



AIRBORNE TOPO & BATHY LIDAR SYSTEM TESTS

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GEOMATICS DATA SOLUTIONS, INC.

- + Private company in business since 2009.
- + Offices in San Diego, CA and Vancouver, BC.
- + 12+ years experience with topo and bathy lidar
- + 18+ years experience with acoustic sensors



+ GDS personnel have:

- + Operated bathymetric lidar sensors for over 12 years
- + Acquired & processed over 50 projects worldwide
- + Experience with LADS, Optech SHOALS, Riegl VQ820-G, HawkEye II, III and Chiroptera I and II

+ In the past 5 years we have worked on projects in:

- + United States / Taiwan / South Korea / Saudi Arabia / France / Germany / Sweden

+ In the US, GDS personnel have acquired bathy lidar data in:

- + Alaska / East Coast / West Coast / Great Lakes
- + Rivers in Washington and California

- + 35 kHz Shallow Bathy (1.7 x Secchi)
- + 500 kHz Topo
- + 80 MP RGBI RCD30 Camera



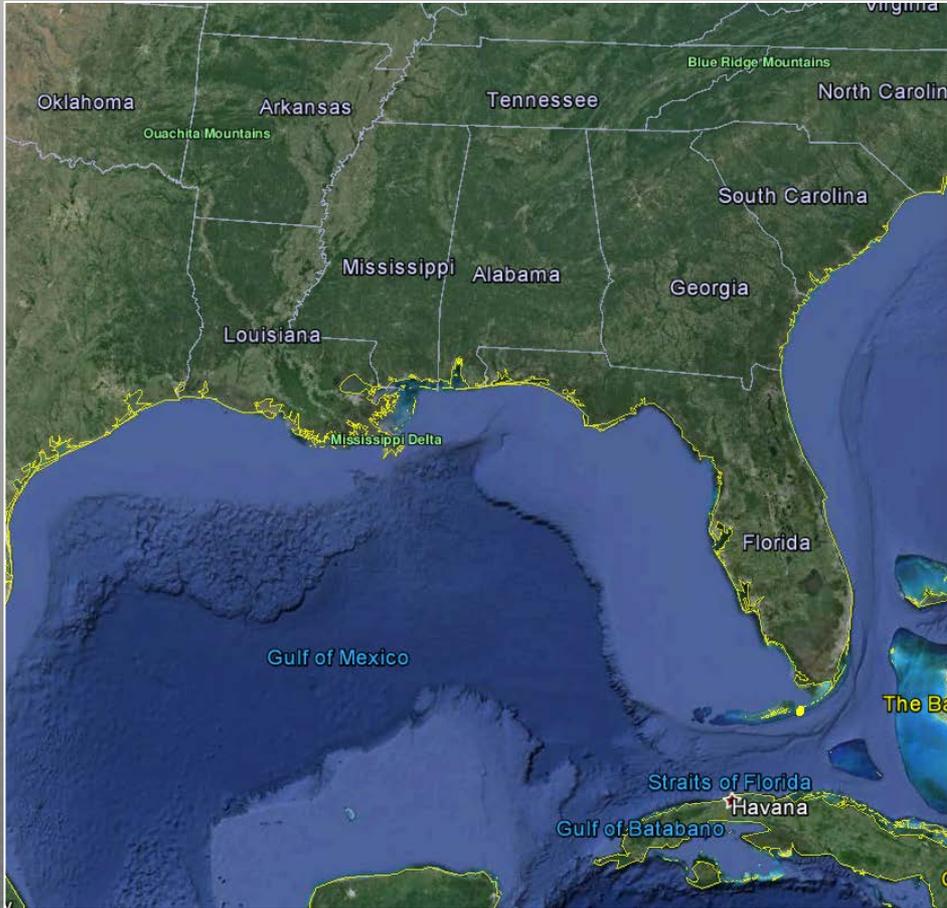
FASTER ACCESS TO USABLE INTELLIGENT DATA

- + Sample project > 200km²
- + Very shallow depths (3m on average)

Technology	Time to Survey
Full Coverage Multibeam	1 year
100% Sidescan Sonar (with singlebeam or skunk striped bathy)	60 days
Bathy Lidar	2 days

- + Combination of sensors (bathy, topo, 4-band imagery) allows us to serve multiple client needs and expand into new markets.
- + Sensor stability and reliability
- + Ease of install and use
- + Excellent data accuracy and quality
- + Good compromise between data density and depth penetration – fills the gap!
- + Robust existing processing algorithms, and continued development to advance algorithm capabilities.
- + Great customer support

SYSTEM TESTING – MARATHON, FL



+ 10 – 12 February, 2015

SYSTEM TESTING – MARATHON, FL

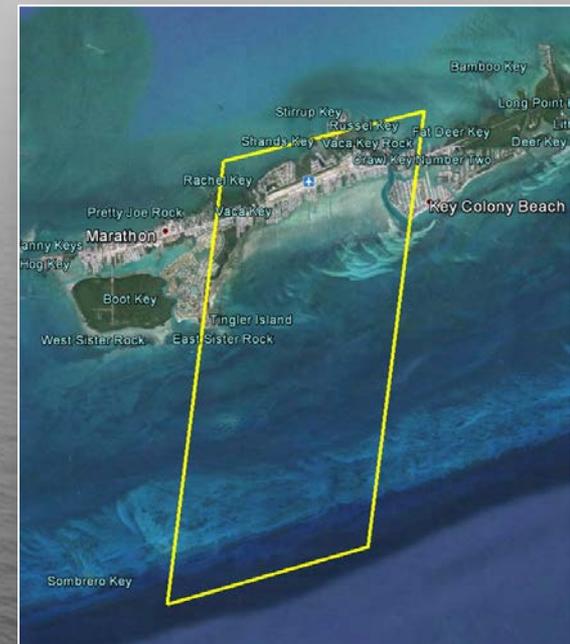


GNSS Base Station

SYSTEM INSTALLATION



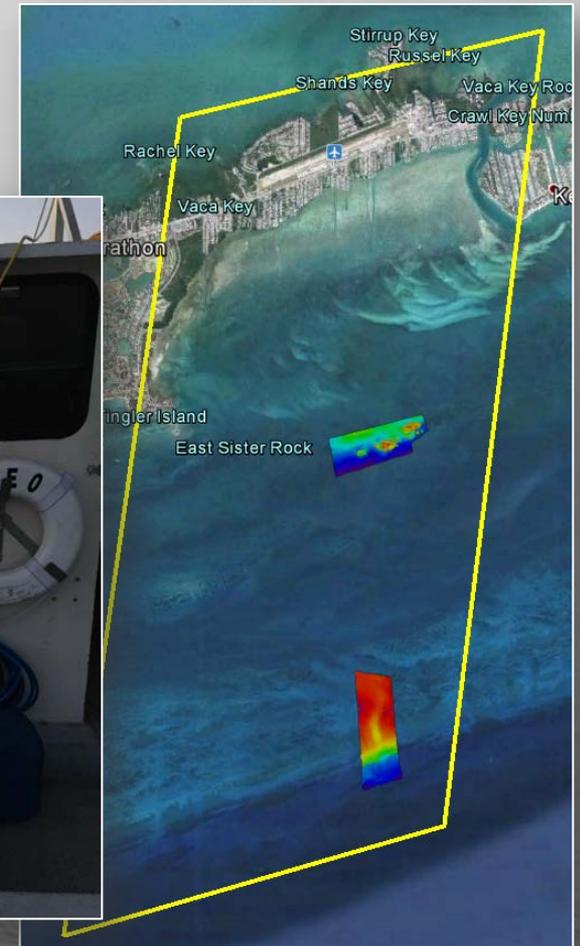
- + Calibration Data over airport – 500m, 1000m
- + Survey Data – 400m, 2 lines at 500m
- + Topo Altitude Tests – 800m to 1600m



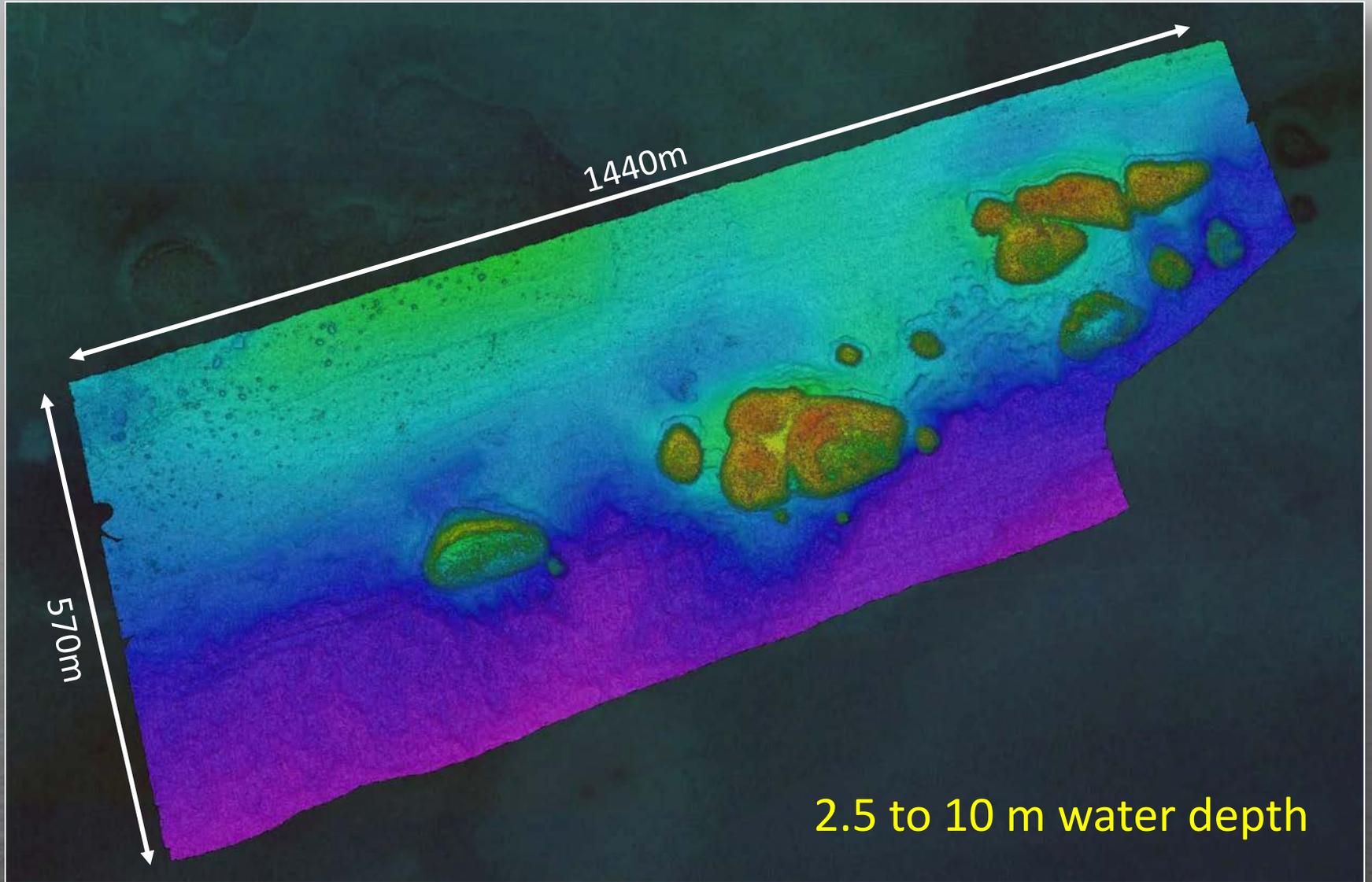
MULTIBEAM GROUND TRUTH

- + Reson T20-P with POS MV Wavemaster
- + Same GNSS Base Station as lidar
- + 2 areas collected:
 - + Area A: 2.5 to 10 m
 - + Area D: 6.5 to 24m

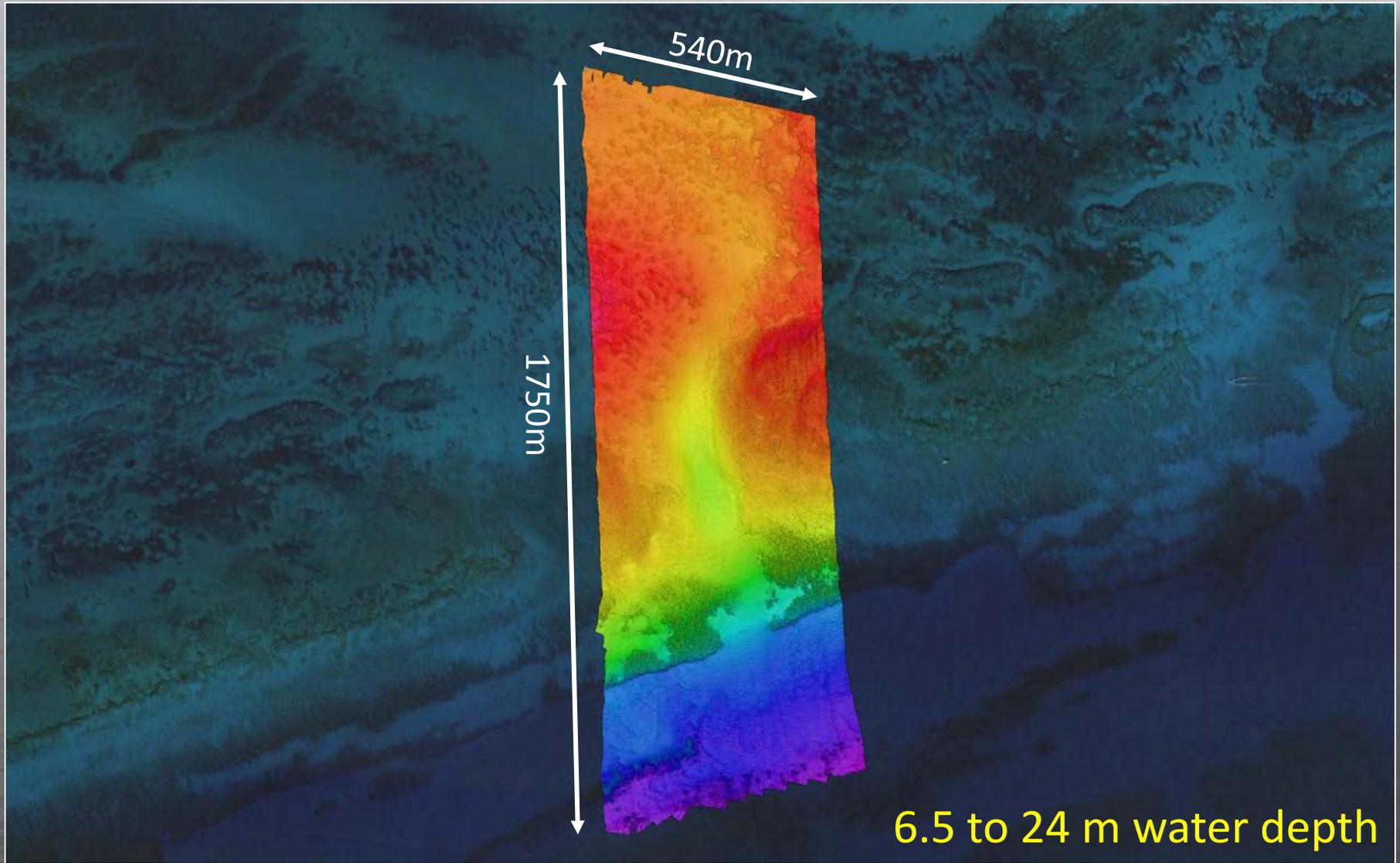
16 – 18 February, 2015



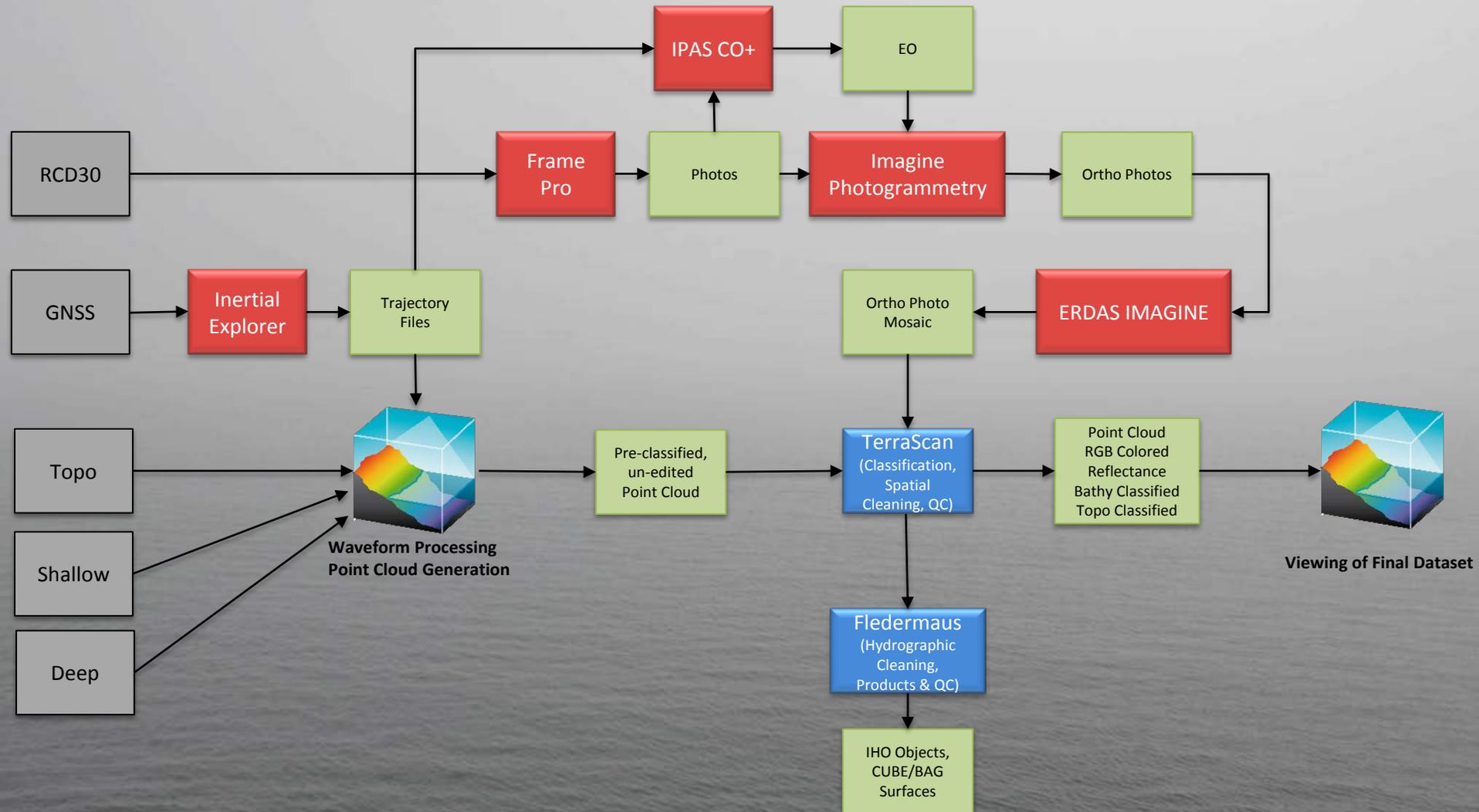
MULTIBEAM AREA A



MULTIBEAM AREA D

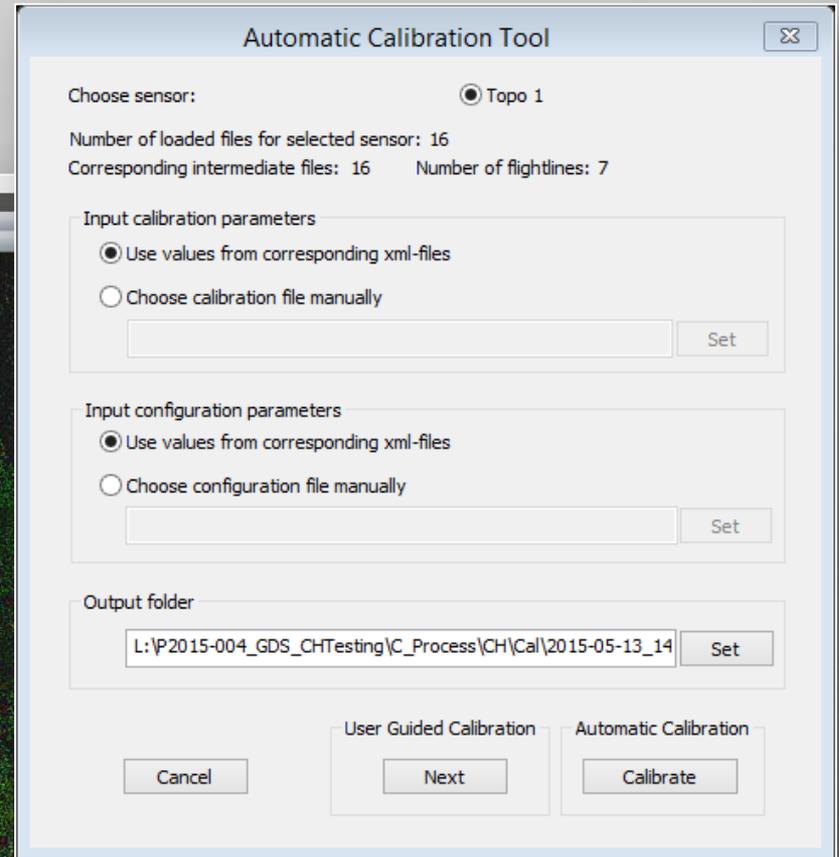
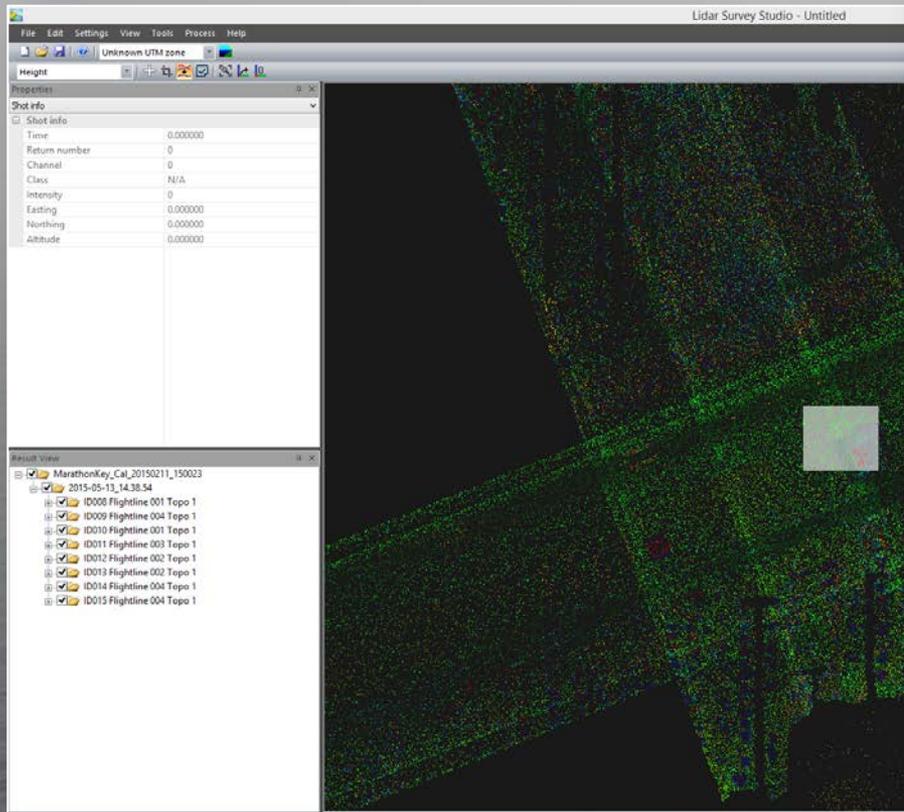


CHIROPTERA II PROCESSING WORKFLOW



AUTOMATED LIDAR CALIBRATION

- + Topo laser
- + Shallow laser



- + Compare front to back scan
- + Compare line to line
- + Compare topo to shallow for 500m
- + Compare to ground truth on land

CALIBRATION QUALITY CONTROL

Quality Assurance Tool
✕

Calc. Mode

Detailed
 Fast
 UTM Zone

Scan Accuracy

Flightline Accuracy

Save / Load Settings

Limits

Error: 0 m

Limit1: █

Limit2: █

Limit3: █

Limit4: █

Error: Infinity █

Save settings and close dialog

Advanced Patch Specification

Patch size (m)

X: Y:

Normal z component (m)

Min: Max:

Minimum number of hits: Show Signs

Maximum RMS value:

Outputs

Flightline Accuracy Report Output:
ID011 Flightline 003 Topo 1 vs. ID010 Flightline 001 Topo 1 FL Accuracy

Limits	Patch#	First FL Positive	Average Error	Percentage
0.00 <= ERR <0.02	8187	65.32%	0.0051	96.72%
0.02 <= ERR <0.05	237	56.96%	0.0278	2.80%
0.05 <= ERR <0.10	30	56.67%	0.0625	0.35%
0.10 <= ERR <0.15	6	66.67%	0.1243	0.07%
0.15 <= ERR < Inf.	5	20.00%	0.6834	0.06%
<hr/>				
Summary	8465	65.03%	0.0065	
Accuracy Index: 99				
<hr/>				
Patch Statistics				
All#: 48705 Valid: 32.23% NumHit.fail:49.66% ConDist.fail:0.51% NormalZ.fail:6.26% RMS.fail:11.34%				

Save Text Output: ||
 Open Output Folder: ||
 Open Plot Viewer:

CALIBRATION QUALITY CONTROL

	Topo 1000m	Topo 500m	Shallow 1000m	Shallow 500m
Front - Back Scan (m)	0.0168 0.0023	0.0117 0.0036	N/A	0.0262 0.0033
Line to Line (m)	0.0152 0.0019	0.0185 0.0110	N/A	0.0253 0.0065
Topo 1000m – 500m	0.02 0.05			
Topo 500m – Hydro 500m	0.0669 0.0154			

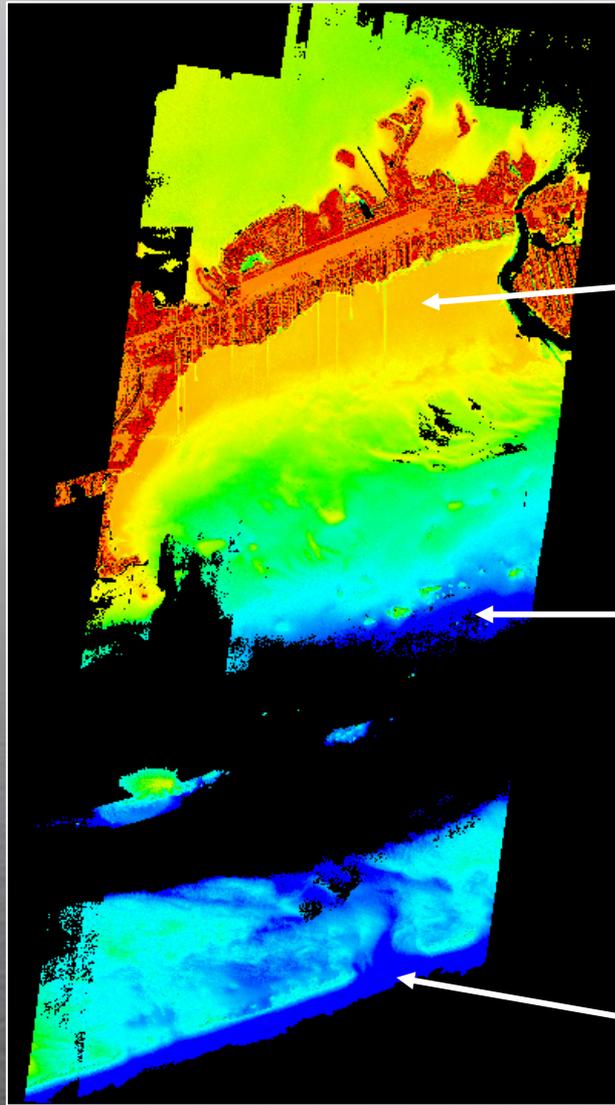
COMPARISON TO GROUND TRUTH

	1000m Topo	500m Topo	400m Topo	500m Shallow	400m Shallow
Average dz	-0.0060	0.0230	0.0363	-0.0363	0.0440
Std. Deviation	0.0219	0.0174	0.0241	0.0232	0.0190
RMSE	0.0189	0.0270	0.0413	0.0410	0.0467

+ Topo Mean = 0.017m (St Dev. 0.021)

+ Shallow Mean = 0.004m (St Dev. 0.057)

CHIROPTERA II LIDAR DATA



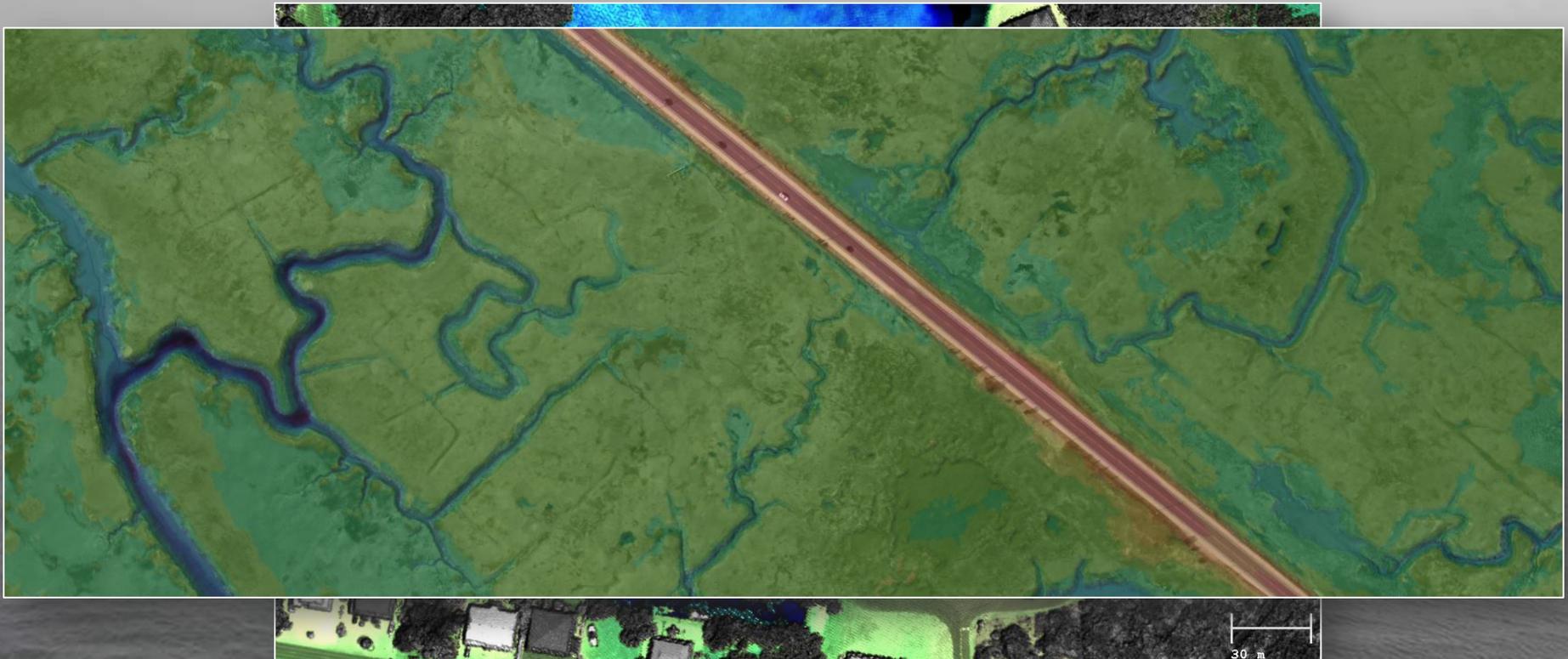
0.5 – 1m Depth Shelf

10m Depth

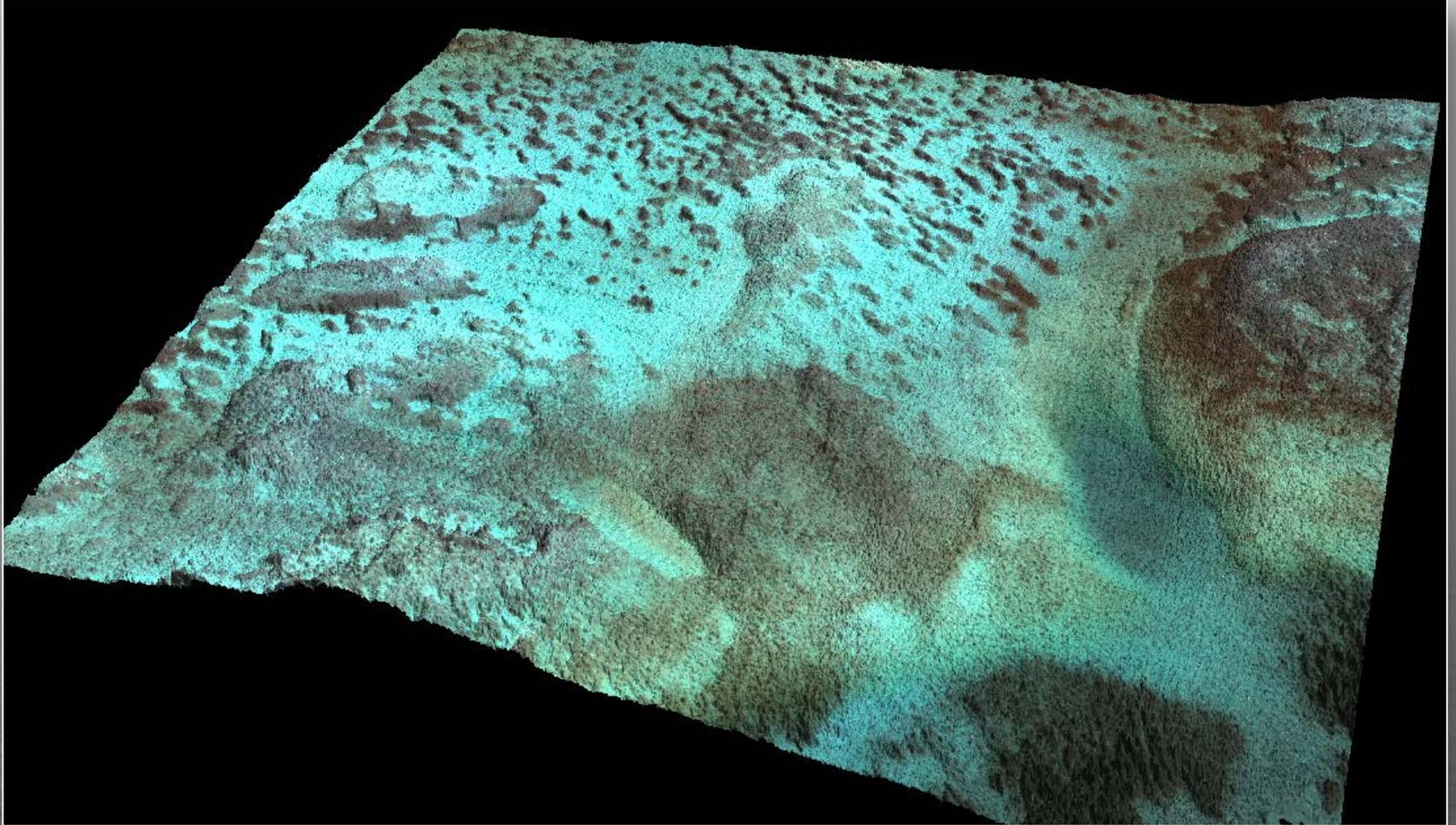
15m Depth

SHALLOW CHANNELS AND INLAND WATERS

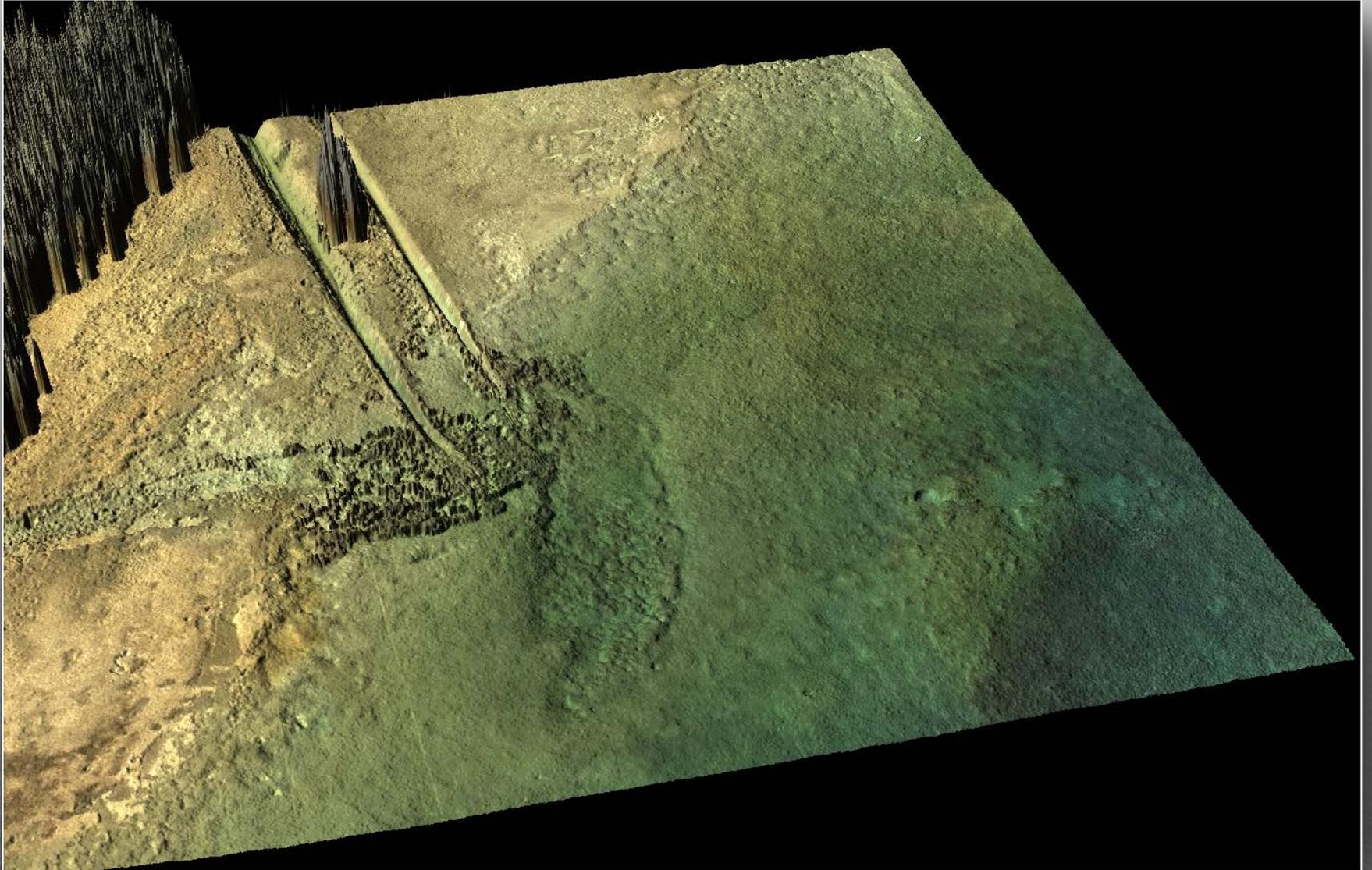
- + Provides good detail & accurate depths
- + Automatic Land/Water Discrimination
- + Calculation of accurate water surface



Vertical Exaggeration x15

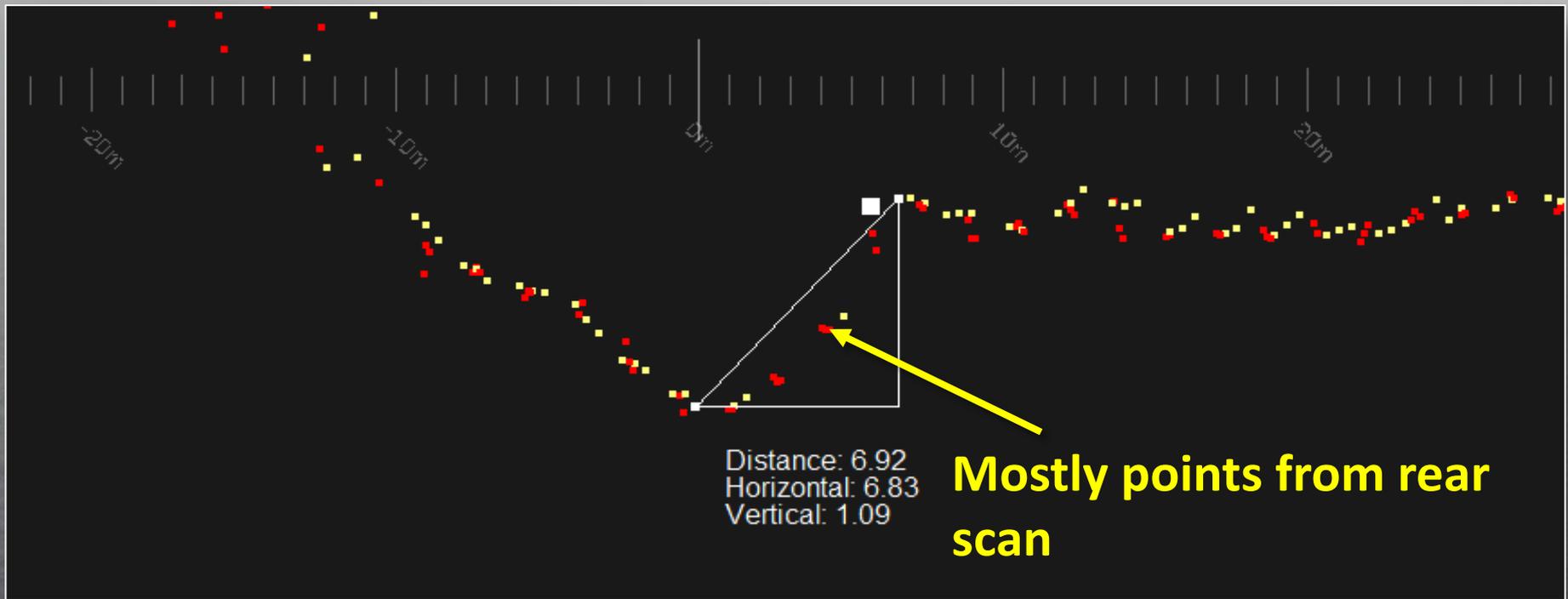


SAMPLE BATHY (x5 AND x15)

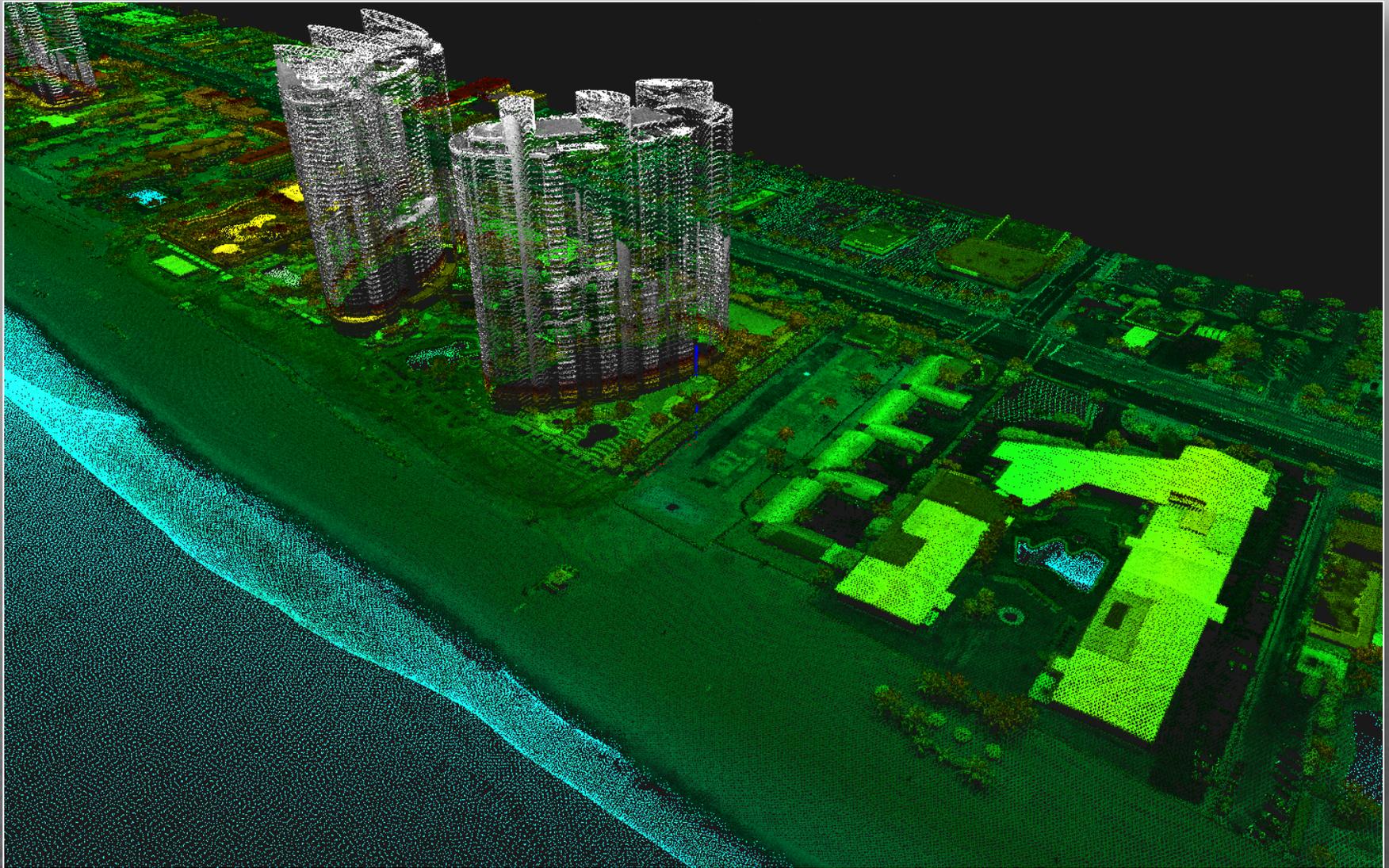


ELLIPTICAL SCAN EXAMPLE

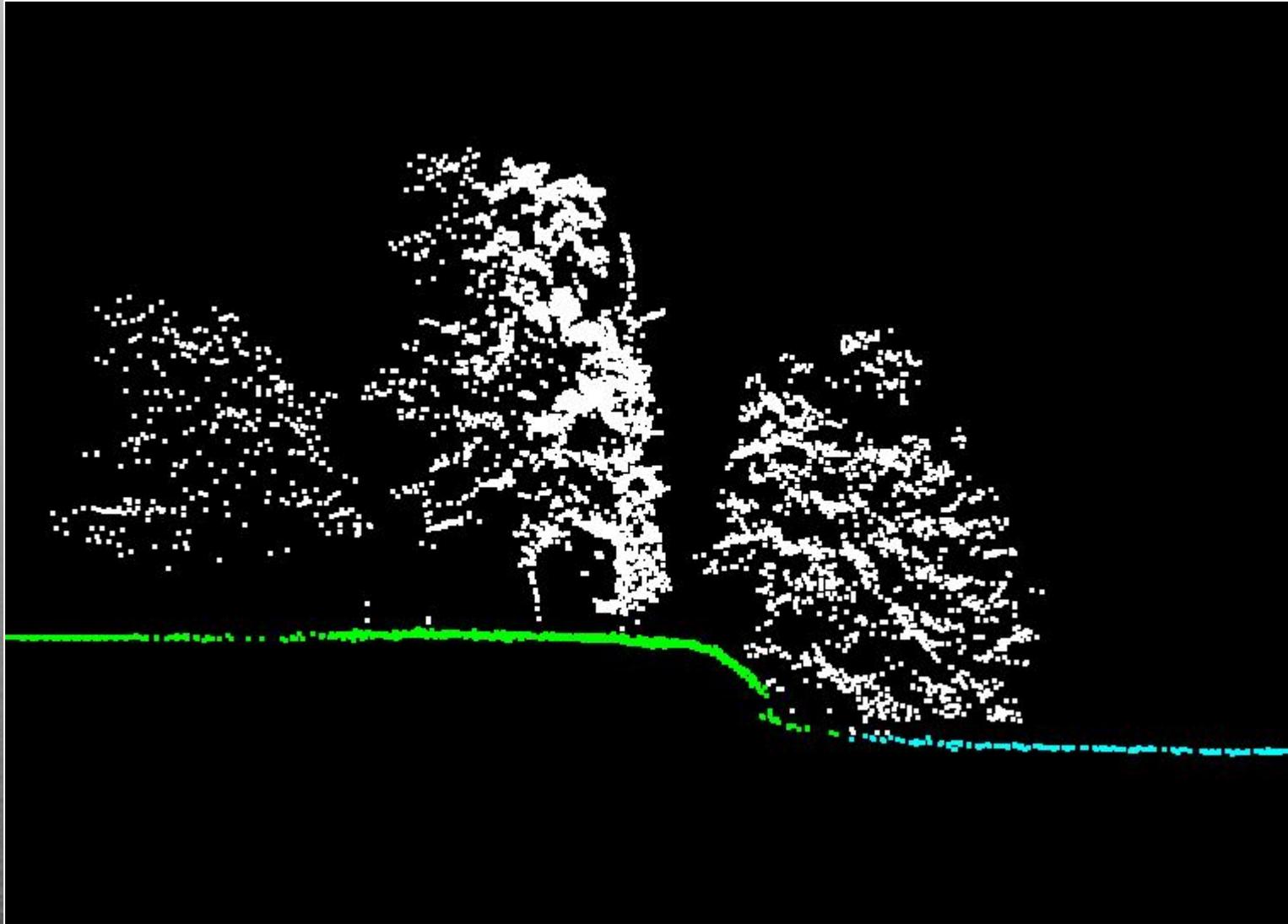
- + Channel runs perpendicular to line of flight
- + Most bathy points on steepest side, from one side of scan



ELLIPTICAL SCAN PATTERN – NO SHADOWING EFFECT



ELLIPTICAL SCAN PATTERN / HIGH DATA DENSITY



COMPARISON TO MULTIBEAM

	MBES Area A	MBES Area D	Land Ground Truth
AVG	0.06	-0.06	0.04
St Dev	0.08	0.07	0.02
	Lidar is below MBES	Lidar is above MBES	Lidar is above GT
Depths	2.5 to 10 m water depth	6.5 to 19 m water depth	Land

- + Derive settings – power, PRF, MPIA Zones
- + Each altitude line processed with different settings

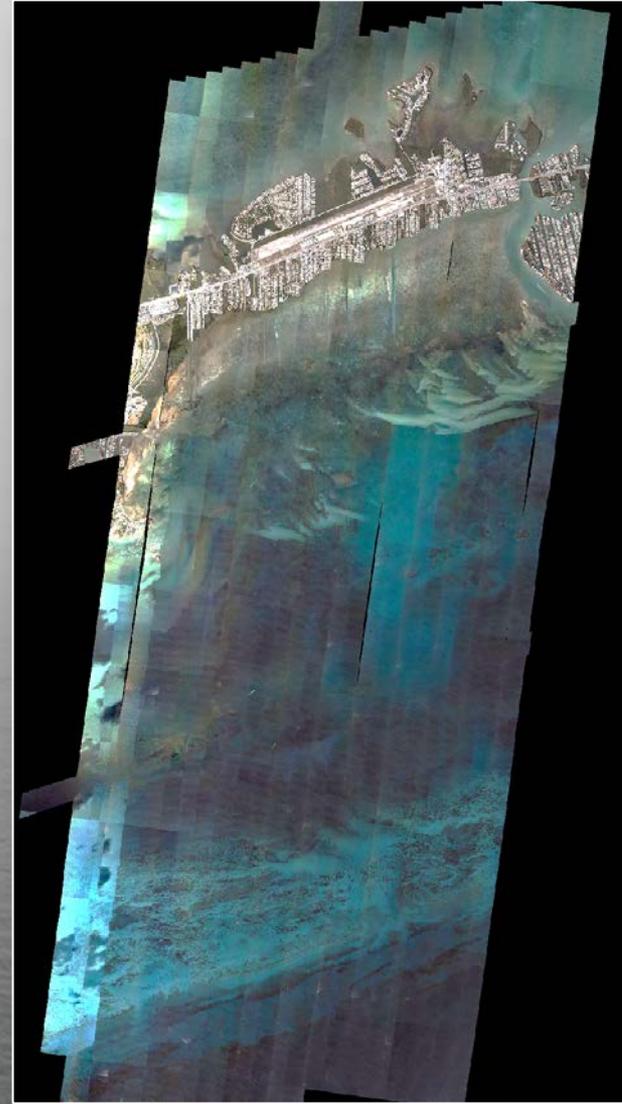
Altitude (m)	Swath Width (m)	PRF	NPS	Pts/m ²
400	280	300	0.29	11.9
500	350	500	0.25	16.0
1000	700	250	0.5	4.0
1200	840	180	0.65	2.4
1300	910	200	0.64	2.4
1400	980	160	0.74	1.8
1500	1050	150	0.79	1.6
1600	1120	130	0.88	1.3

+ Overall Mean dZ = -0.0018m

Flying Altitude	400m	500m	1000m	1200m	1300m	1400m	1500m
Mean dZ (m)	0.0363	0.0230	-0.0060	-0.0077	-0.0197	0.0027	-0.0413
St Dev	0.0241	0.0174	0.0219	0.0264	0.0075	0.0333	0.0371
RMSE	0.0413	0.0270	0.0189	0.0229	0.0206	0.0273	0.0512

RCD30 ORTHO MOSAIC

Flying Altitude (m)	GSD (m)
300	0.034
400	0.045
500	0.057
600	0.068
700	0.079
800	0.091
900	0.102
1000	0.113
1100	0.125
1200	0.135
1300	0.147
1400	0.158
1500	0.170
1600	0.181



50cm



25cm



5cm

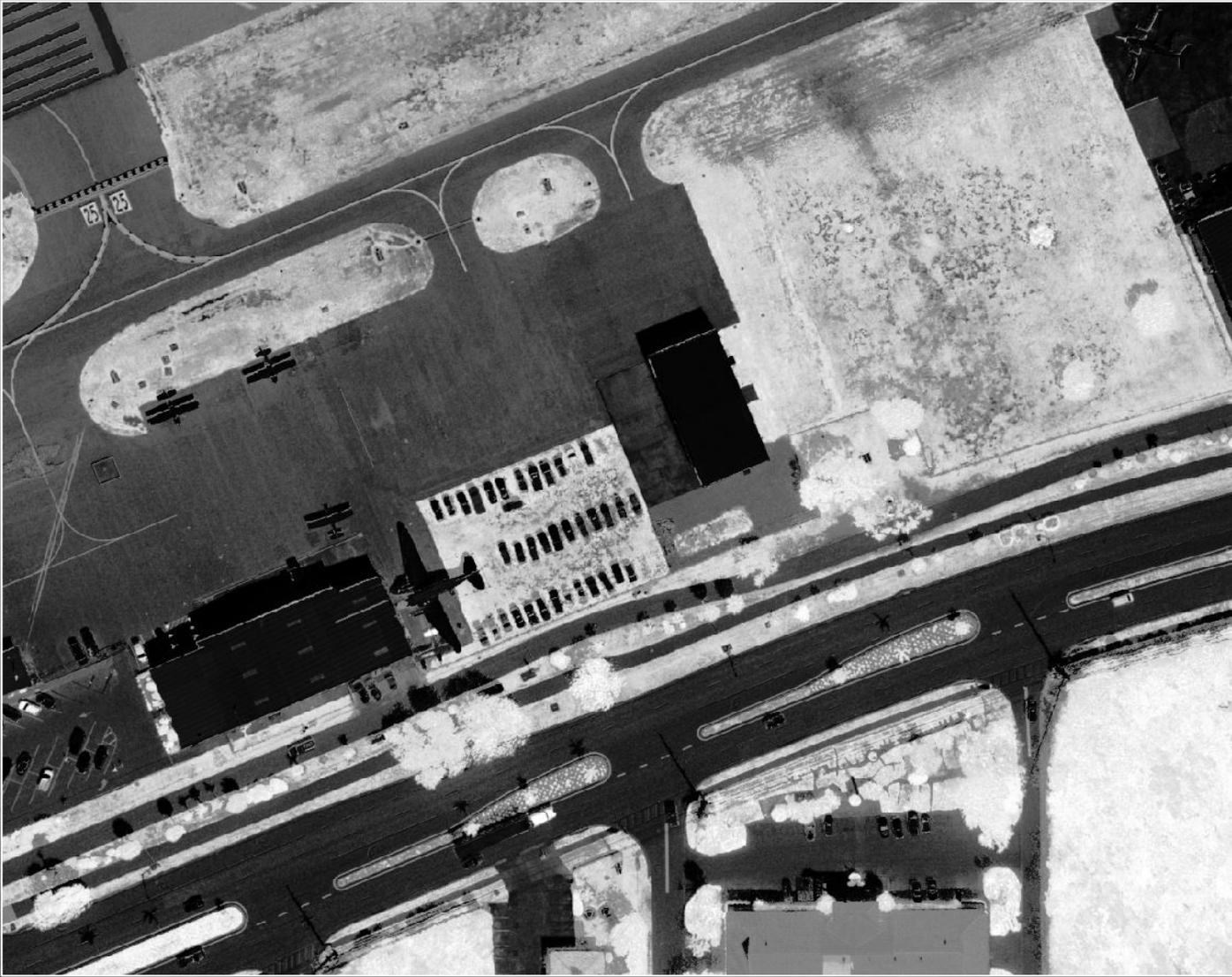


5CM RGBN IMAGERY

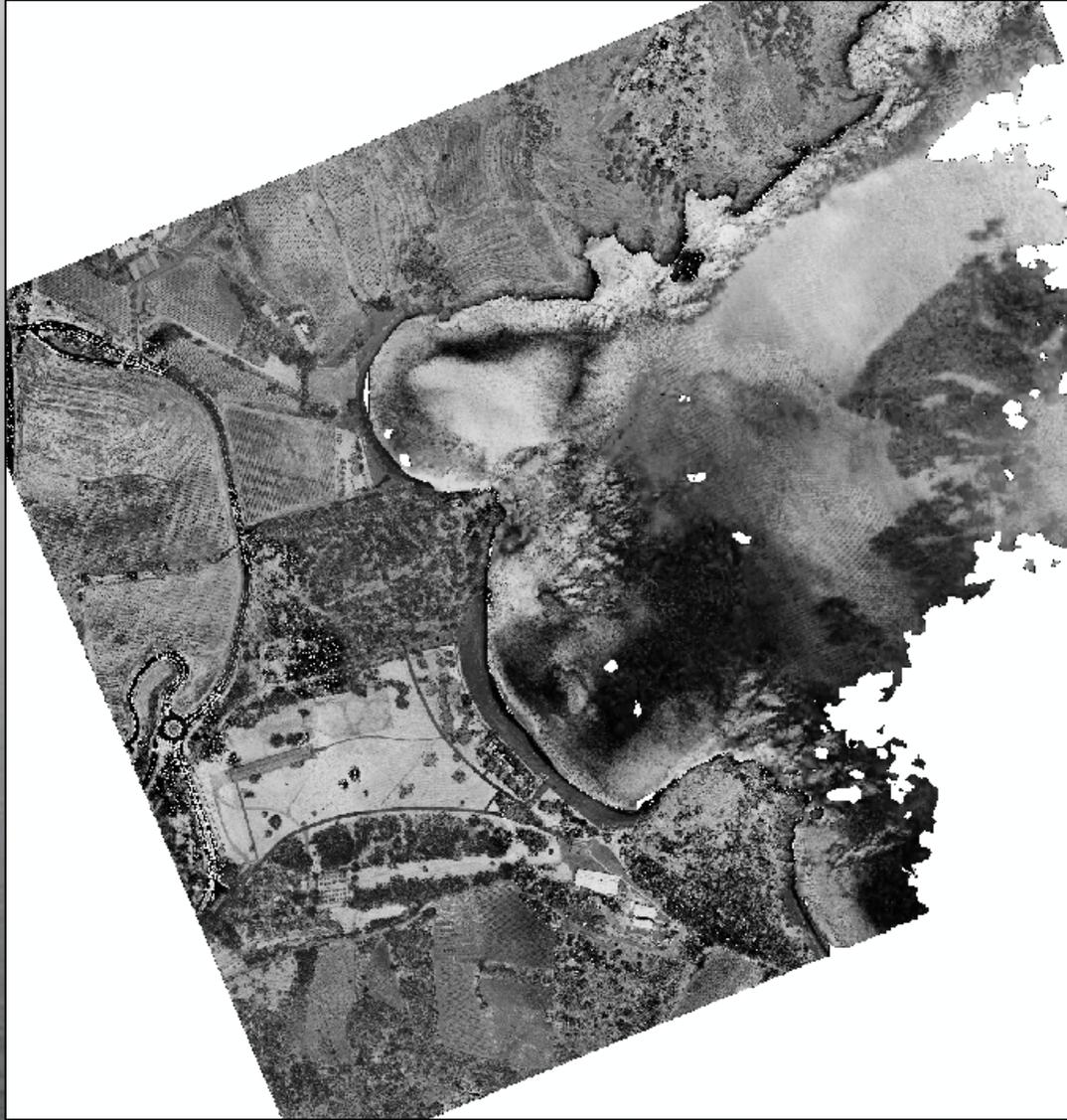


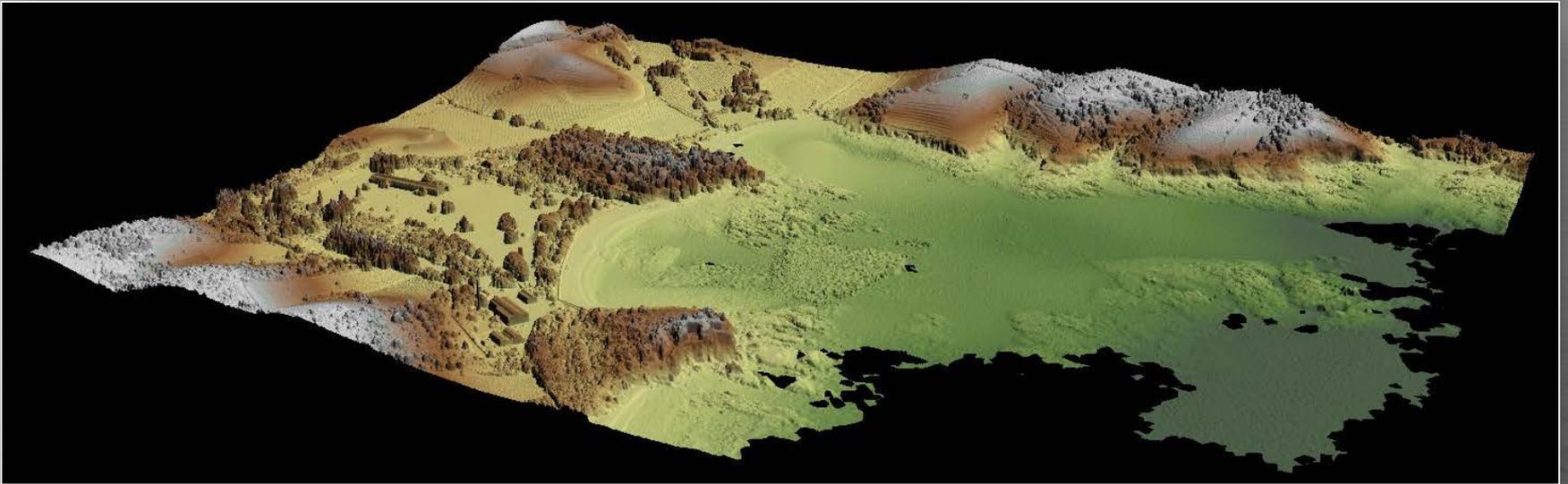
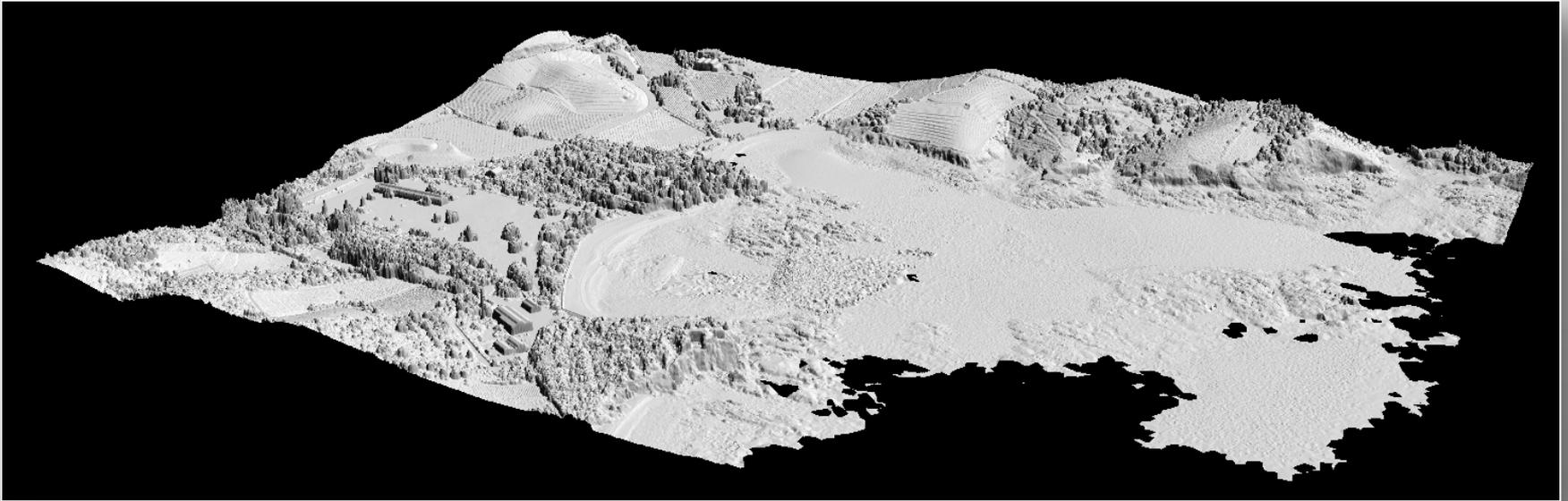


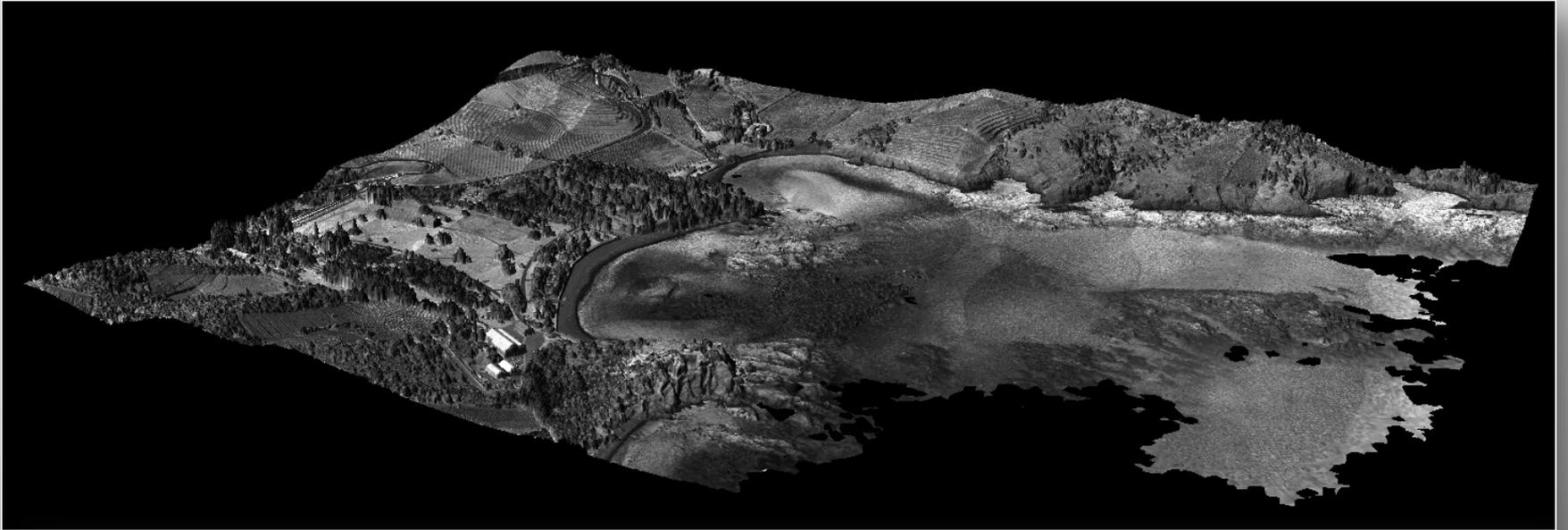
NORMALIZED DIFFERENCE VEGETATION INDEX

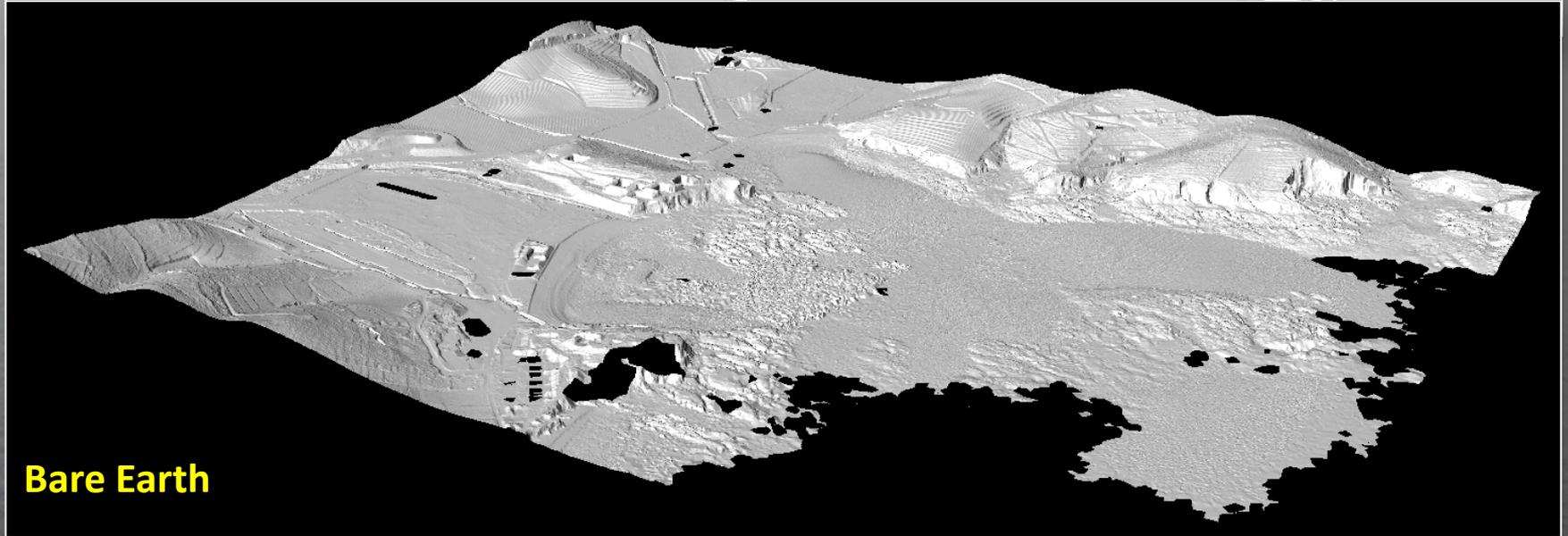
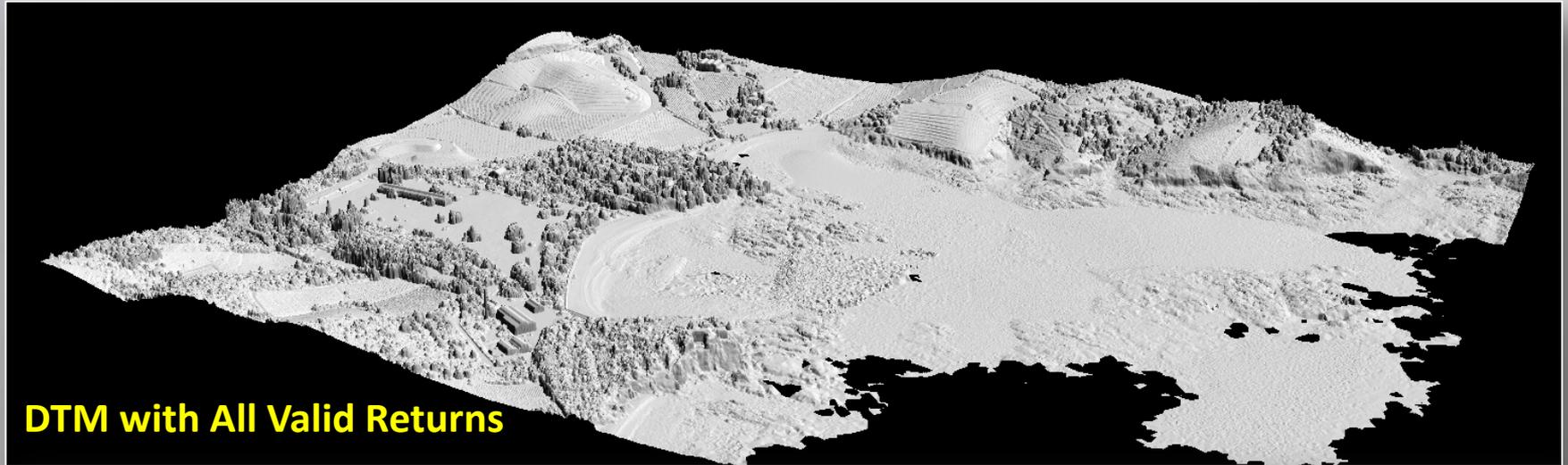


INTENSITY INFORMATION





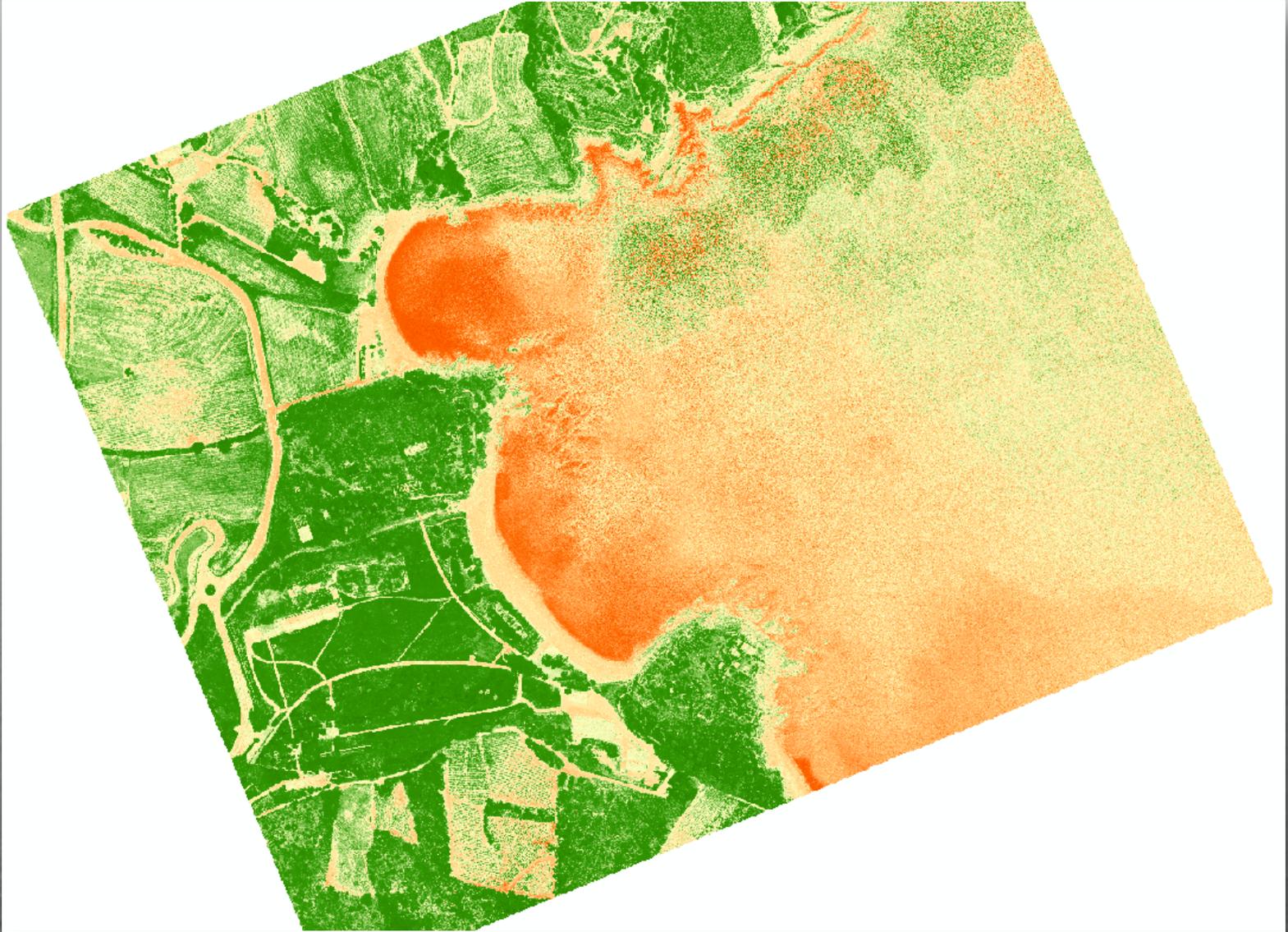




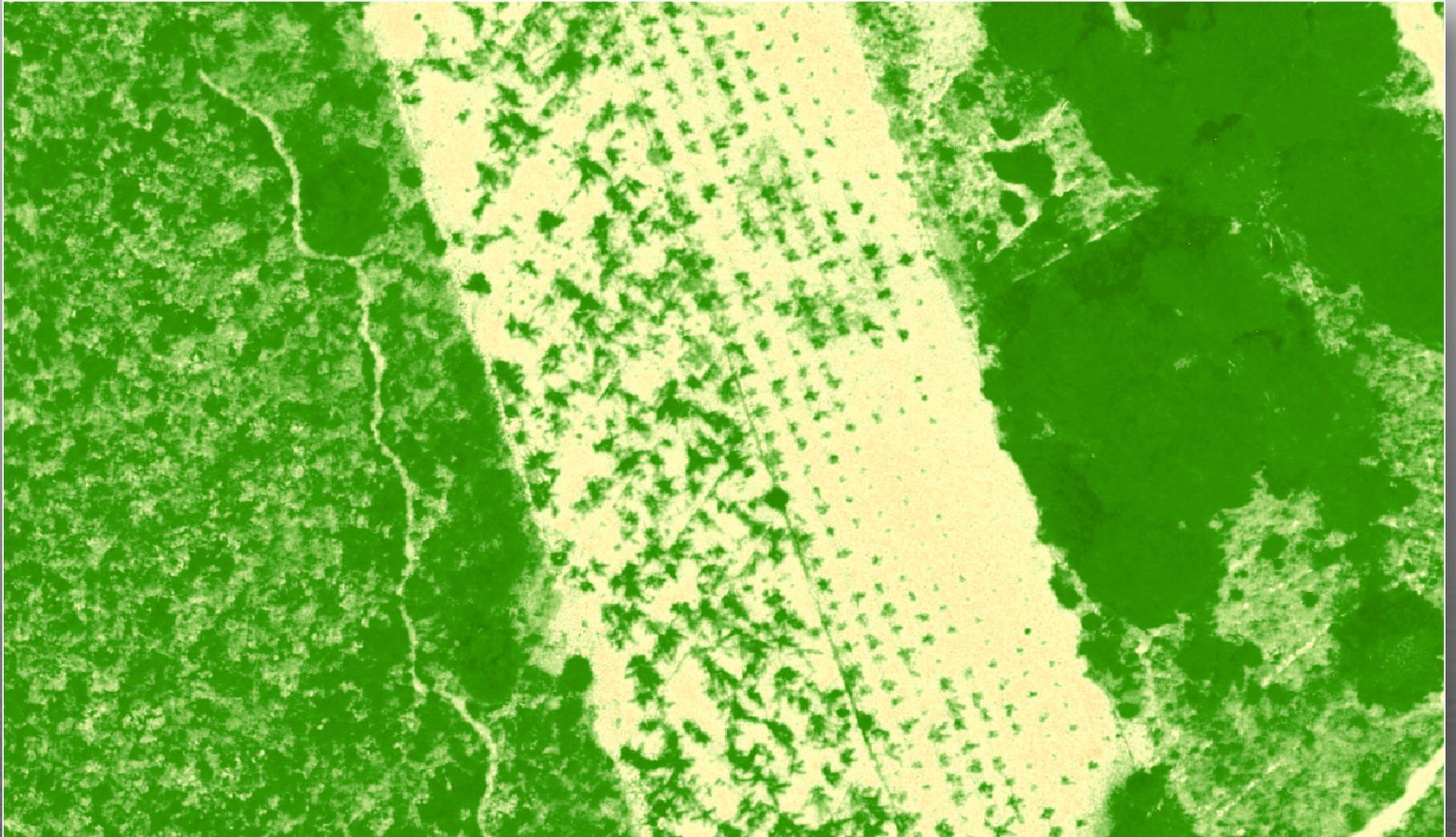
RCD30 IMAGERY – 7CM MOSAIC



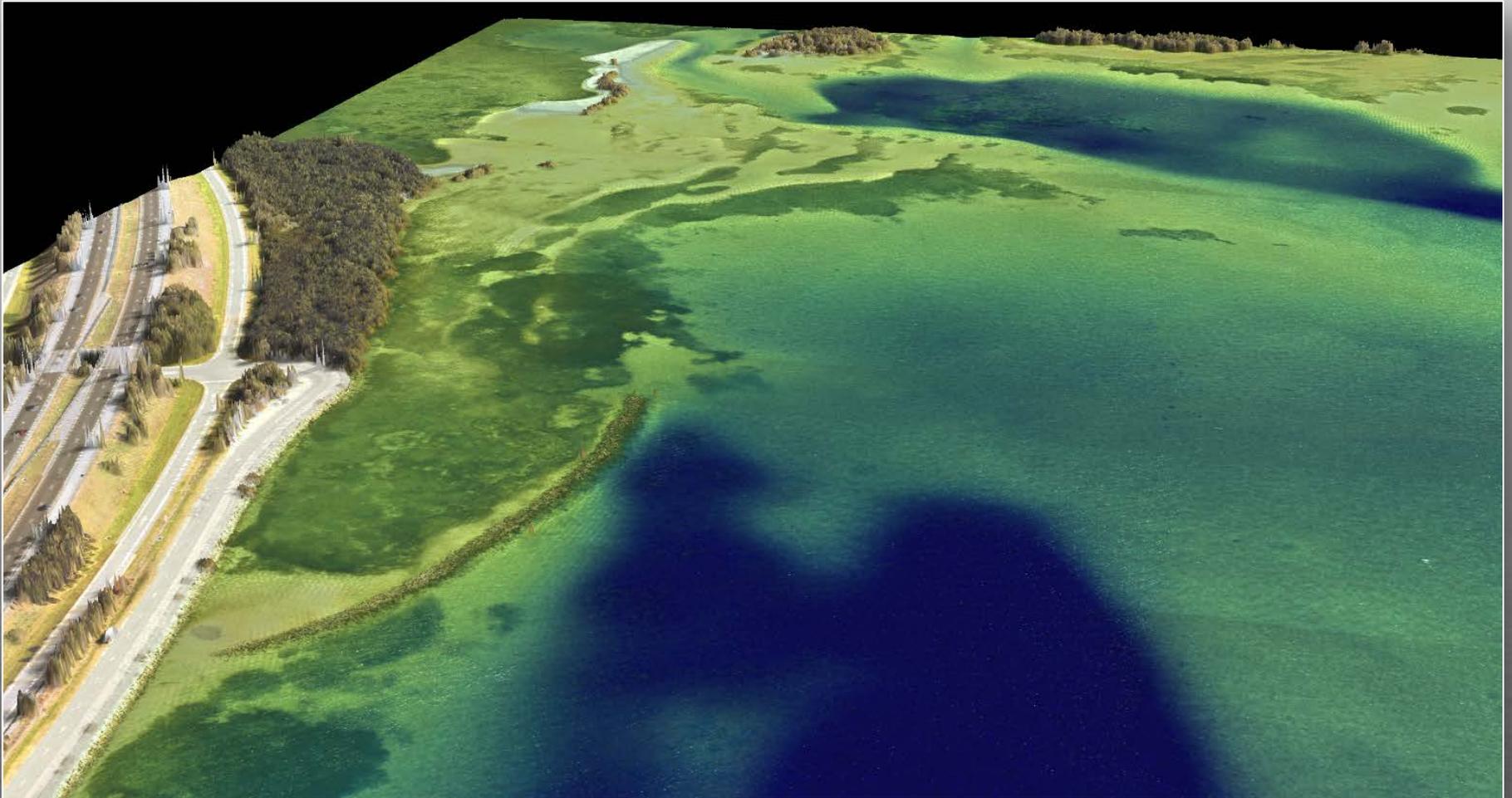
NORMALIZED DIFFERENCE VEGETATION INDEX



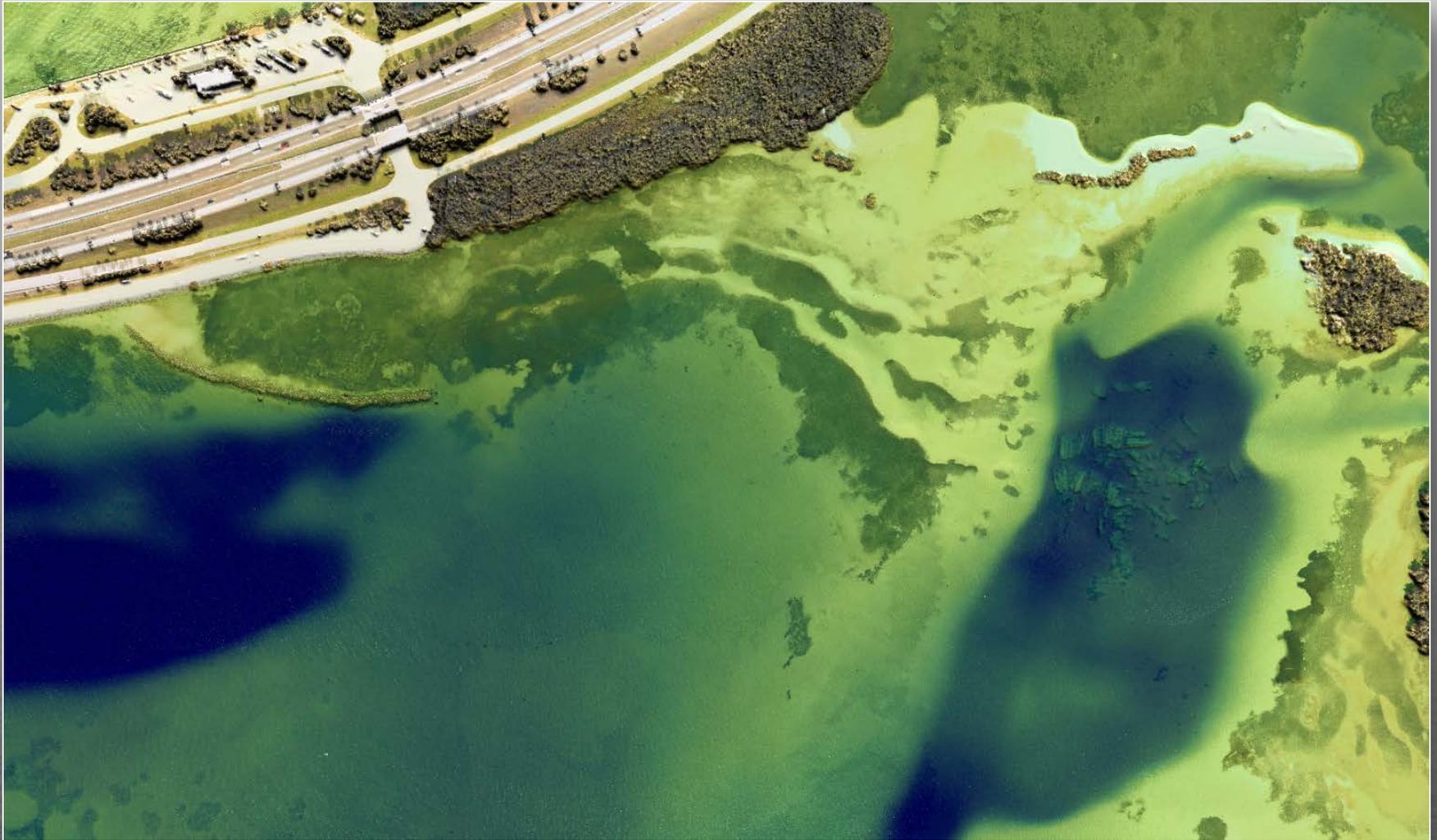




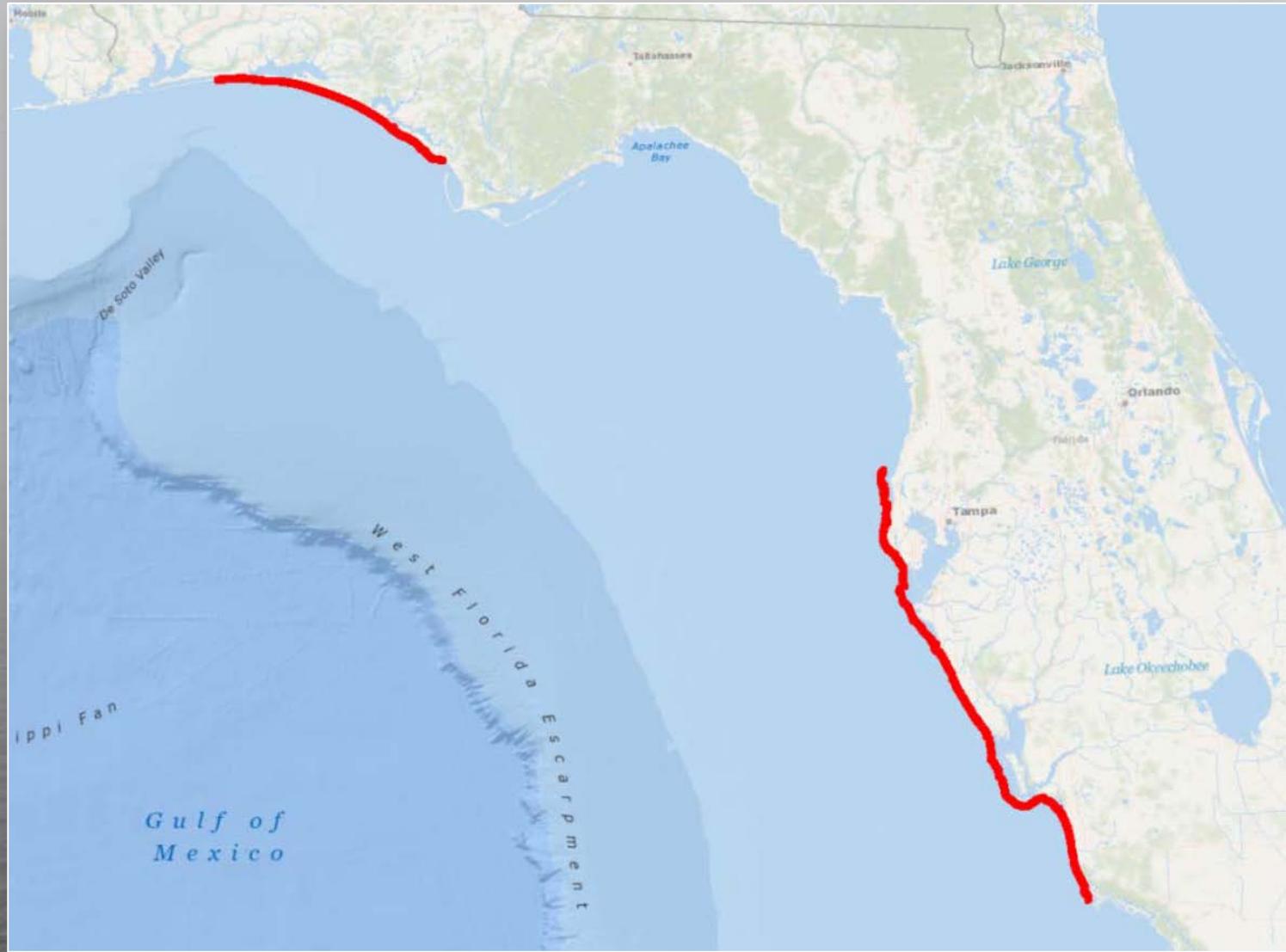
COMBINED LIDAR ELEVATION, INTENSITY AND RCD30



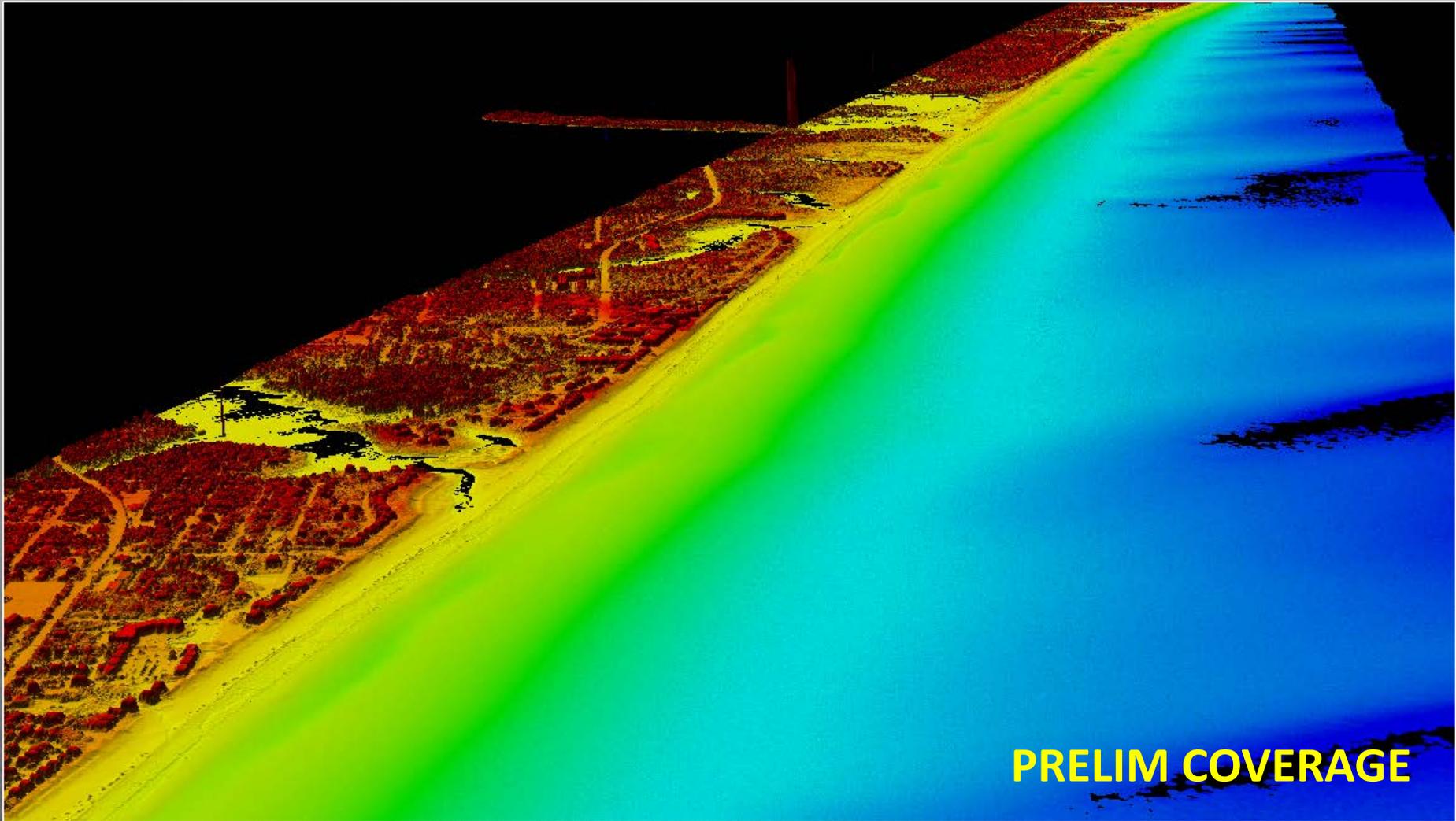
COMBINED LIDAR ELEVATION, INTENSITY AND RCD30



HAWKEYE III – NCMP FLORIDA



HAWKEYE III – NCMP FLORIDA



PRELIM COVERAGE