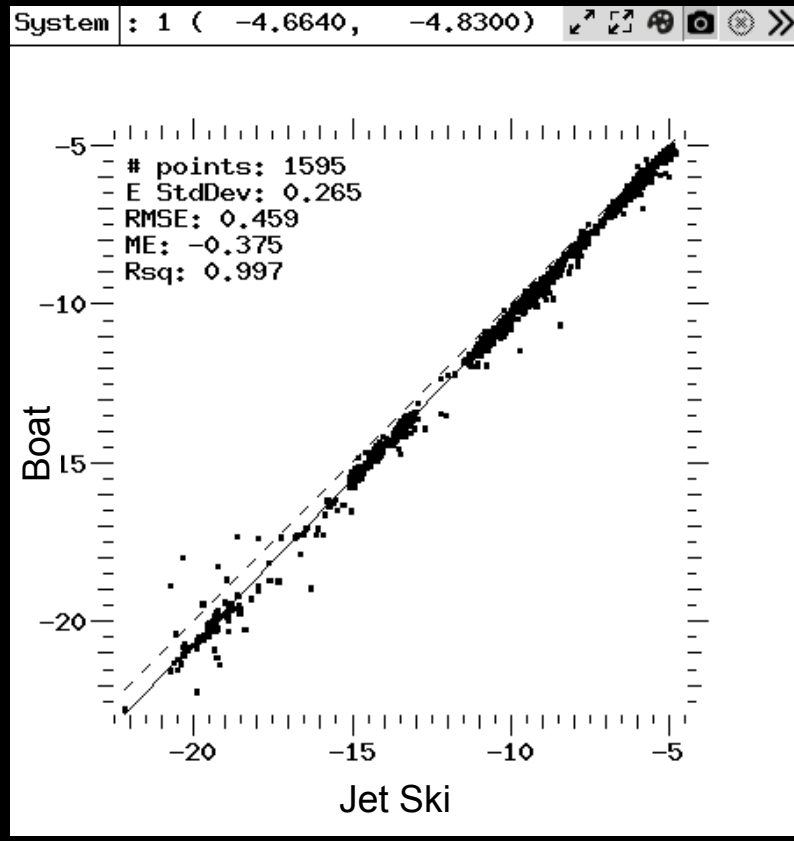


Ft. Lauderdale, Fla JALBTCX Test Site

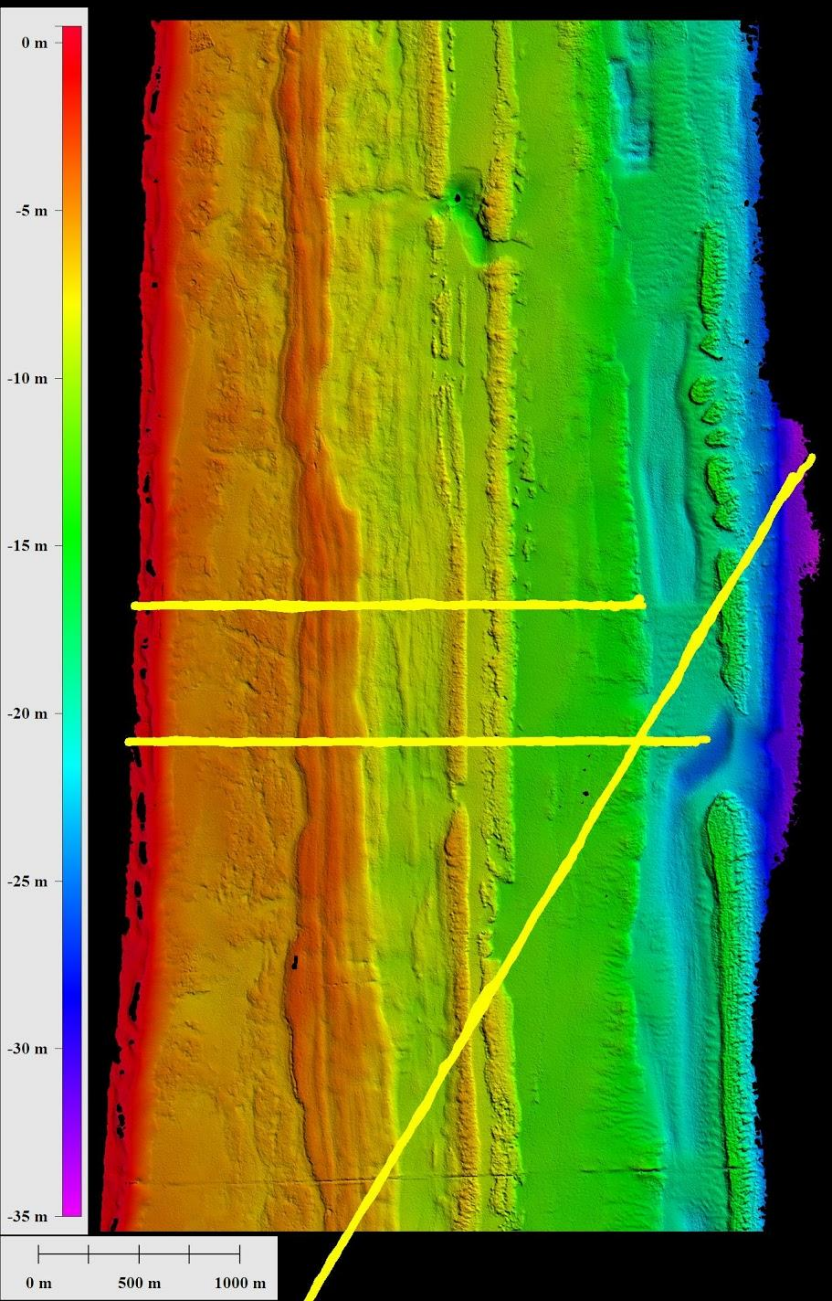
- JALBTCX 2005 SHOALS-3000 Reference Data set
- Depart and recover from KSPG, St. Petersburg, Fla
- Flown April 21 & 22, 2014
- FAA CORS ZMA1 reference station
- Processed and compared data in NAD83
  - EAARL-B vs JALBTCX Reference
  - EAARL-B vs Single-Beam Jet Ski
  - Jet Ski SBS vs Boat SBS
- All GPS data post-processed with precision data

FLL: Boat vs Jet ski

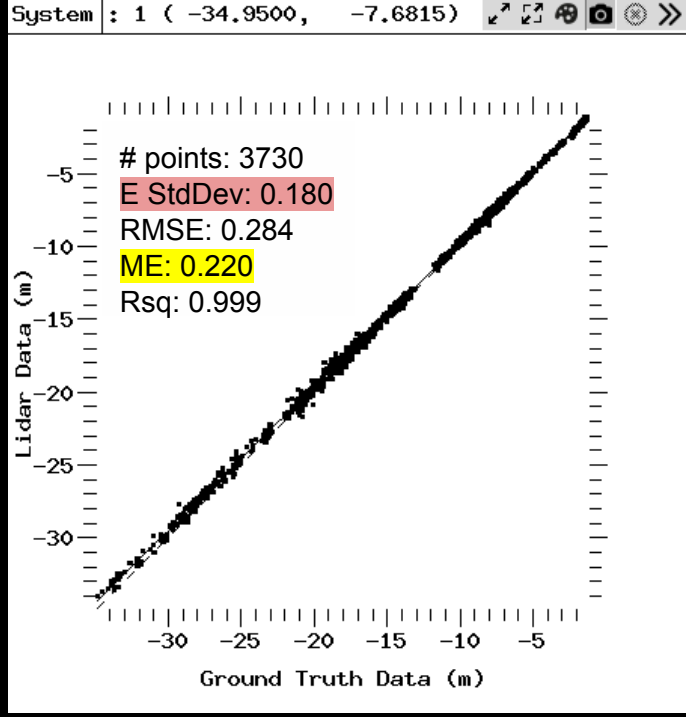




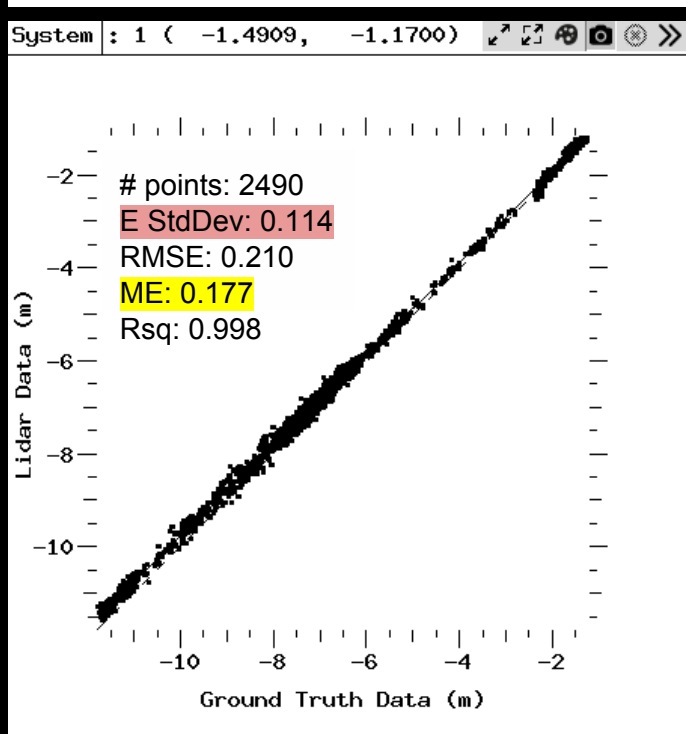
FLL: EAARL-B vs SBS



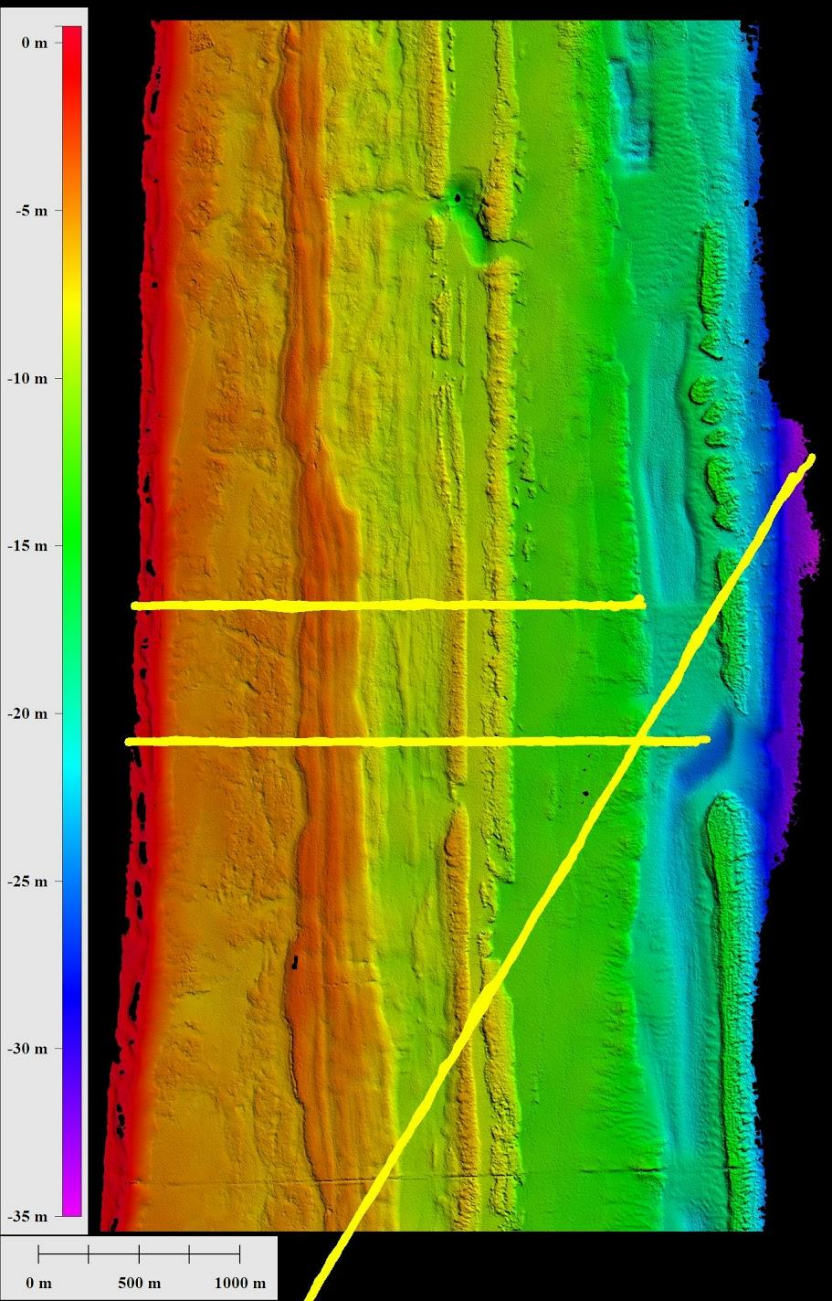
1-35m



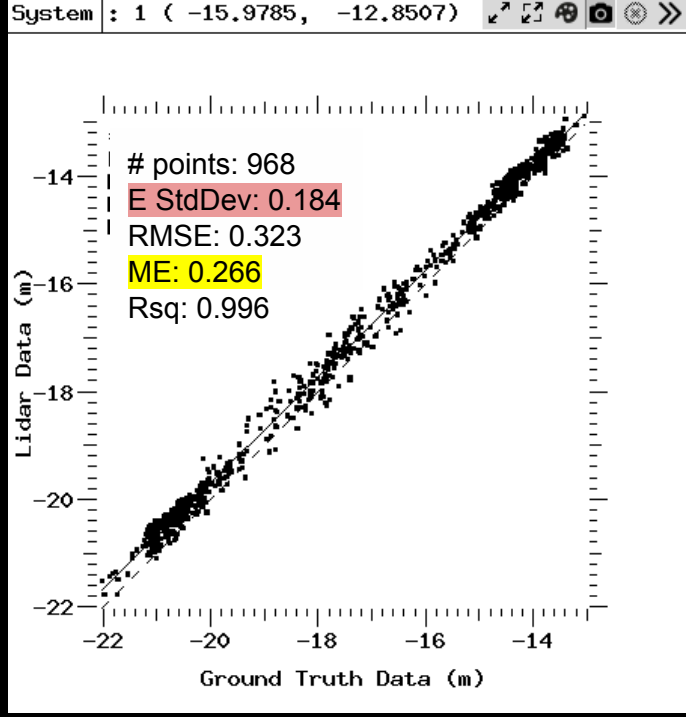
1-12m



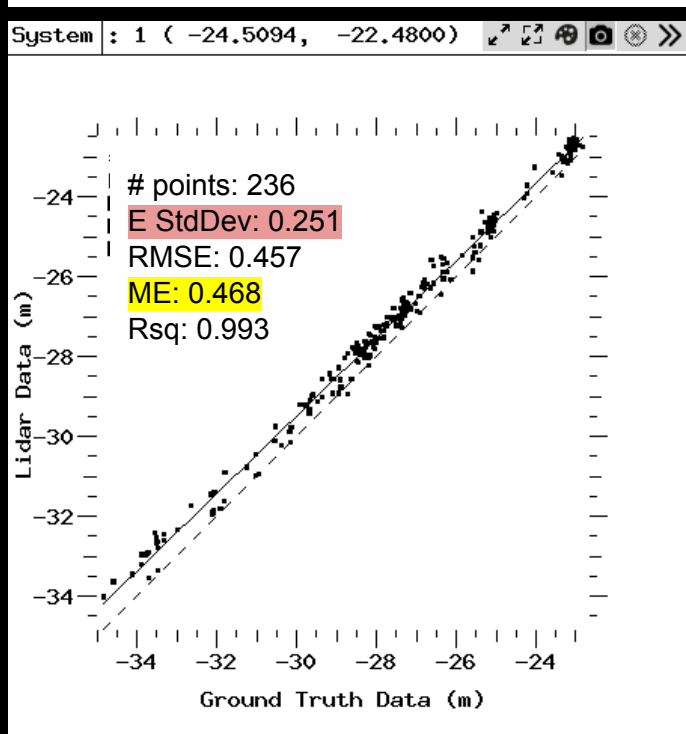
FLL: EAARL-B vs SBS



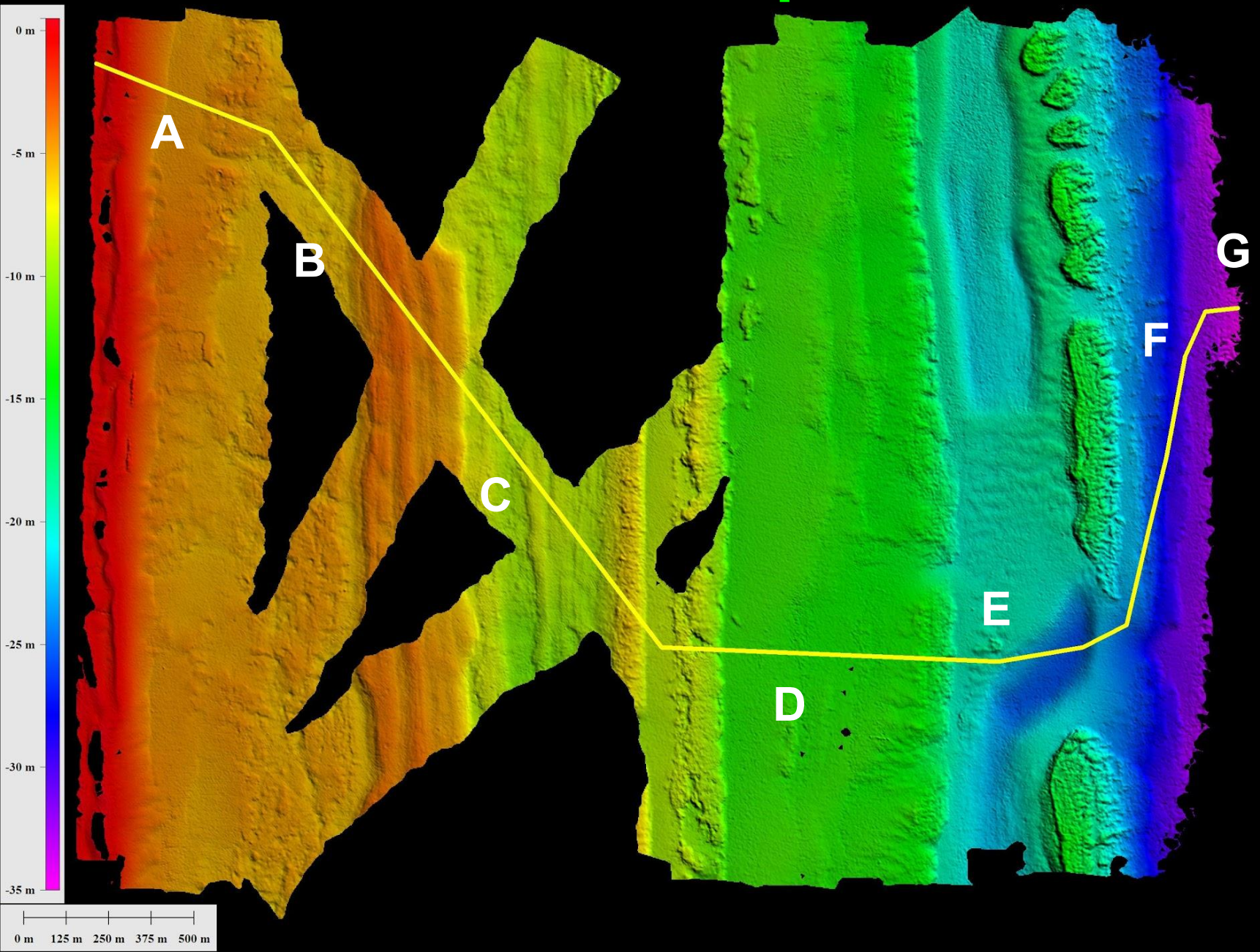
15-22m



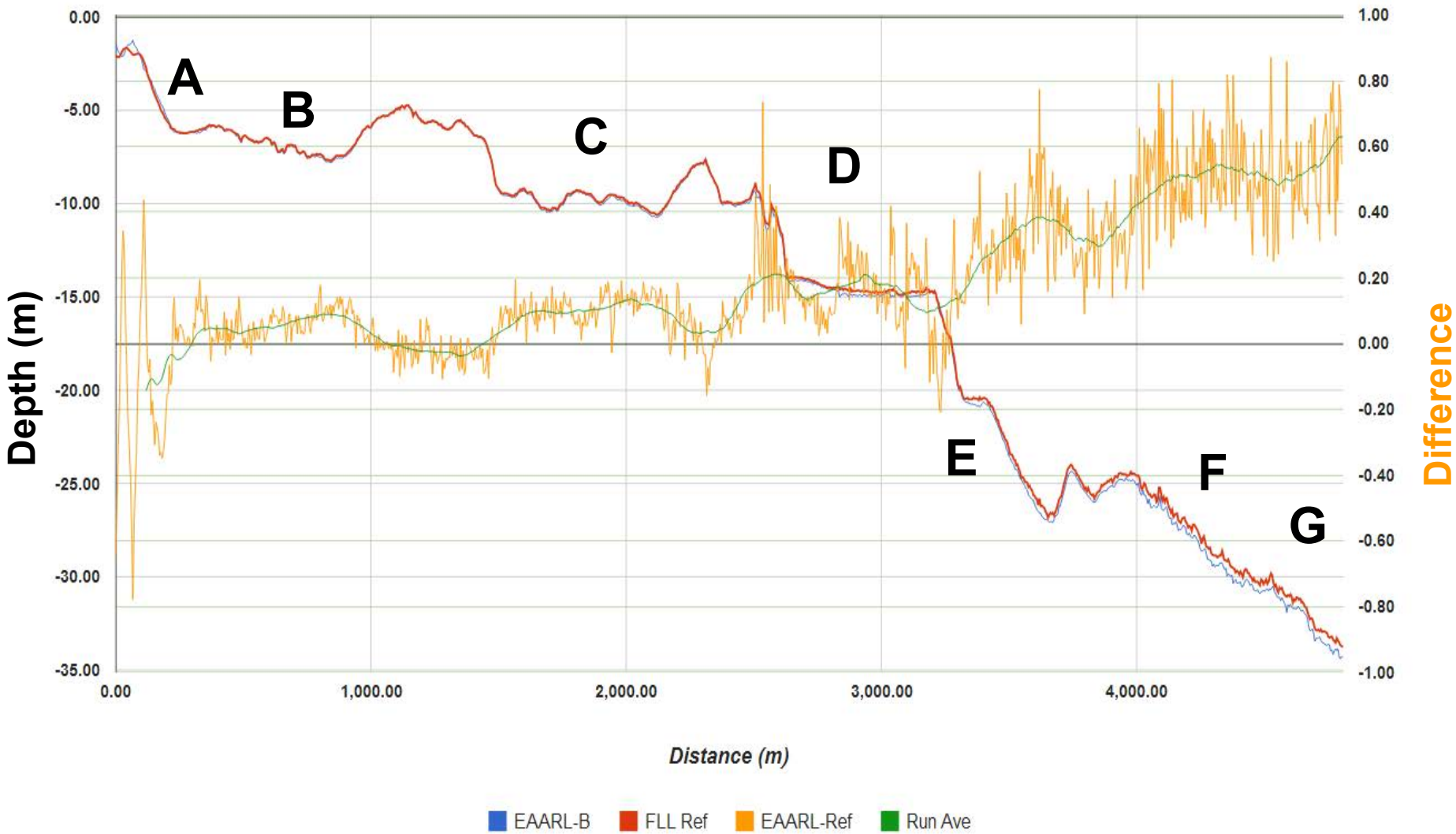
22-35m

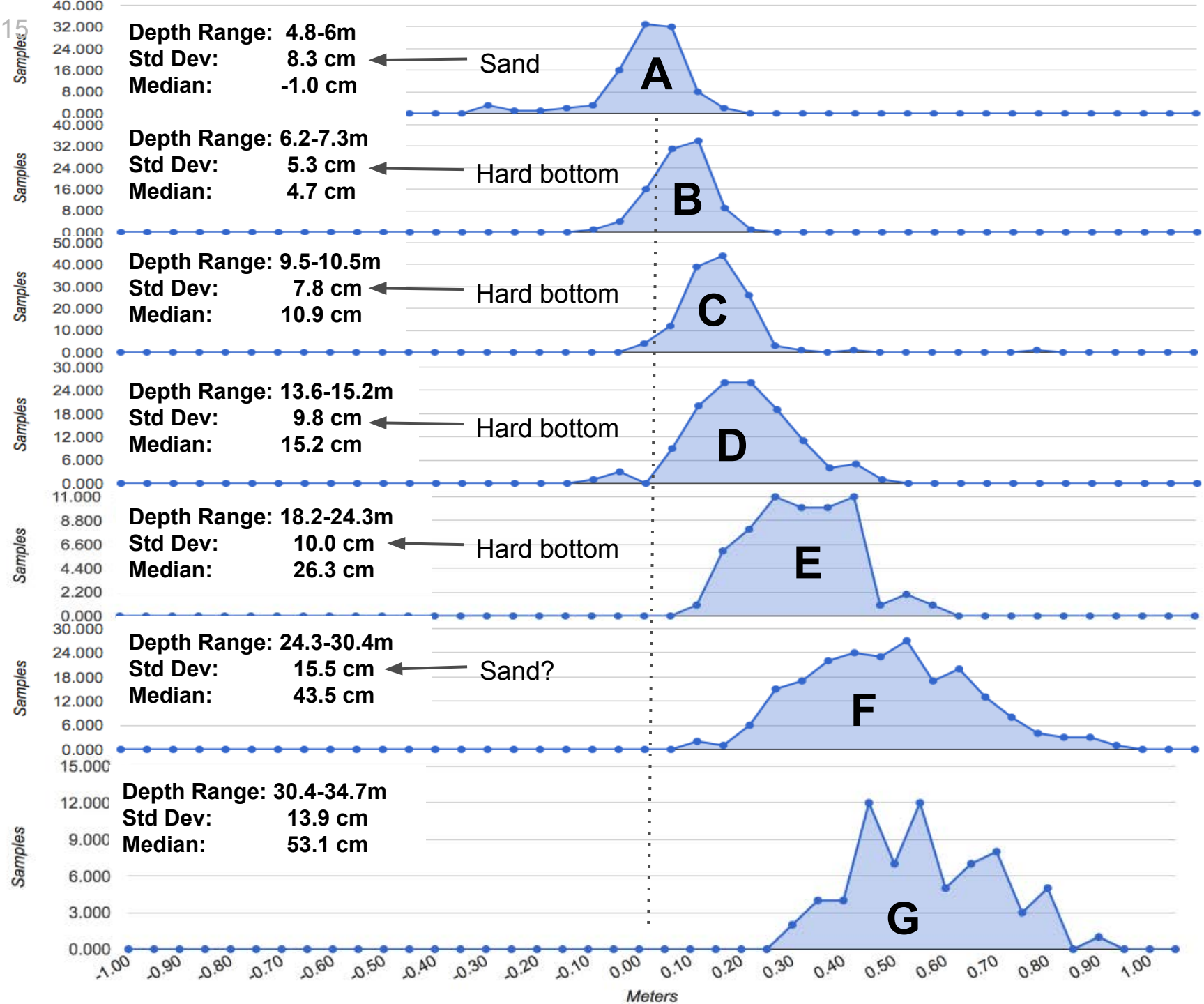


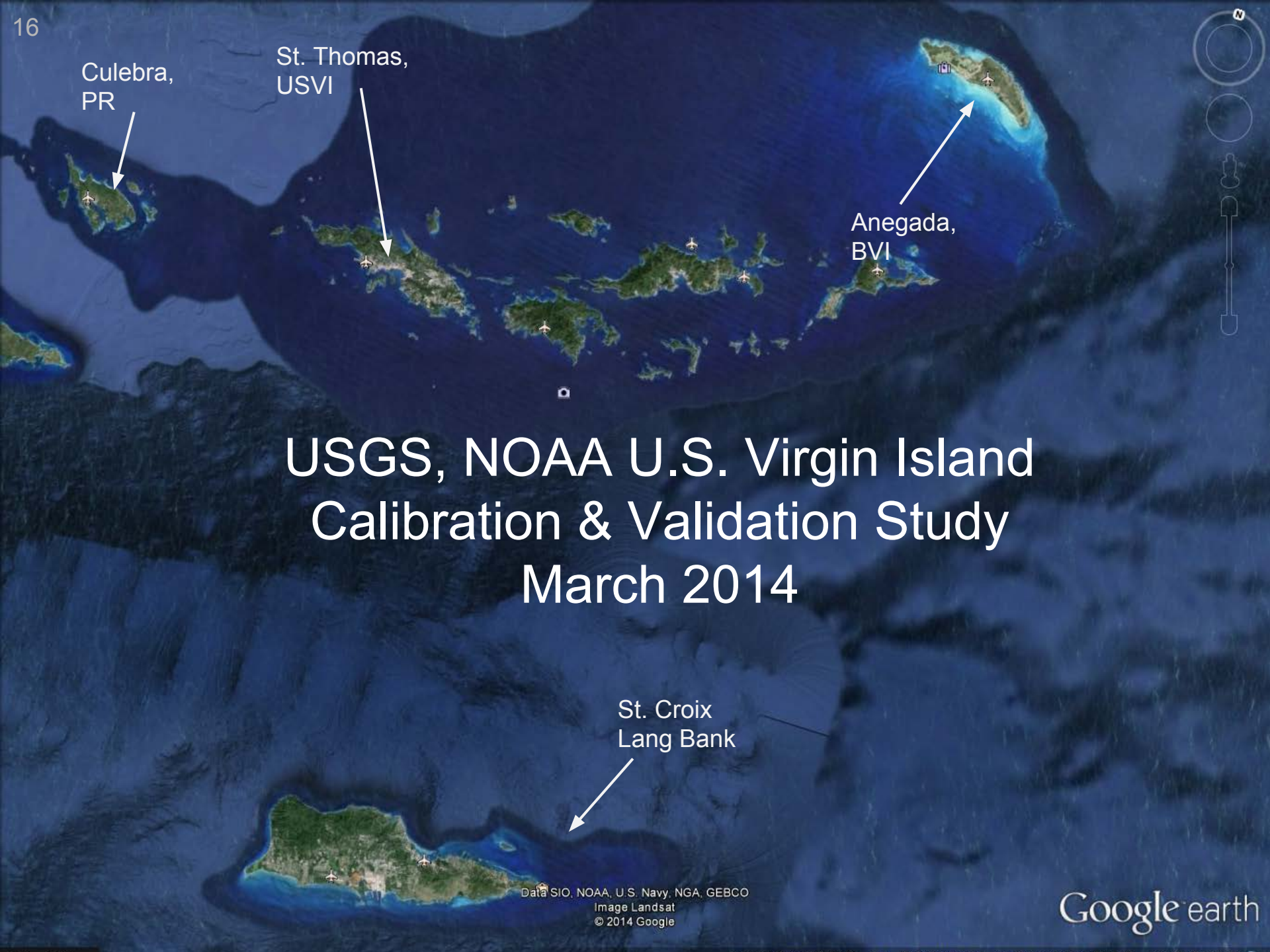
FLL: EAARL-B April 21, 2014



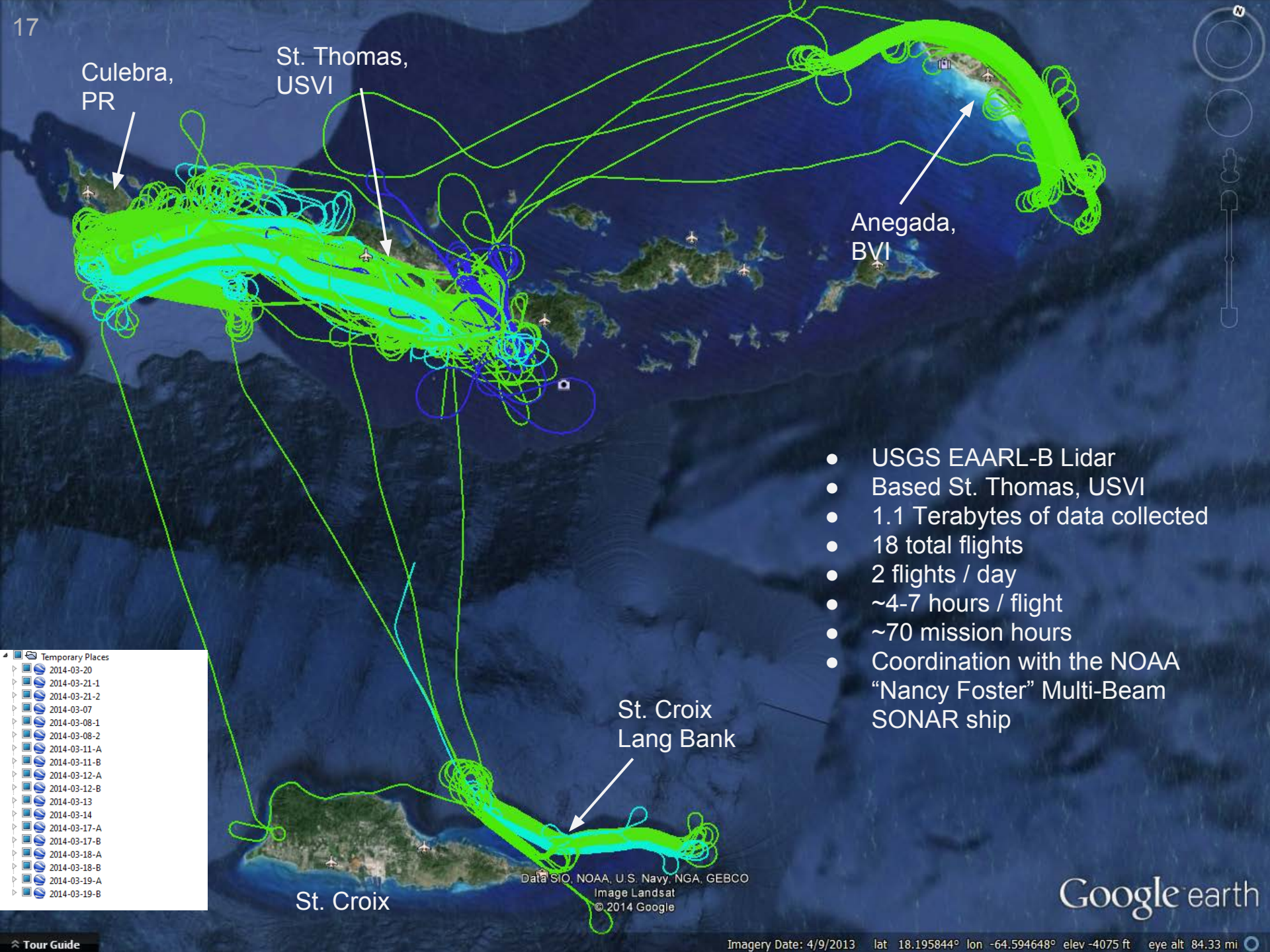
Ft. Lauderdale, Fla
EAARL-B 2014 vs JALBTCX 2005 Ref. Data



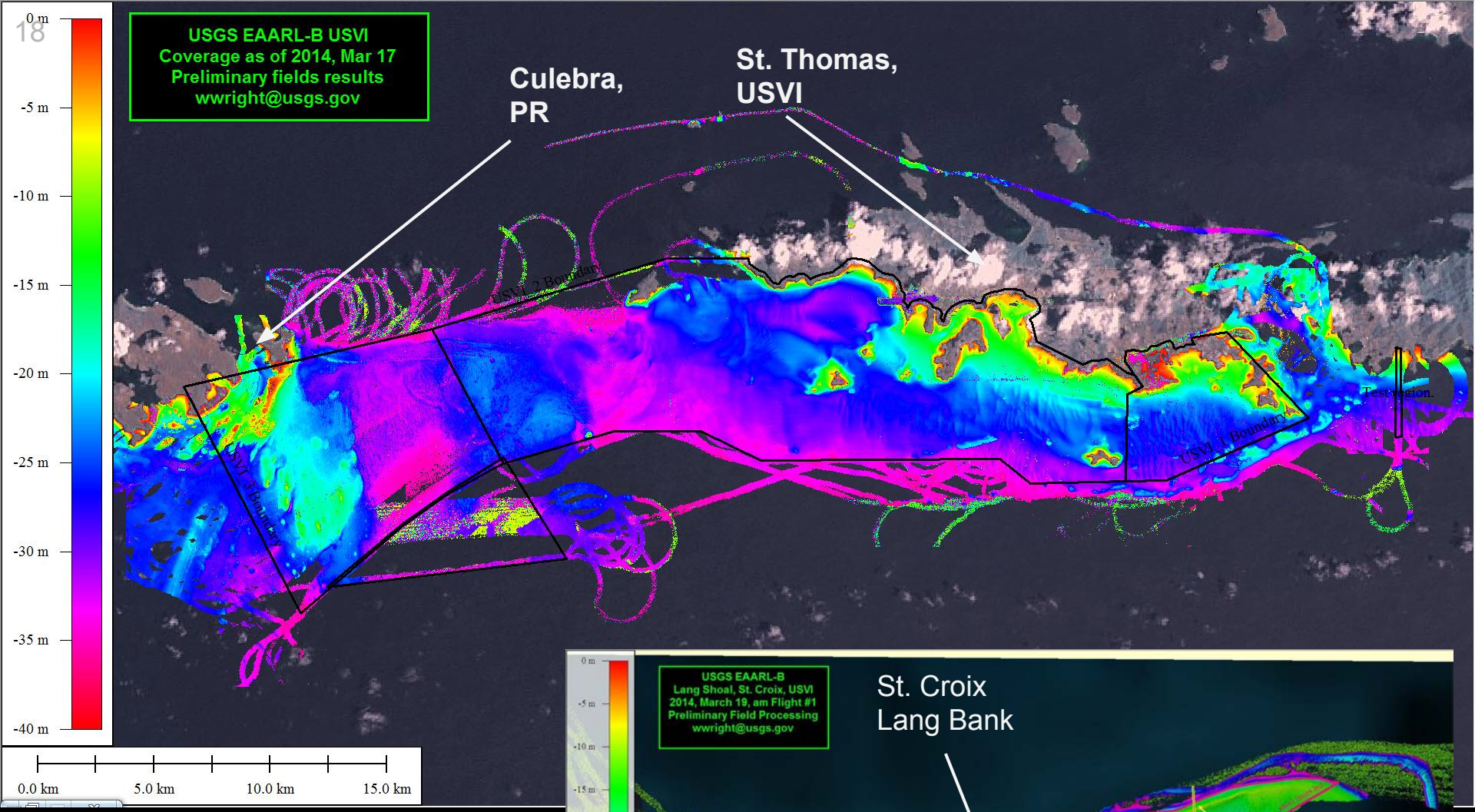

Depth Range: 4.8-6m
Std Dev: 8.3 cm
Median: -1.0 cm
Sand
A
Depth Range: 6.2-7.3m
Std Dev: 5.3 cm
Median: 4.7 cm
Hard bottom
B
Depth Range: 9.5-10.5m
Std Dev: 7.8 cm
Median: 10.9 cm
Hard bottom
C
Depth Range: 13.6-15.2m
Std Dev: 9.8 cm
Median: 15.2 cm
Hard bottom
D
Depth Range: 18.2-24.3m
Std Dev: 10.0 cm
Median: 26.3 cm
Hard bottom
E
Depth Range: 24.3-30.4m
Std Dev: 15.5 cm
Median: 43.5 cm
Sand?
F
Depth Range: 30.4-34.7m
Std Dev: 13.9 cm
Median: 53.1 cm
G
Samples
Meters

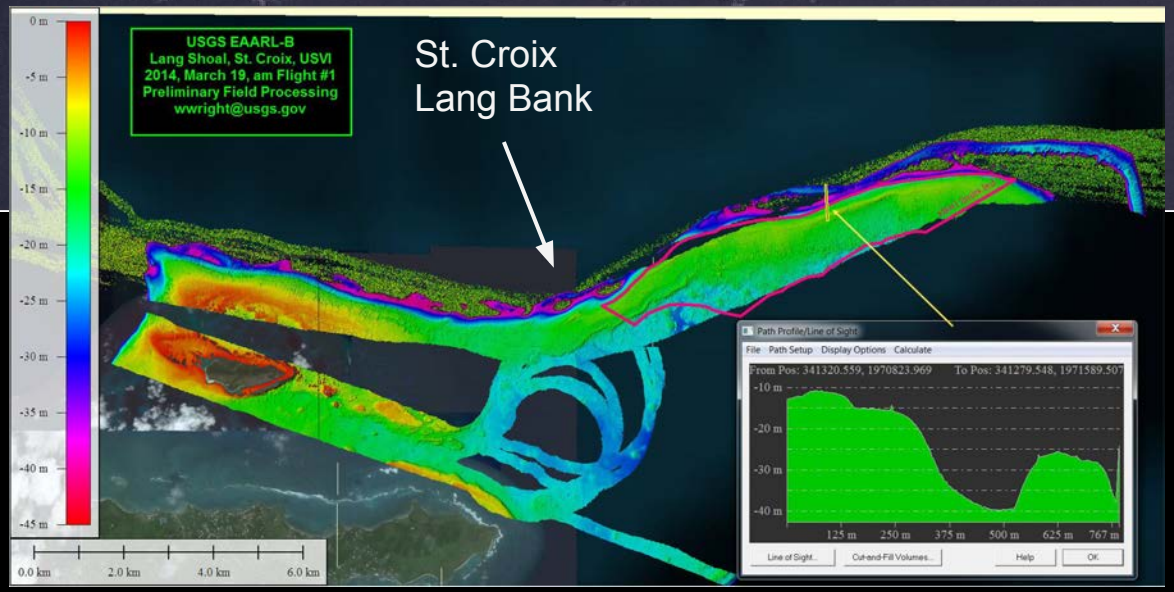


USGS, NOAA U.S. Virgin Island Calibration & Validation Study March 2014



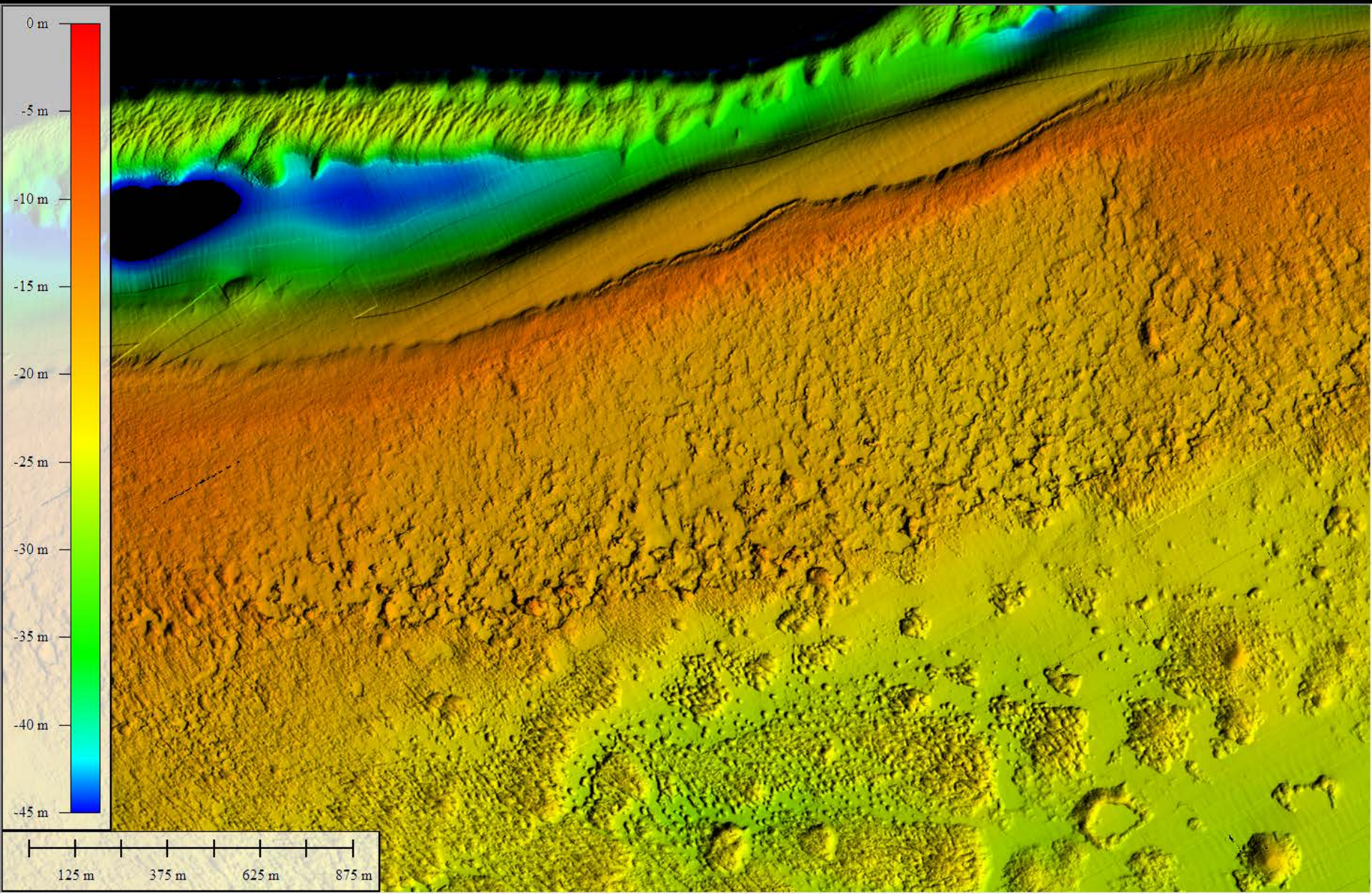
- USGS EAARL-B Lidar
- Based St. Thomas, USVI
- 1.1 Terabytes of data collected
- 18 total flights
- 2 flights / day
- ~4-7 hours / flight
- ~70 mission hours
- Coordination with the NOAA "Nancy Foster" Multi-Beam SONAR ship


USGS EAARL-B USVI
Coverage as of 2014, Mar 17
Preliminary fields results
wwright@usgs.gov
Culebra, PR
St. Thomas, USVI
USVI 2 Boundary
USVI 3 Boundary
USVI 1 Boundary
Transection
0 m
-5 m
-10 m
-15 m
-20 m
-25 m
-30 m
-35 m
-40 m
0.0 km
5.0 km
10.0 km
15.0 km

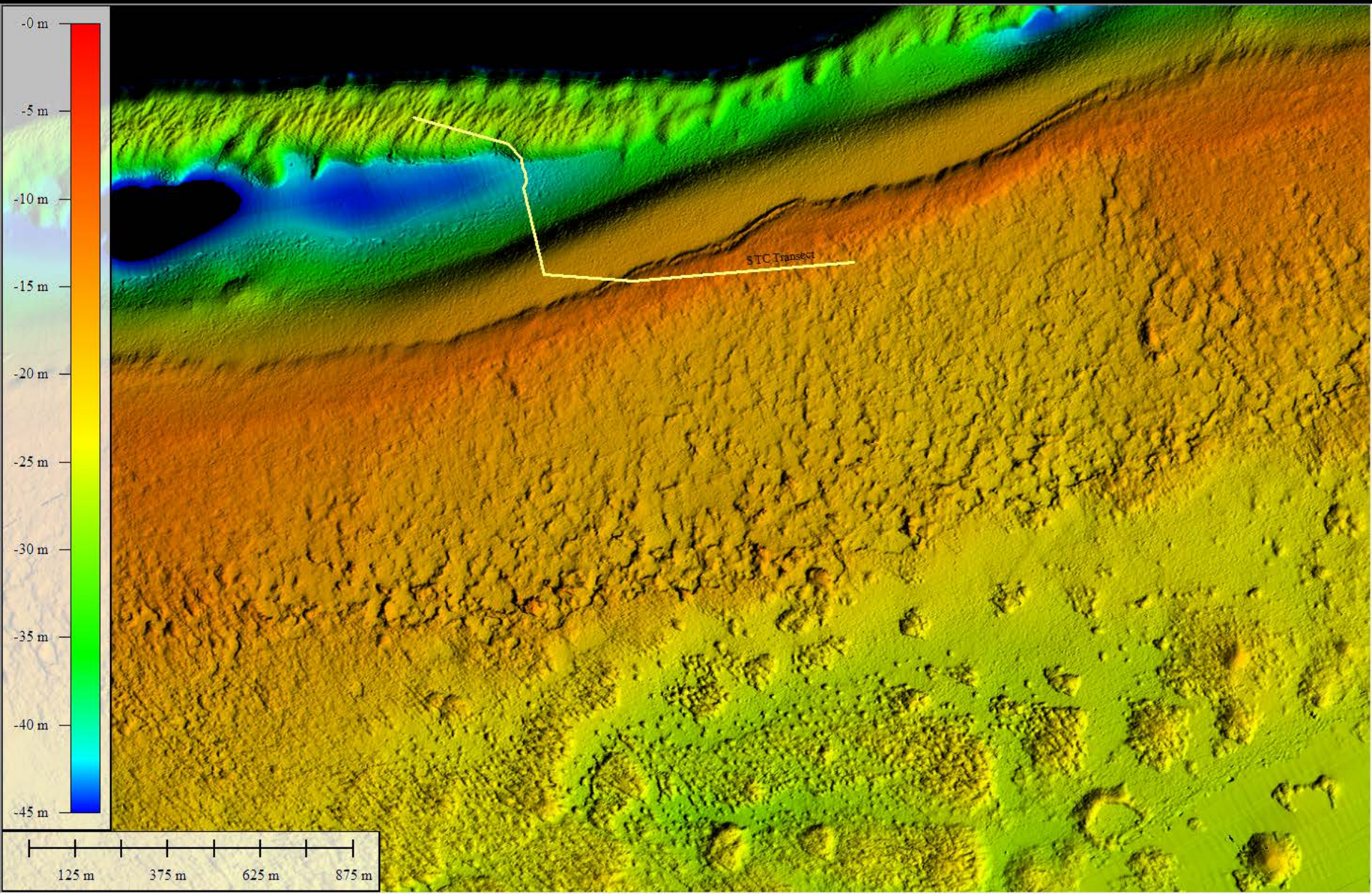

USGS EAARL-B
Lang Shoal, St. Croix, USVI
2014, March 19, am Flight #1
Preliminary Field Processing
wwright@usgs.gov
St. Croix
Lang Bank
0 m
-5 m
-10 m
-15 m
-20 m
-25 m
-30 m
-35 m
-40 m
-45 m
0.0 km
2.0 km
4.0 km
6.0 km
Path Profile/Line of Sight
File Path Setup Display Options Calculate
From Pos: 341320.559, 1970823.969
To Pos: 341279.548, 1971589.507
-10 m
-20 m
-30 m
-40 m
125 m
250 m
375 m
500 m
625 m
767 m
Line of Sight...
Cut-and-Fill Volumes...
Help
OK

St. Croix, Lang Bank, USVI

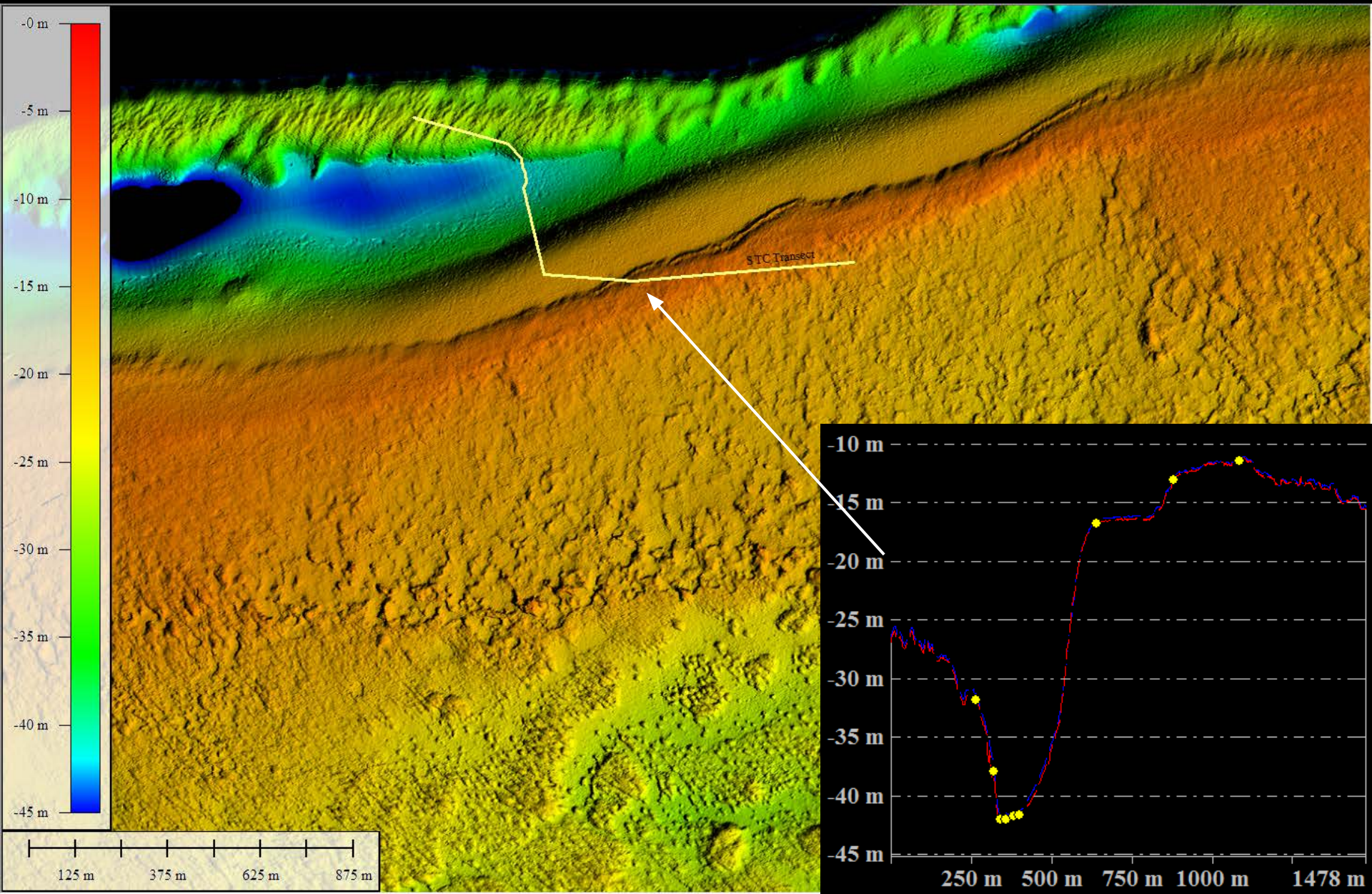
NOAA Ship *Nancy Foster*, Multi-Beam Sonar April 20, 2014



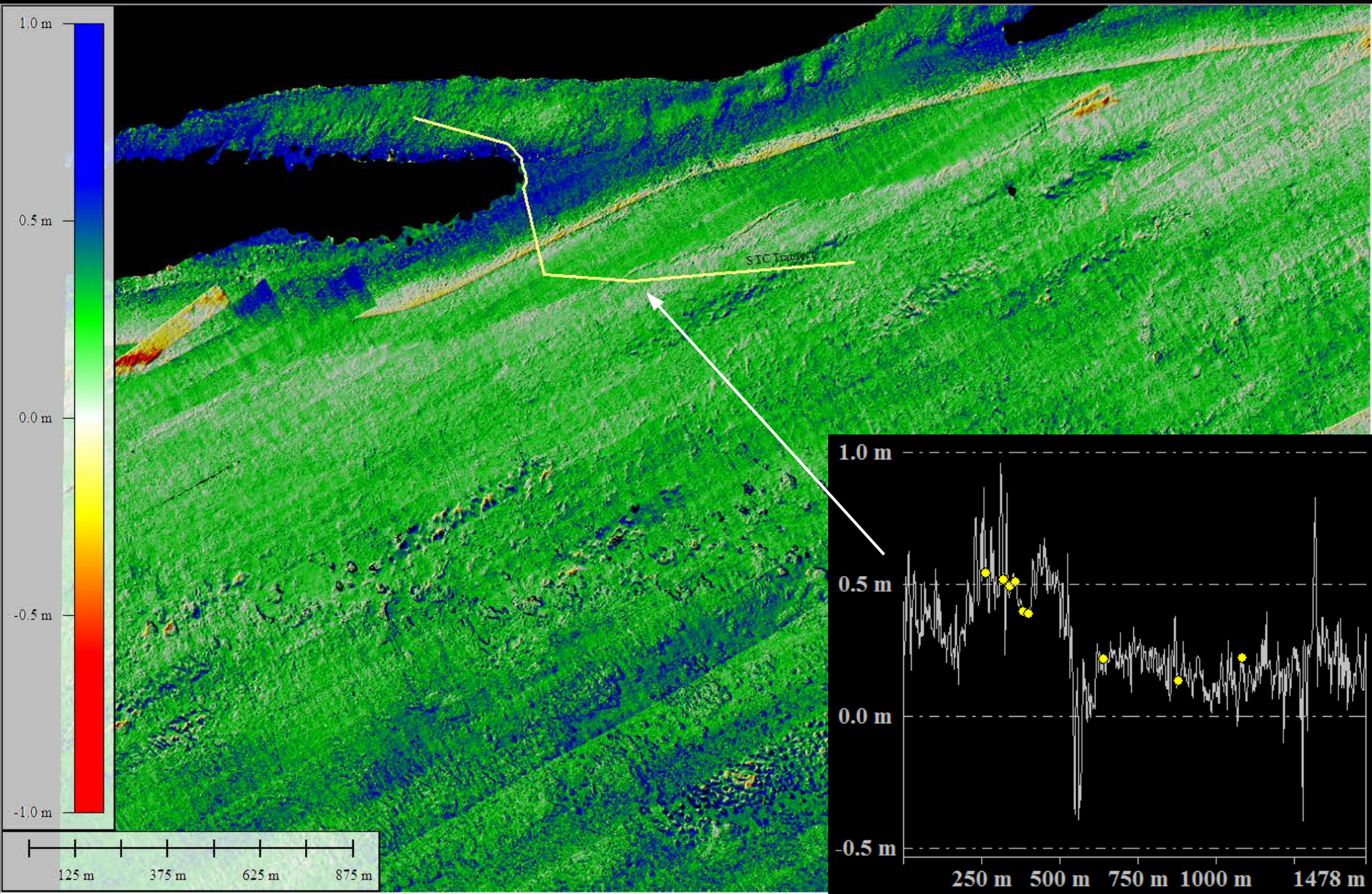
St. Croix, Lang Bank, USVI
NOAA MB Sonar vs. EAARL-B



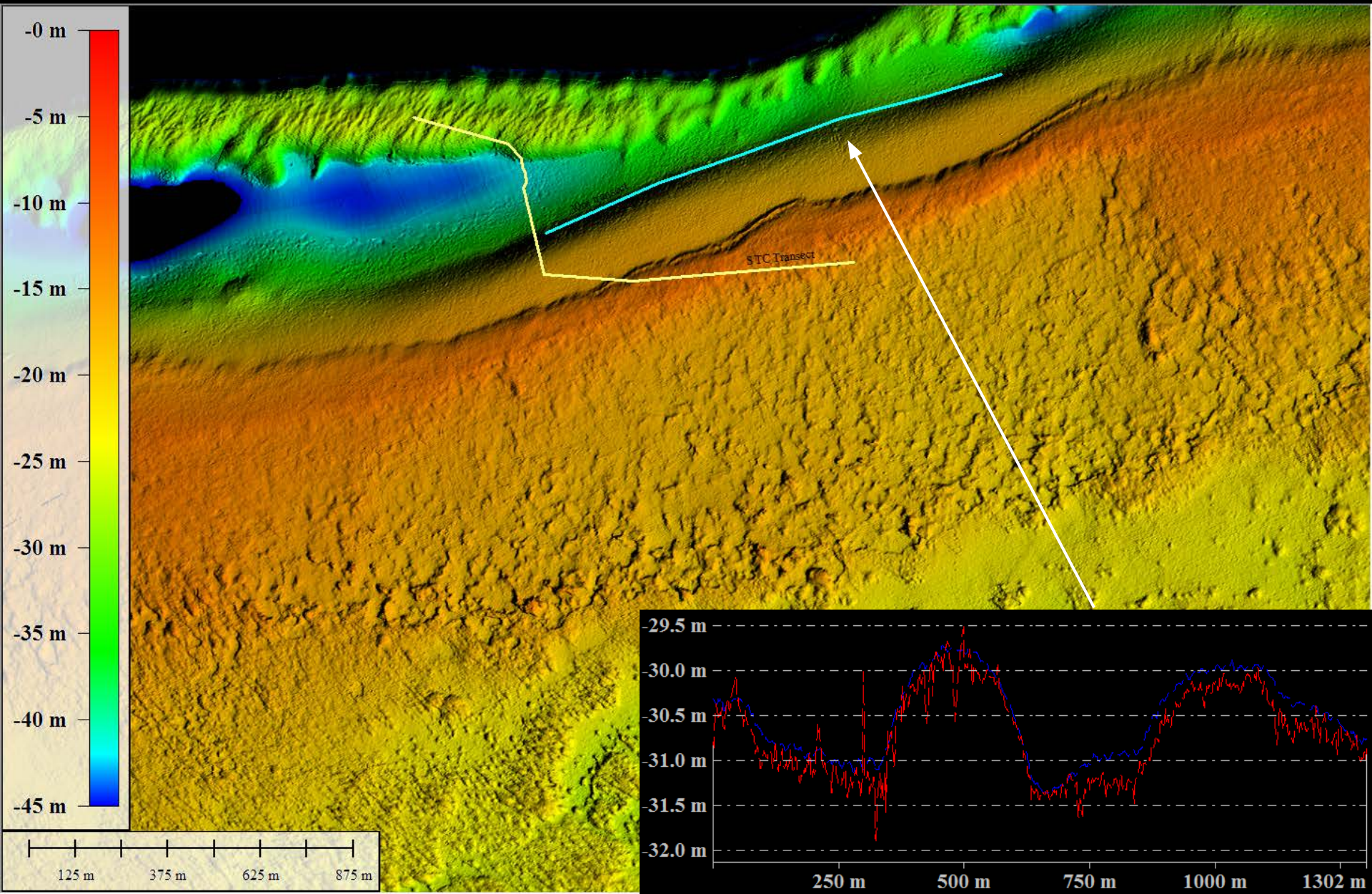
St. Croix, Lang Bank, USVI
NOAA MB Sonar vs. EAARL-B



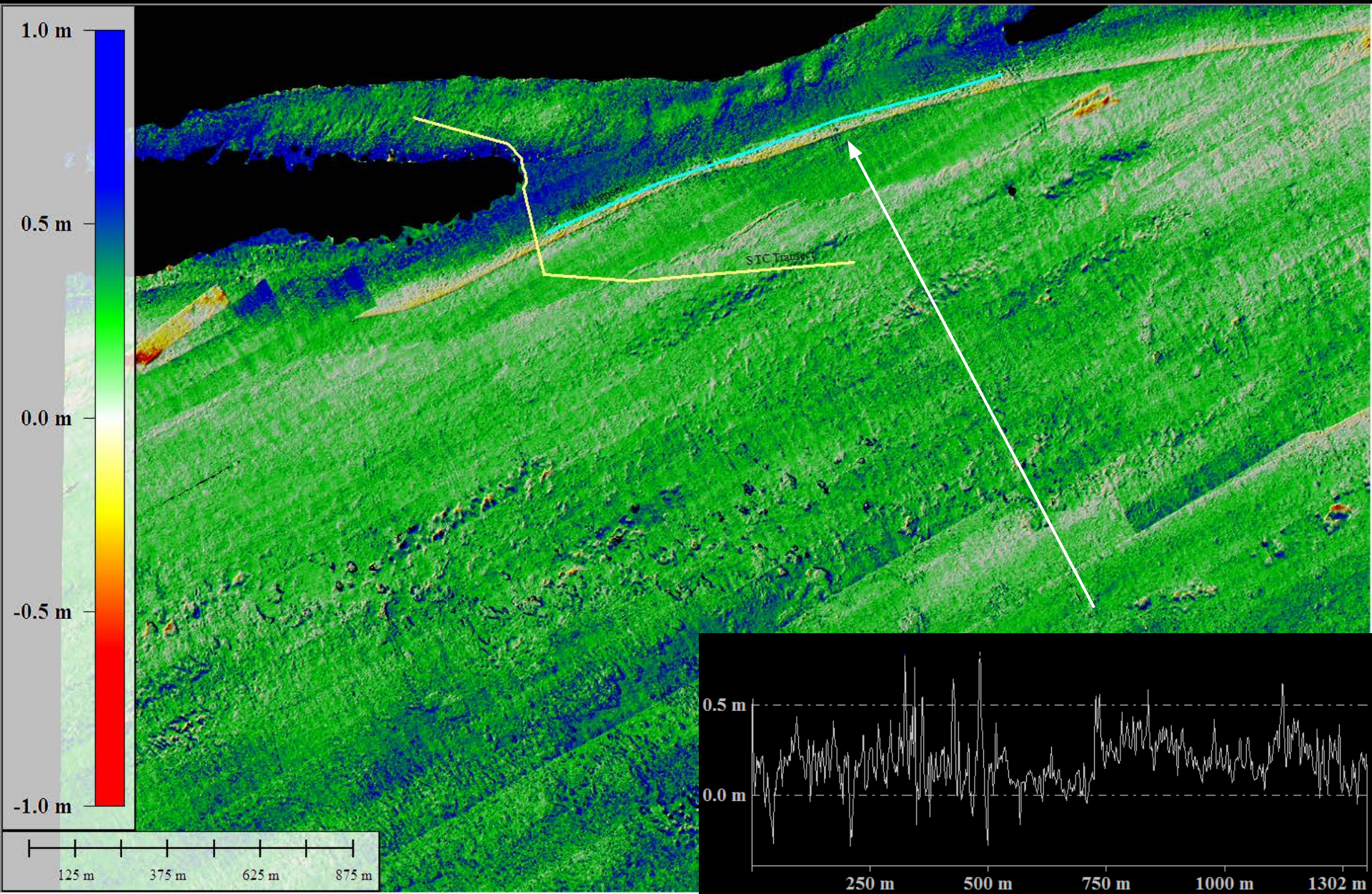
St. Croix, Lang Bank, USVI
NOAA MB Sonar vs. EAARL-B



St. Croix, Lang Bank, USVI
NOAA MB Sonar vs. EAARL-B



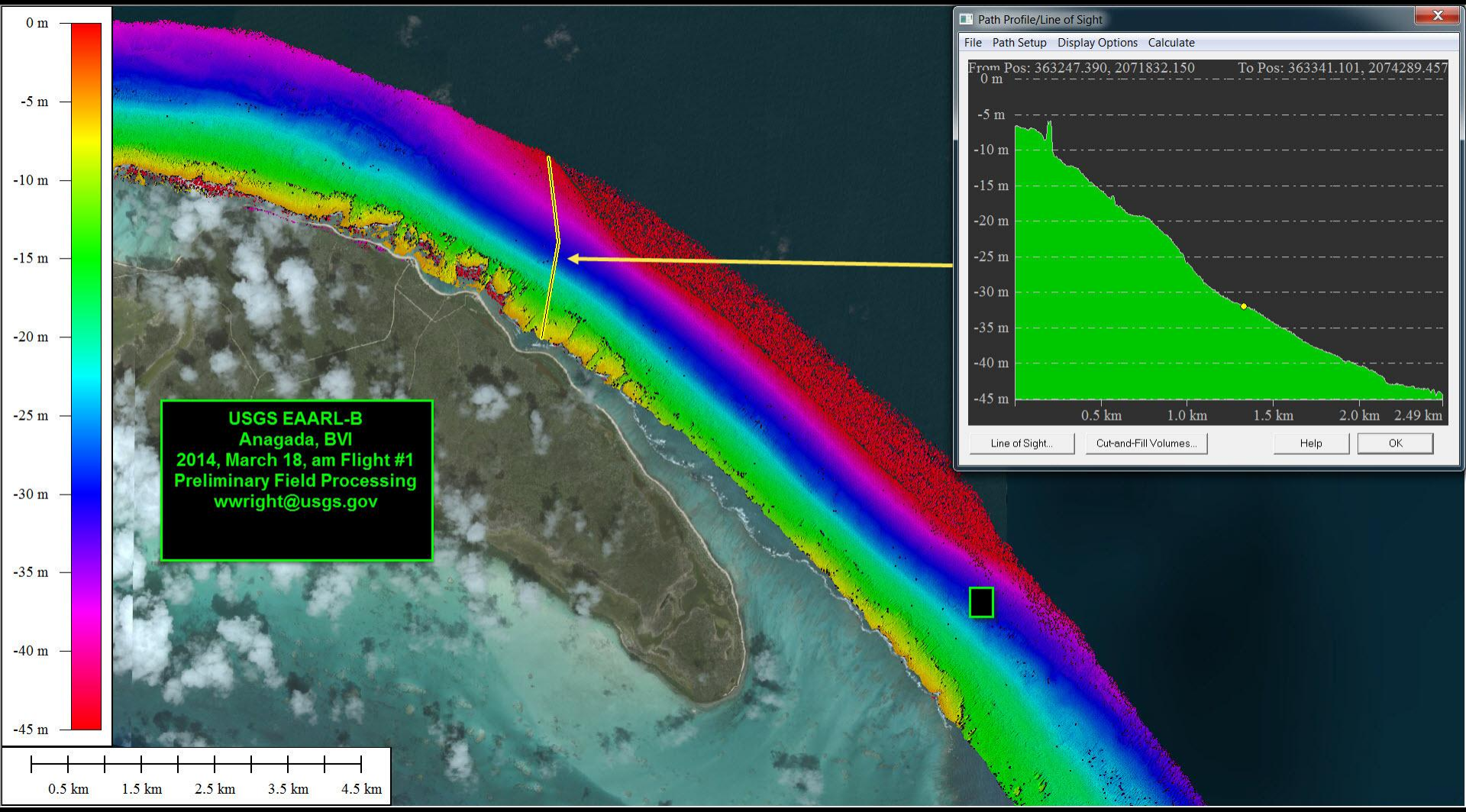
St. Croix, Lang Bank, USVI
NOAA MB Sonar vs. EAARL-B



Summary of Results

Location	Ref Sensor	Depth / m	Std Dev / cm	Mean Error / cm
Chandeleur	SBS	0 - 7	**9.4**	3.4
Ft Lauderdale	SHOALS 3000	4.8 - 6	8.3	-1.0
Ft Lauderdale	SHOALS 3000	6.2 - 7.3	5.3	4.7
Ft Lauderdale	SHOALS 3000	9.5 - 10.5	7.8	10.9
Ft Lauderdale	SBS	1 - 12	11.4	17.7
Ft Lauderdale	SHOALS 3000	13.6 - 15.2	9.8	15.2
Ft Lauderdale	SBS	15 - 22	18.4	26.6
Ft Lauderdale	SHOALS 3000	18.2 - 24.3	10.0	26.3
Ft Lauderdale	SHOALS 3000	24.3 - 30.4	15.5	43.5
Ft Lauderdale	SBS	22 - 35	25.1	46.8
Ft Lauderdale	SHOALS 3000	30.4 - 34.7	13.9	53.1

Anegada, BVI


0 m
-5 m
-10 m
-15 m
-20 m
-25 m
-30 m
-35 m
-40 m
-45 m
0.5 km
1.5 km
2.5 km
3.5 km
4.5 km
USGS EAARL-B
Anagada, BVI
2014, March 18, am Flight #1
Preliminary Field Processing
wwright@usgs.gov
Path Profile/Line of Sight
File
Path Setup
Display Options
Calculate
From Pos: 363247.390, 2071832.150
To Pos: 363341.101, 2074289.457
0 m
-5 m
-10 m
-15 m
-20 m
-25 m
-30 m
-35 m
-40 m
-45 m
0.5 km
1.0 km
1.5 km
2.0 km
2.49 km
Line of Sight...
Cut-and-Fill Volumes...
Help
OK

Method to compare Potential Bathy Lidar Performance independent of Water Column Measurements

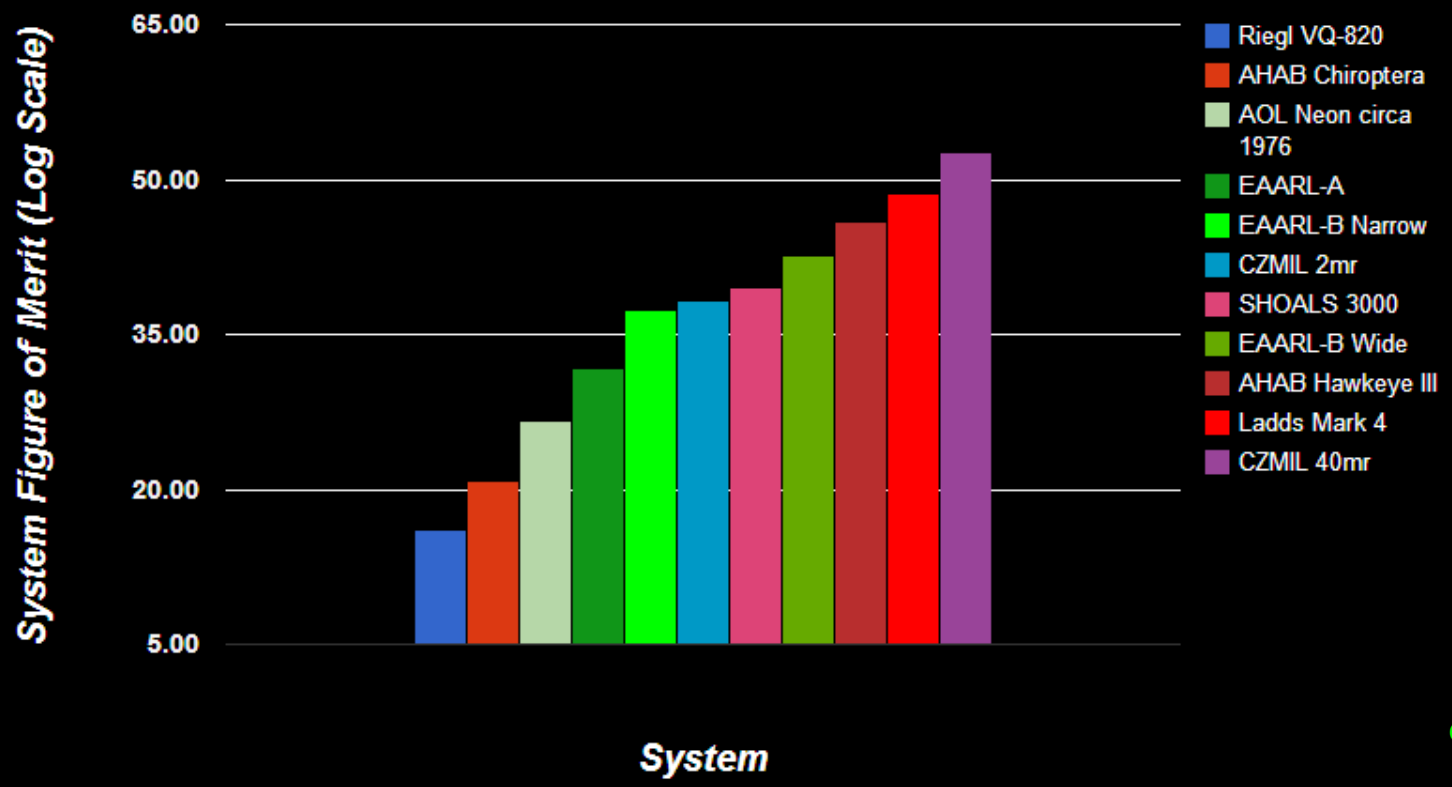
$$S = [\log(A * W) - 4] * 11$$

Where:

A = Area of Receiver in cm^2

W = Peak Pulse Power (Watts)

Single Pulse Bottom Detection
Figure of Merit (S)



USGS
C. W. Wright wwright@usgs.gov

USGS

Questions?

Wayne Wright
wwright@usgs.gov
lidar532@gmail.com
443-783-3319

USGS