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PERFORMANCE OF THE RIEGL VQ-880-G LIDAR SENSOR IN MAPPING COASTAL NEAR-SHORE BATHYMETRY

Coastal GeoTools 2017
Wednesday, February 7

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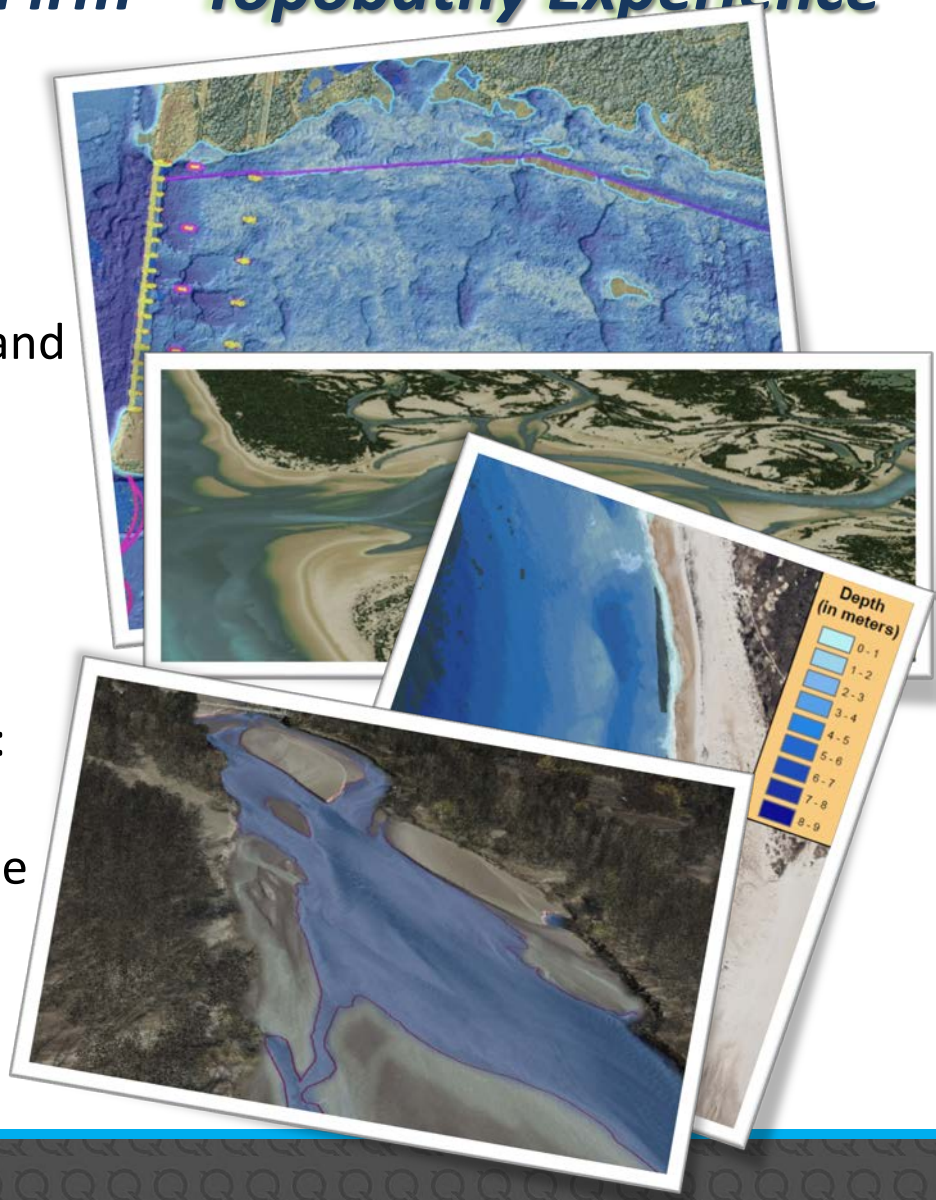
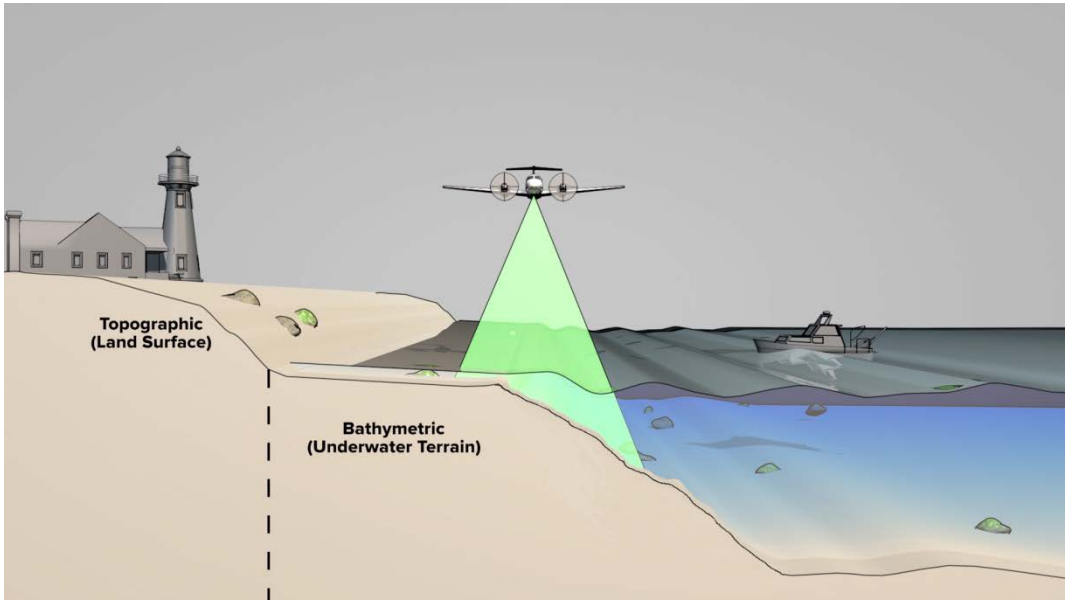
QSI – Full Service GeoSpatial Firm – Topobathy Experience

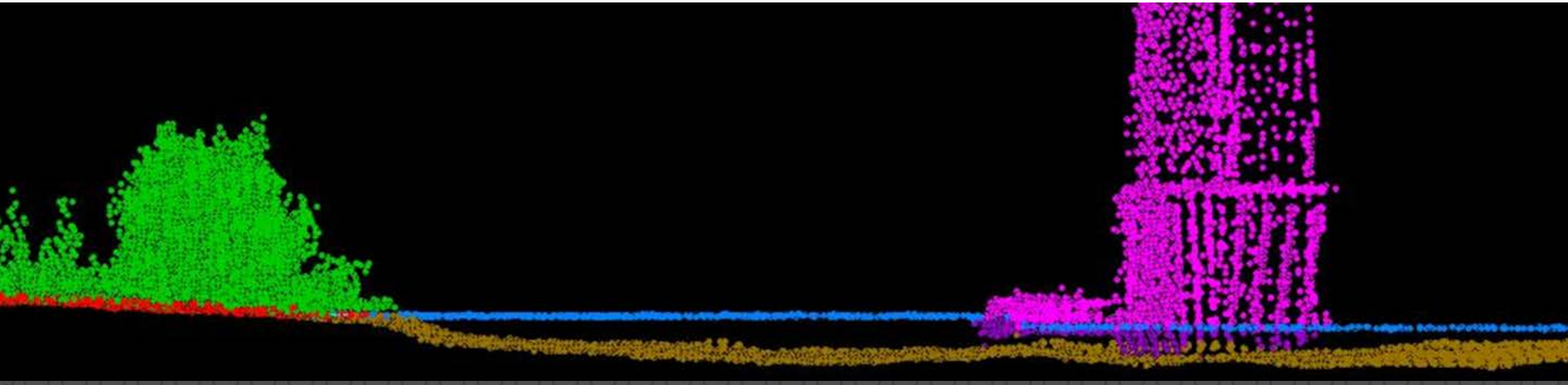
- Started in 2012 with the Sandy River in Oregon
- Over 4,325 square miles surveyed
- 25 states plus New Brunswick, Ontario, and British Columbia
- Over 42 projects
- Growing client base (29+)
- QSI provides remote sensing services nationally under the following contracts:
  - ✓ NOAA NGS Shoreline Mapping
  - ✓ USGS Geospatial Product and Service Contract(GPSC) III
  - ✓ USACOE JALBTCX (AE) Survey and Mapping Support Services



Topobathy: extending the survey under water

- Using green wavelength lidar to create a seamless survey





Shallow Water – Airborne Hydrographic LiDAR Systems

2002

	USGS EAARL
Pulse Length	1.3 ns
Beam Divergence	1.5 mrad
Max PRF	3KHz
Hydrography	1.5 SD

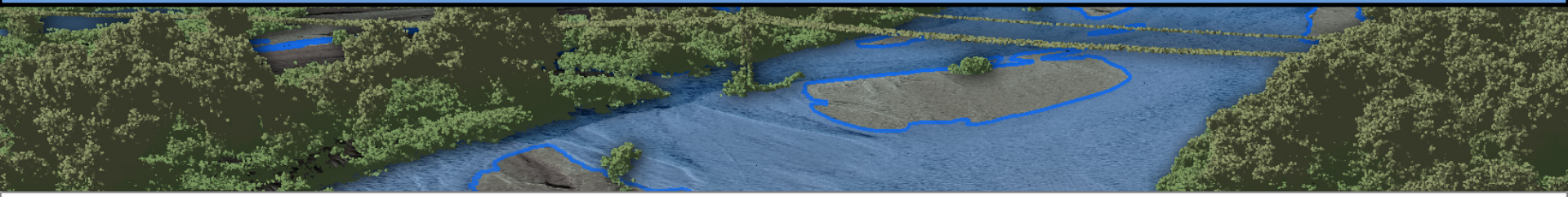
2011 - 2012

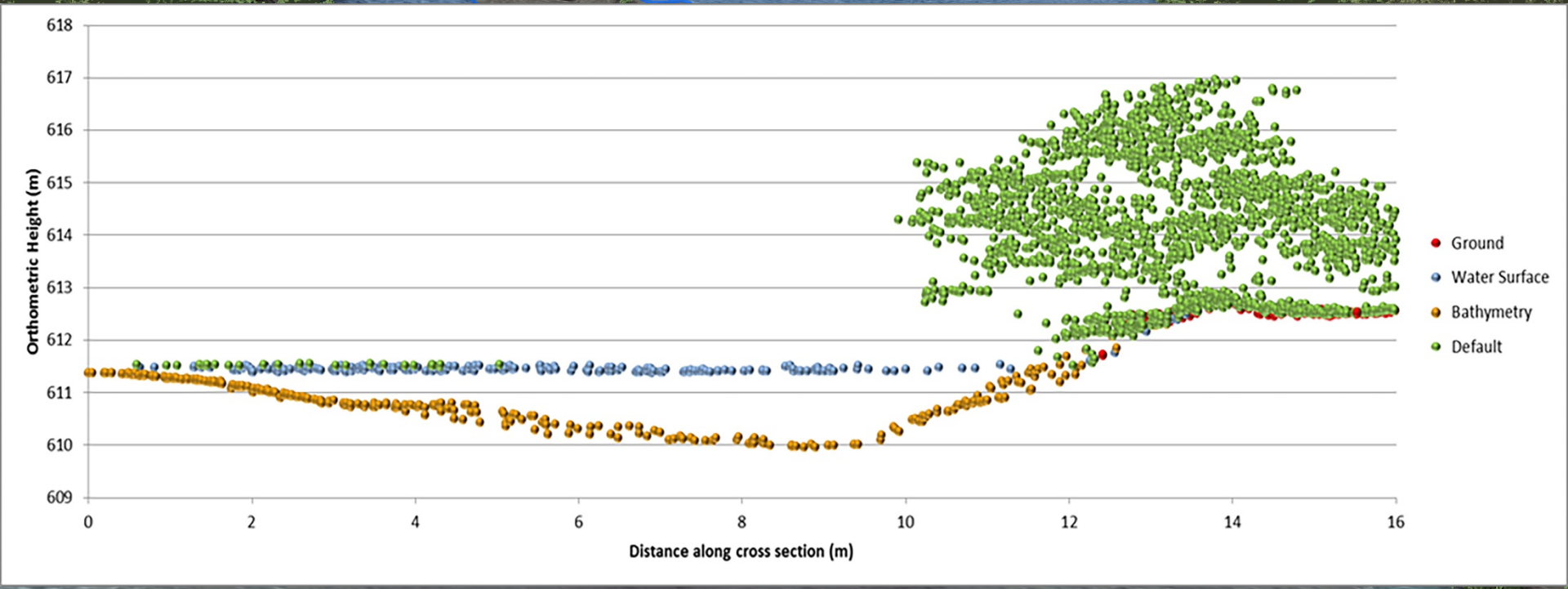
Riegl VQ-820-G	AHAB Chiroptera I	Optech Aquarius
1.0 ns	2.5 ns	NA
1.0 mrad	3.0 mrad	1.0 mrad
285kHz	18 kHz	70KHz
1.0 SD	10 m (for Kd=0.15)	10 m (for Kd < 0.1/m)

2014 - 2015

Riegl VQ-880-G	AHAB Chiroptera II	Optech Titan
500kHz Green 500k Hz NIR	35 kHz Green 500k Hz NIR	300KHz Green IR, NIR
1.5 SD	1.5 SD 3.0 SD (Option)	NA

Topobathy DEM with above ground lidar returns





How it helps

Lay the foundation for sound decision making

Sea Level Rise Viewer

View potential impacts of sea level rise along the coast

Contributing Partners

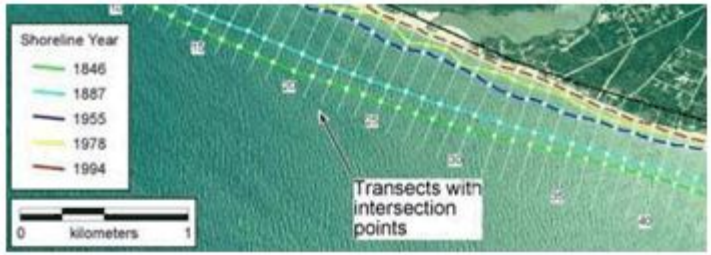
NOAA OCM

Riverine Flood Inundation Maps

View riverine flood forecasts in a visual format

Contributing Partners

FEMA, NOAA NWS, NOAA OCM, USACE, USGS



Digital Shoreline Analysis System

Computes the rate of shoreline change using multiple historical shoreline positions

Contributing Partners

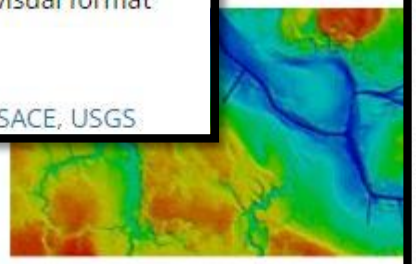
USGS

Sea Level Affecting Marshes Model

Simulates potential impacts on wetlands and shorelines from long-term sea level rise

Contributing Partners

EPA, Warren Pinnacle Consulting



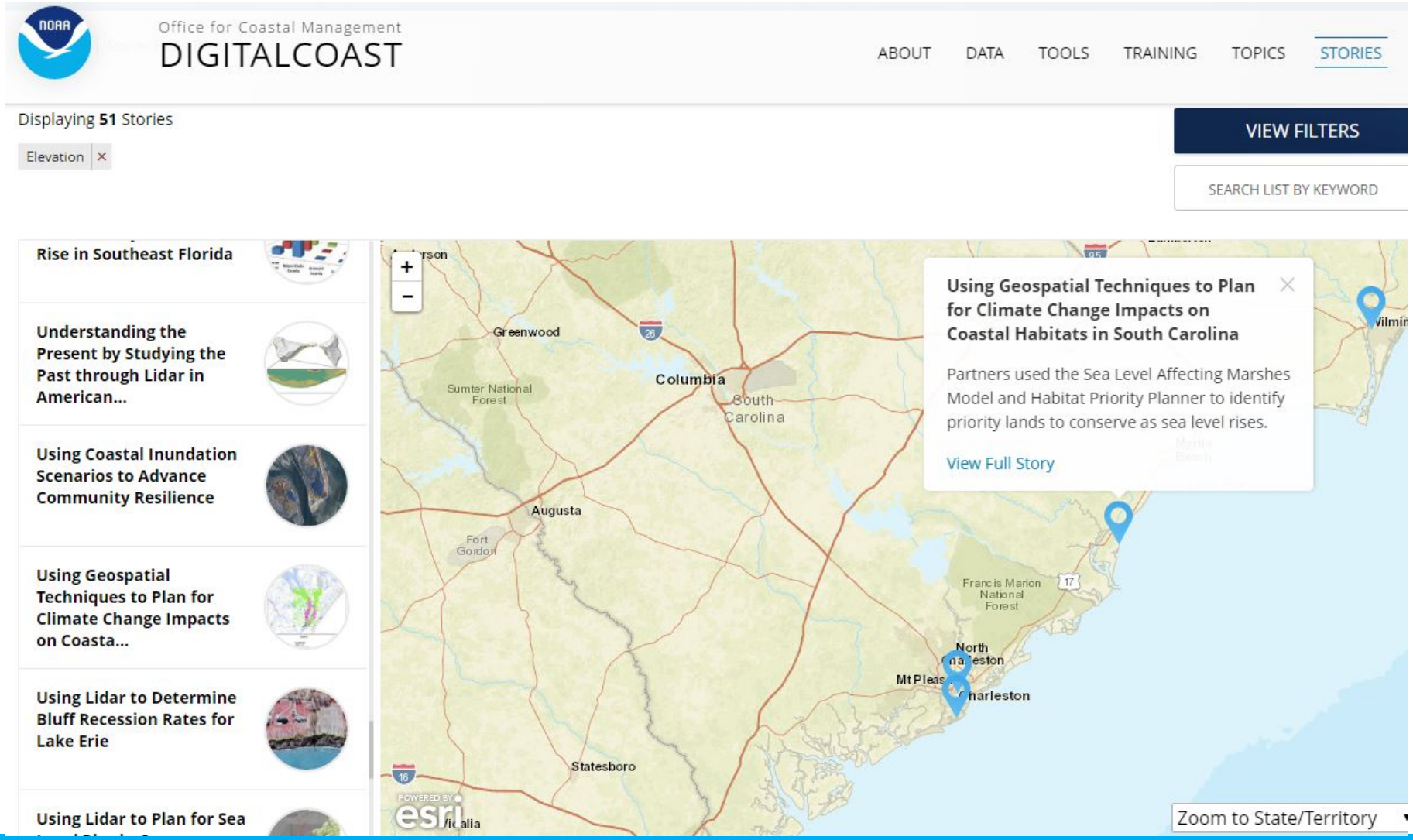
VDatum

Vertically transforms geospatial data between a variety of tidal, orthometric, and ellipsoidal datums

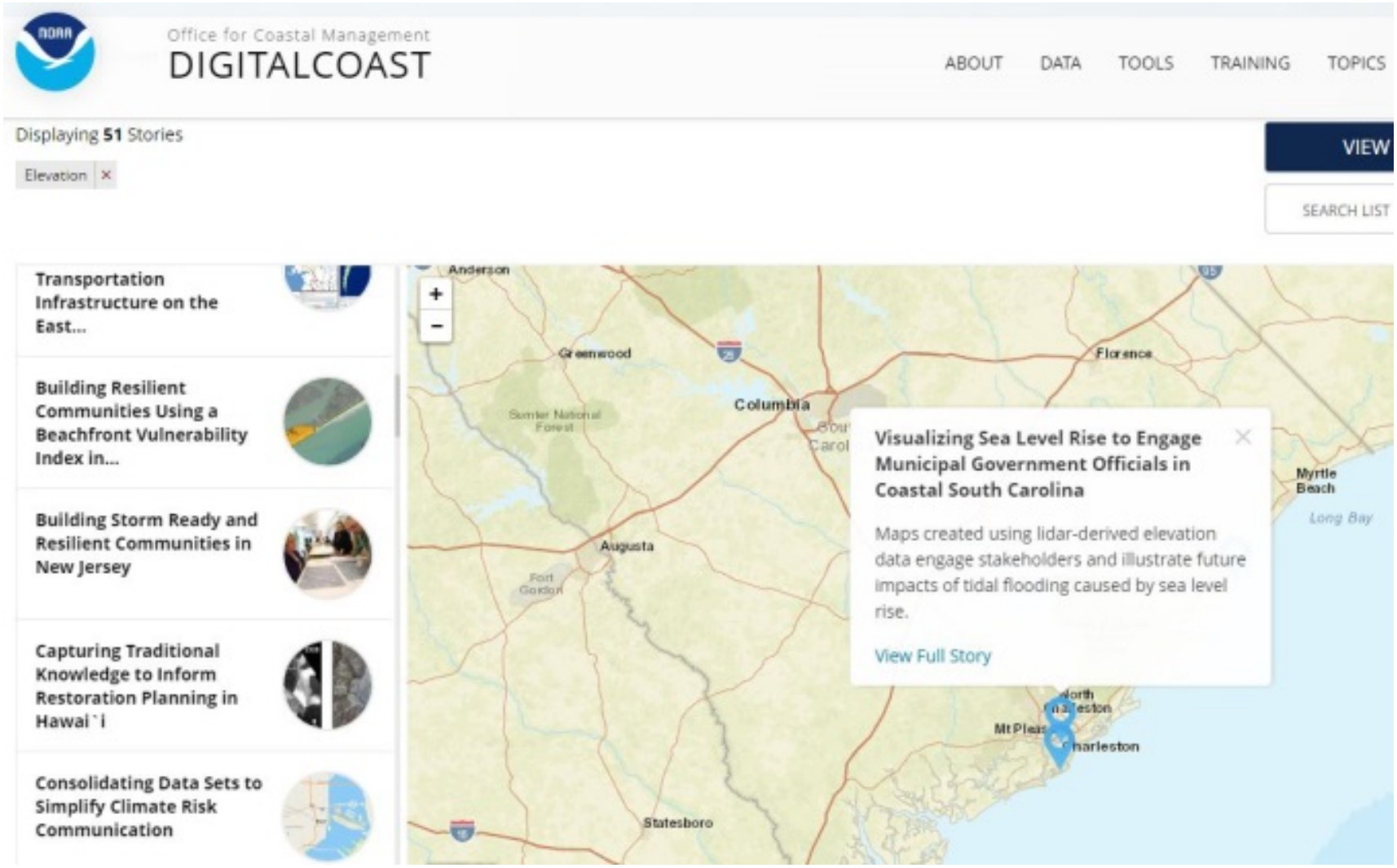
Contributing Partners

NOAA CO-OPS, NOAA NGS, NOAA OCS

Stories right here in SC using elevation data



Stories right here in SC using elevation data

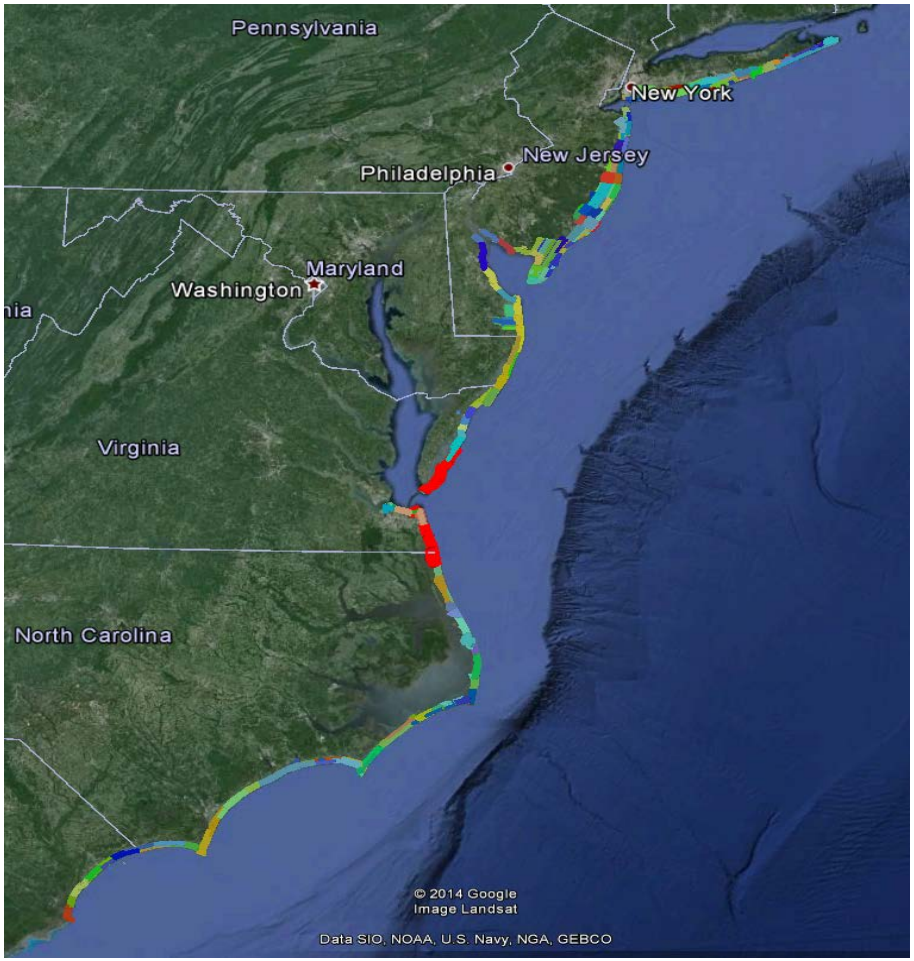


Sandy Topo-Bathymetric Project (2013/14)

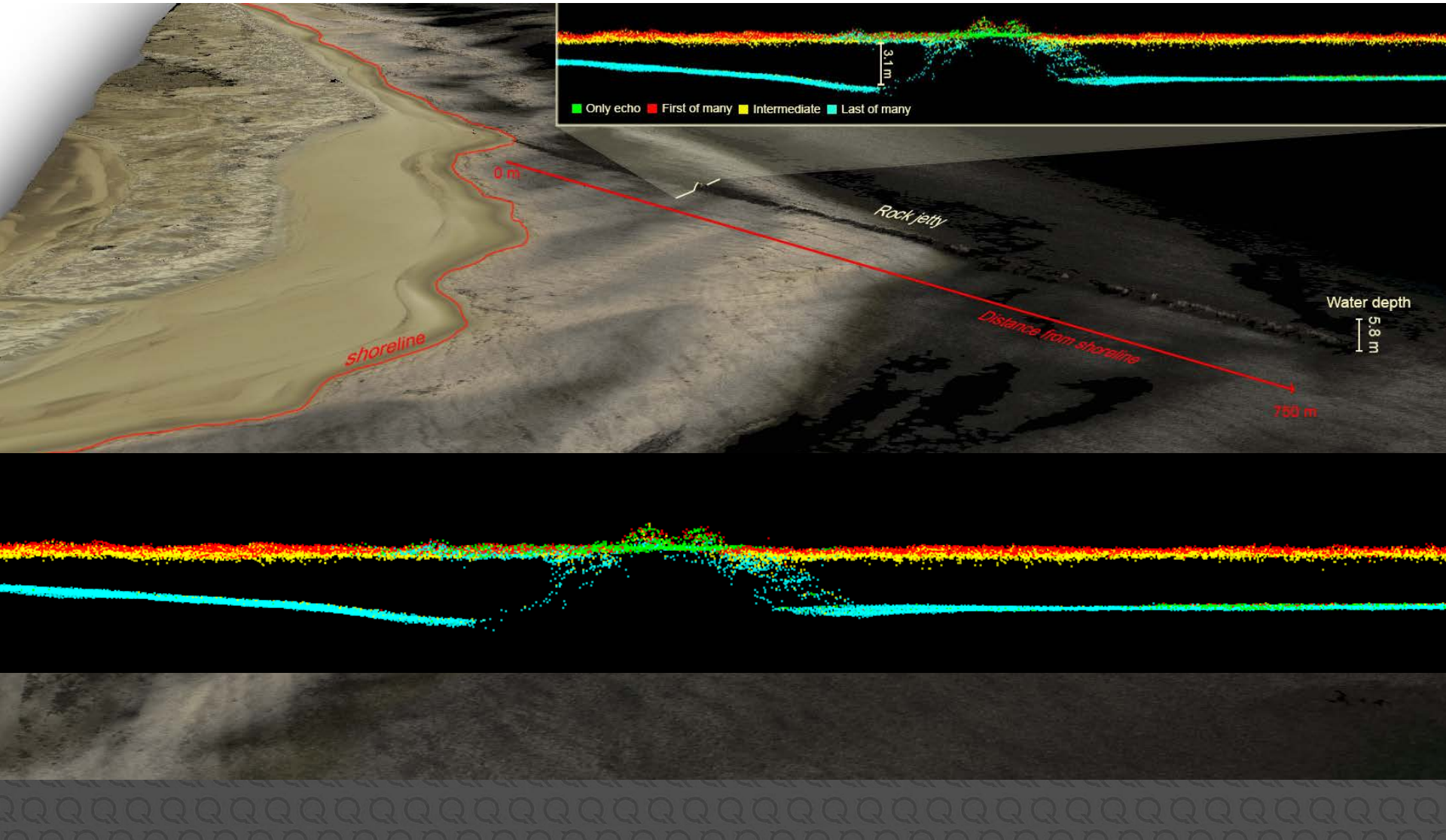
- NOAA - National Geodetic Survey (NGS) Shoreline Mapping Program

- Foundational data needed for:
  - ✓ Coastal Zone Management
  - ✓ Inundation Modeling
  - ✓ Habitat Mapping

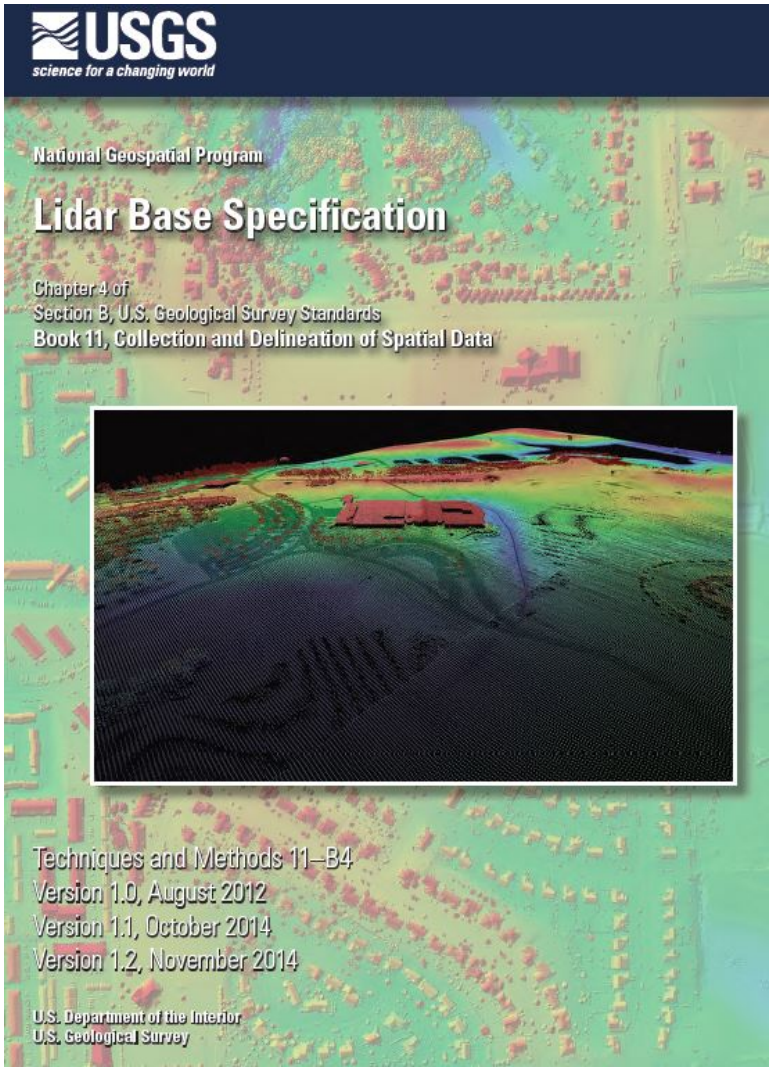
- Deployed three Riegl VQ-820-G topo-bathymetric sensors

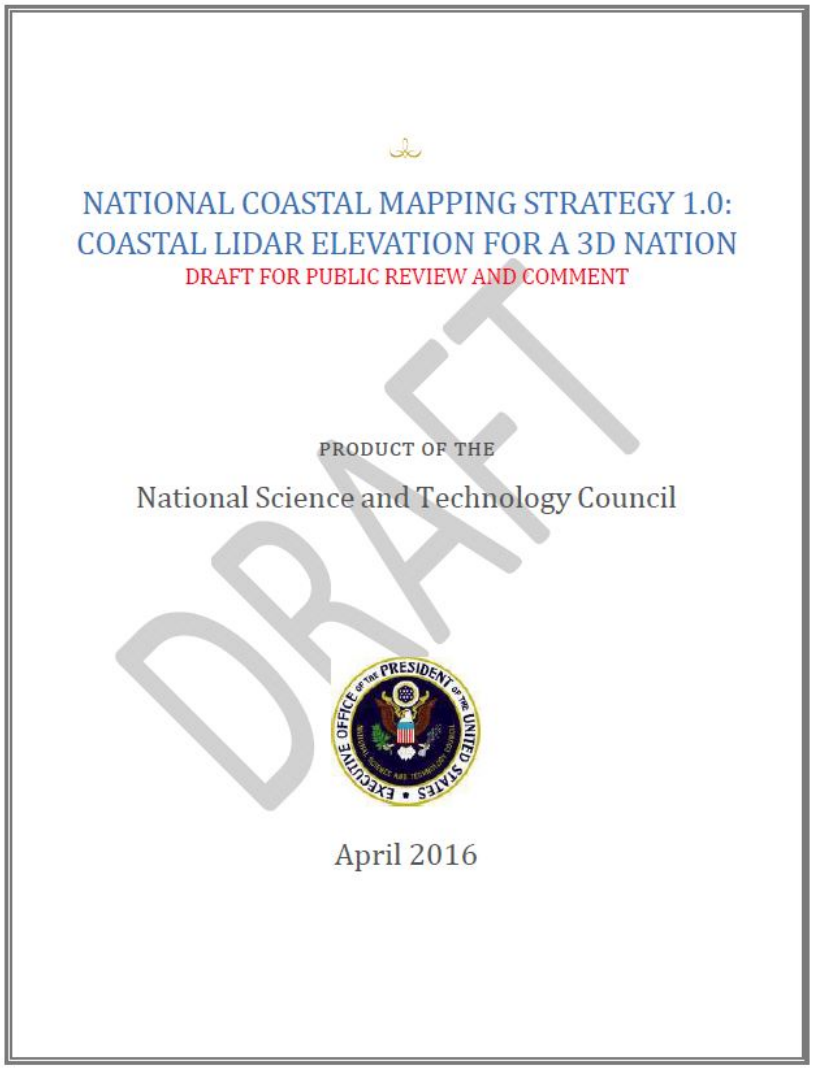


Sample Results/Profiles



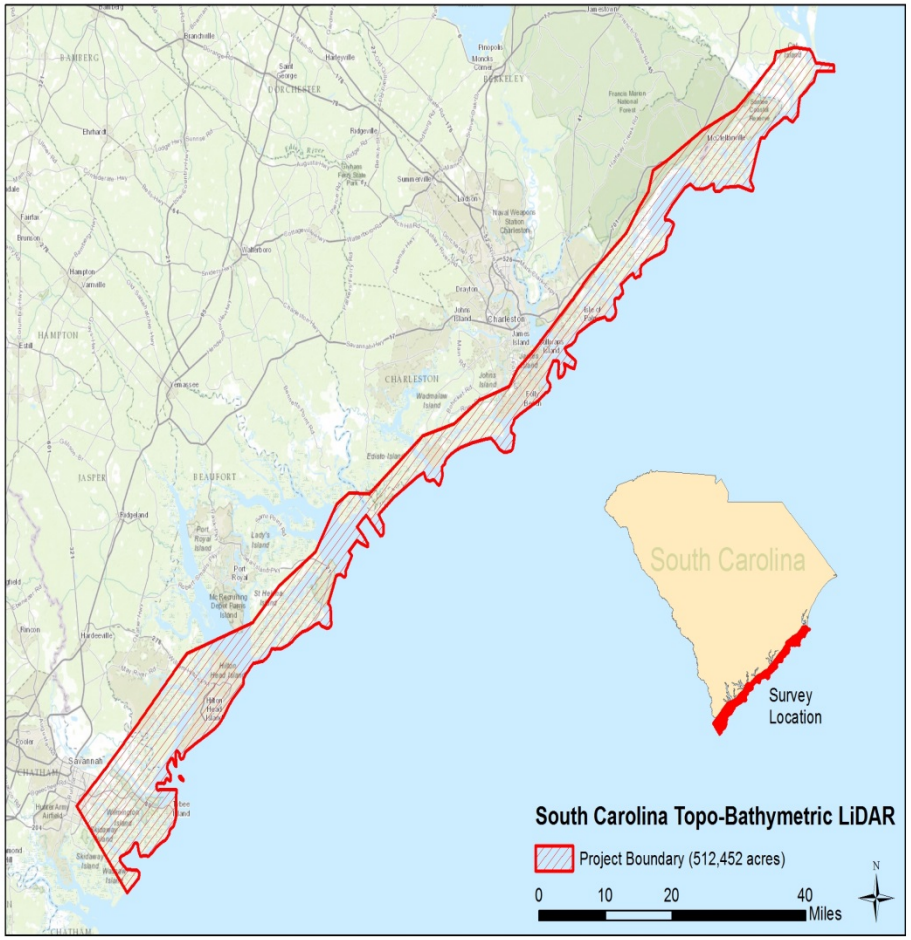
USGS spec & National Coastal Mapping Strategy





South Carolina Topo-bathy Project

Topo-Bathymetric LiDAR Settings and Spec.	
Aircraft	Cessna Caravan
Sensors	Riegl VQ-880-G
Survey Altitude (AGL)	400 m
Swath Overlap	30% side-lap
Field-of -View	40º (20º off-NADIR)
Single Swath Density	≥ 15 pulses/m^2
No. of Flight Lines	1,289
Flight Line Length	8,454 nautical miles
GPS Baselines	≤ 13 nm
Primary Control Monuments	16 Existing, 8 New
Collection Conditions	Clarity-dependent, within 20% of Mean Range around MLLW



Riegl VQ-880-G

circular and linear
scan pattern

- High Pulse Rate (284 kHz for SC)
- Online waveform digitizing
- Integrated IMU
- 1.5 Secchi Depth “depth rating”

Yaquina Bay, Oregon (Port of Newport)

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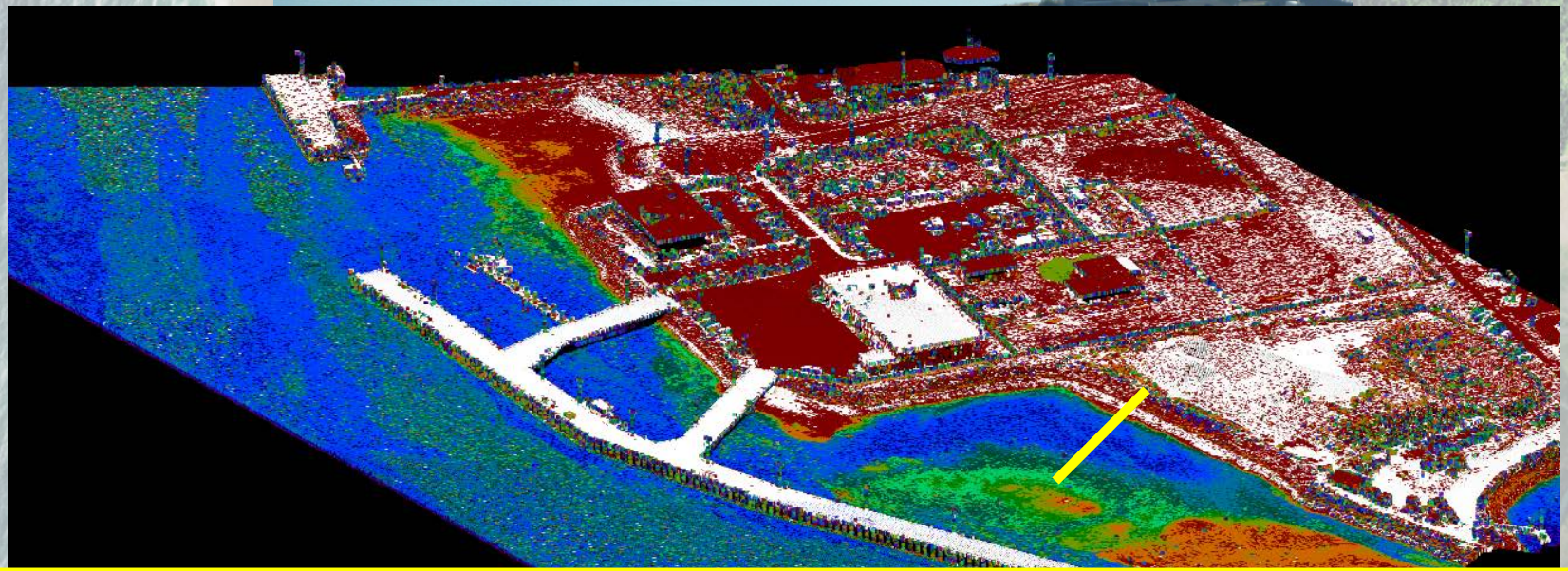
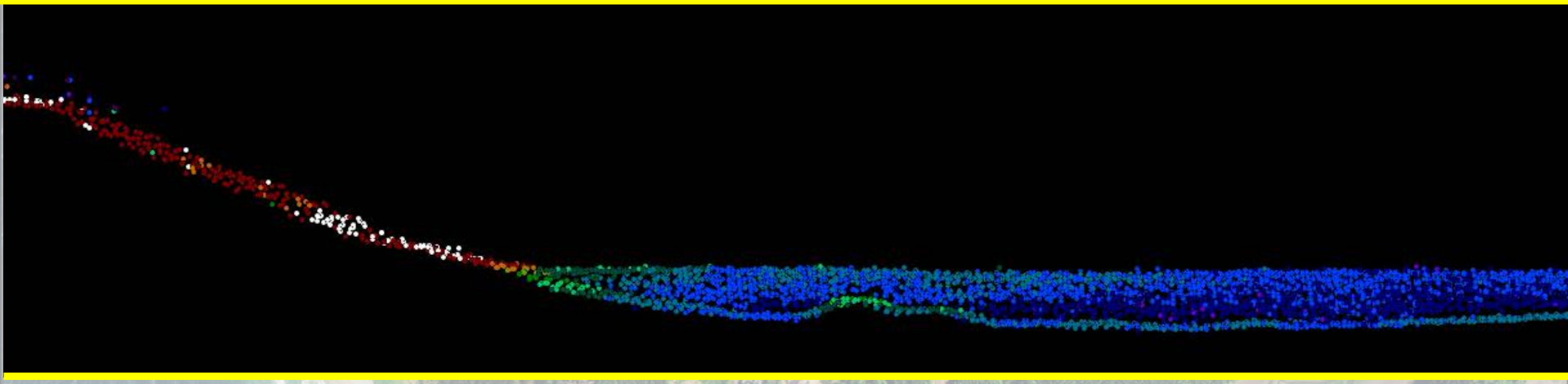
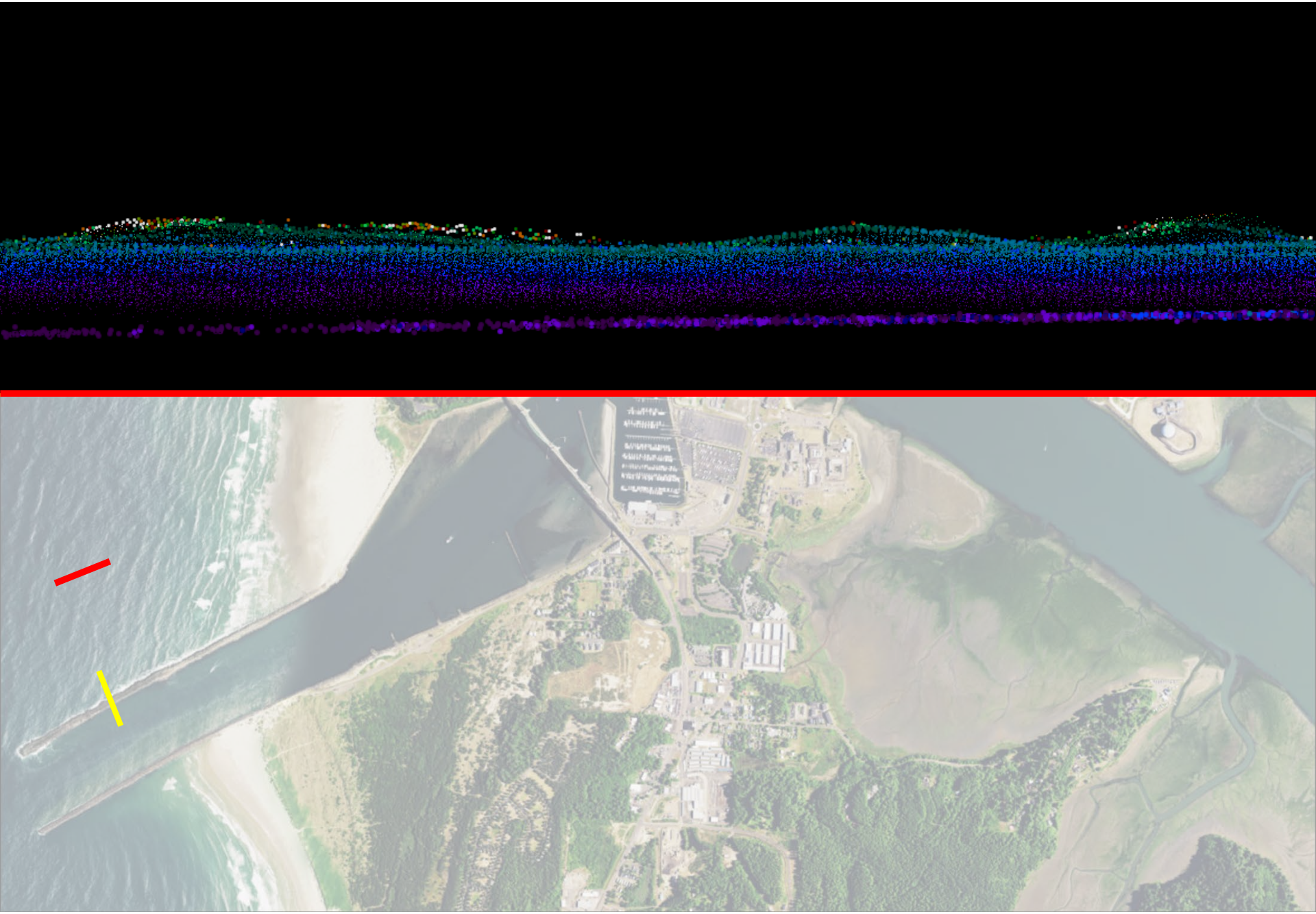
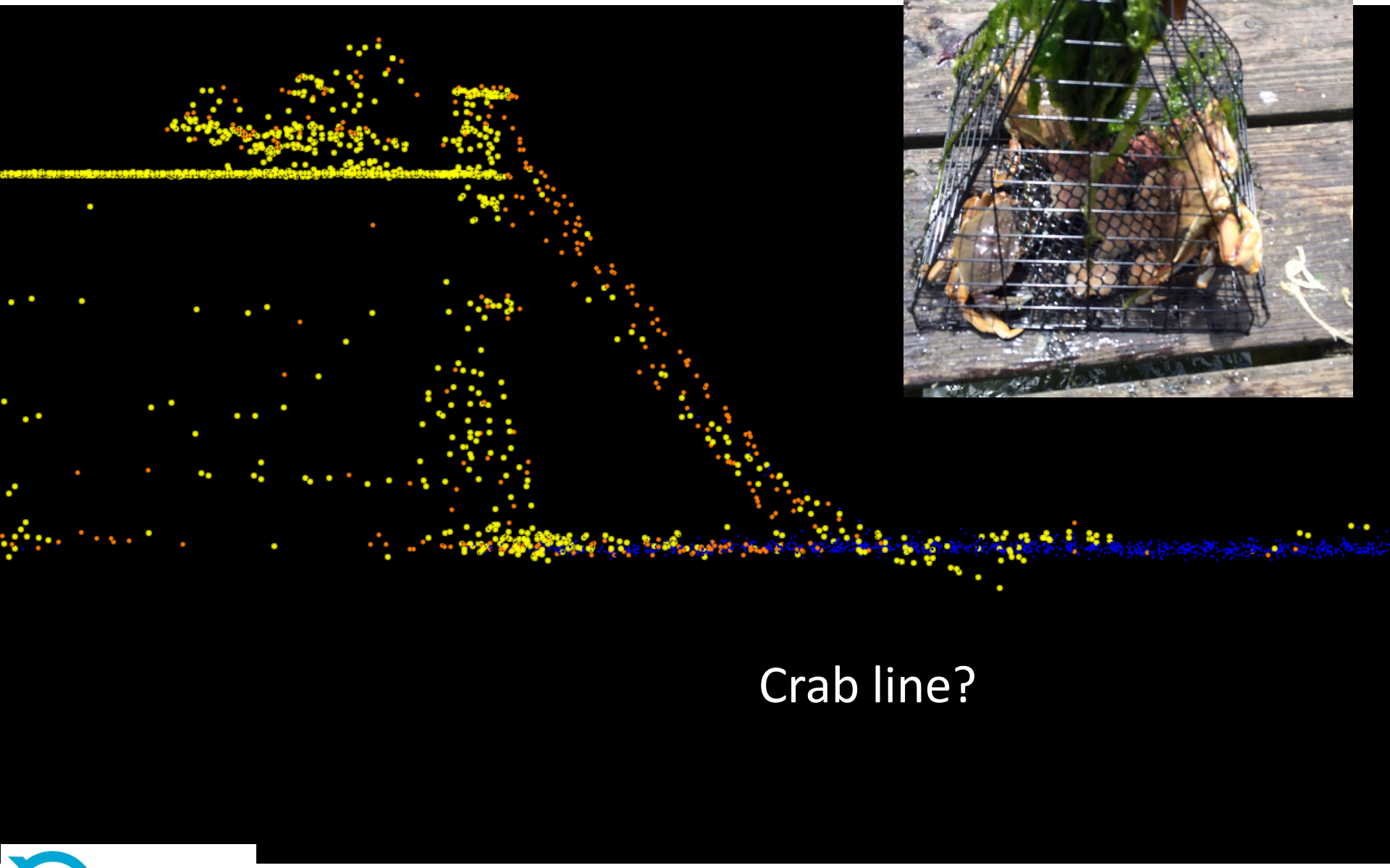
NOAA Marine Operations Center









Crab line?

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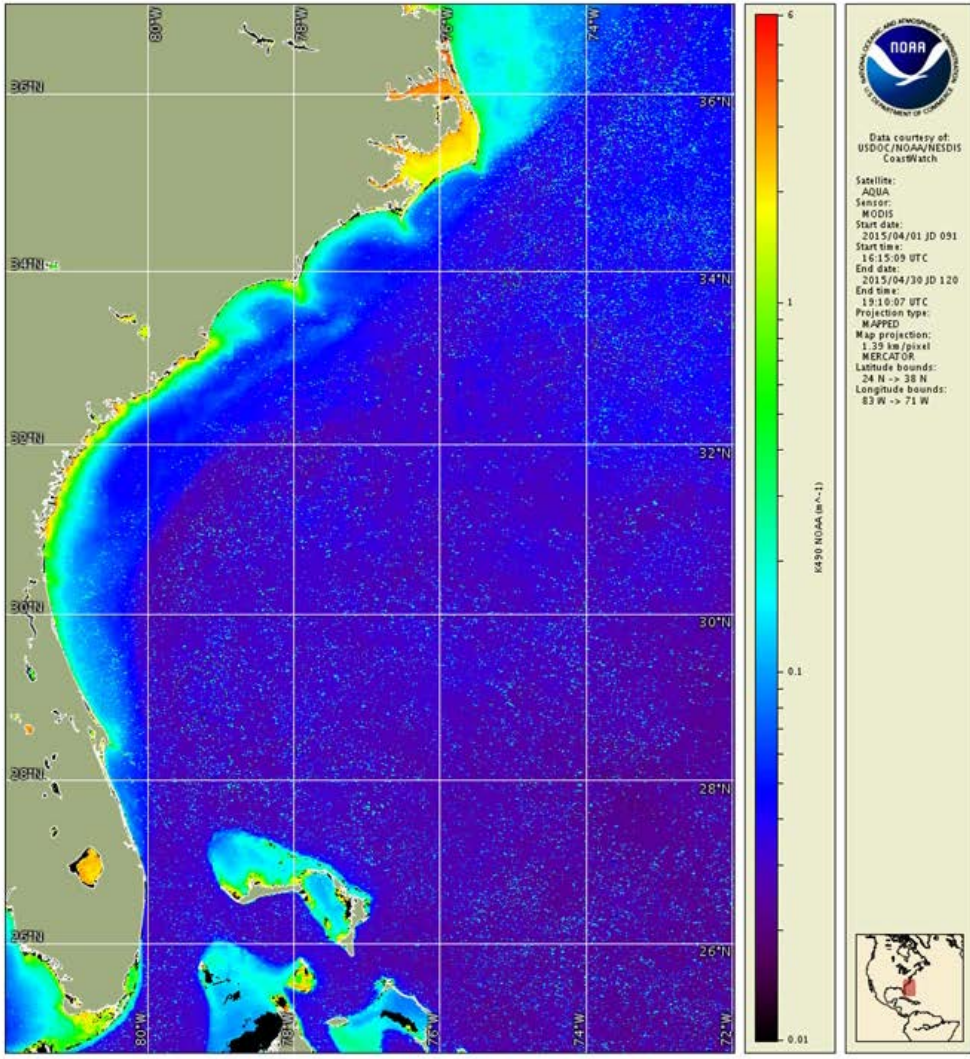
Coast of Florida – Test Data

Back to South Carolina

Predicting Water Clarity

- Qualitative water clarity assessments based on existing imagery and satellite data.
- Site observations of local conditions and trends.
- Quick look analysis of topo-bathymetric data as it is collected.



South Carolina Water Clarity

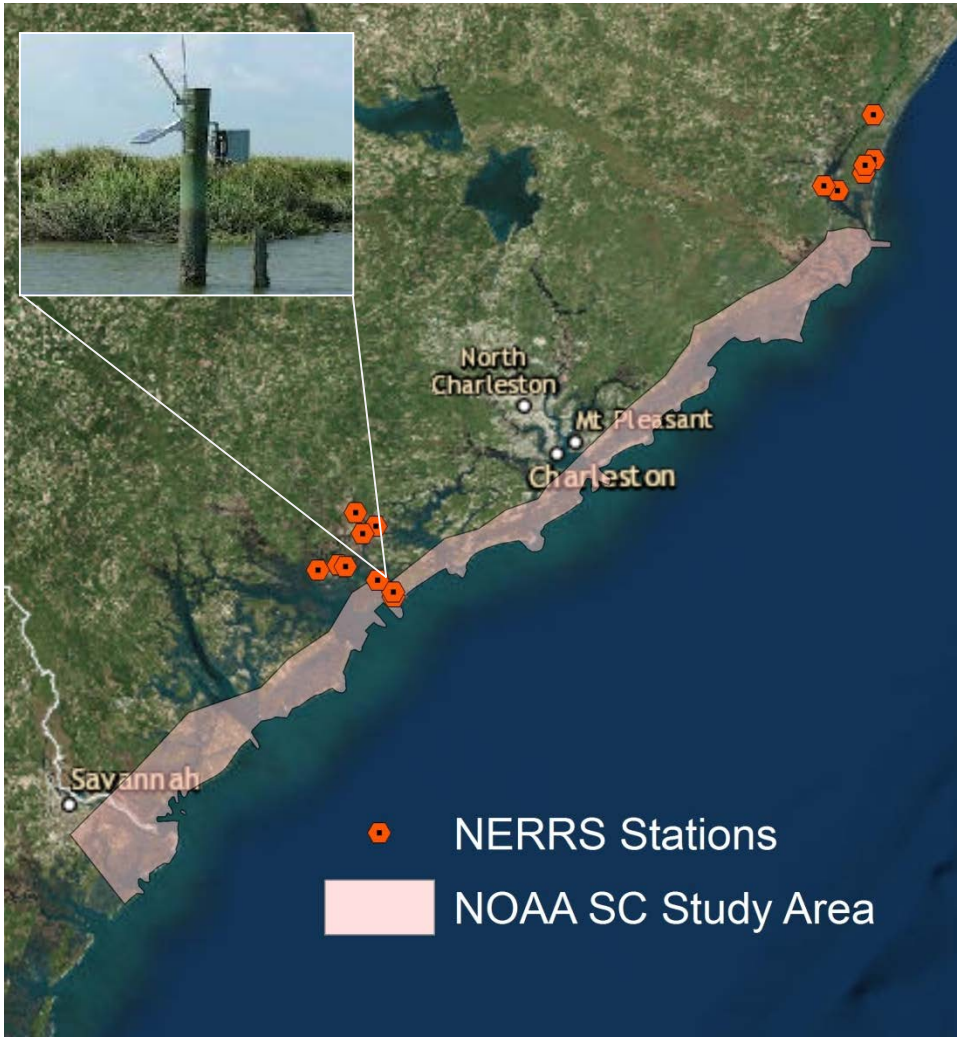
- High local spatial and temporal variability
- How to quantify trends and “optimal” conditions?
- How many “optimal” flight days do we get a in a month, in a year?

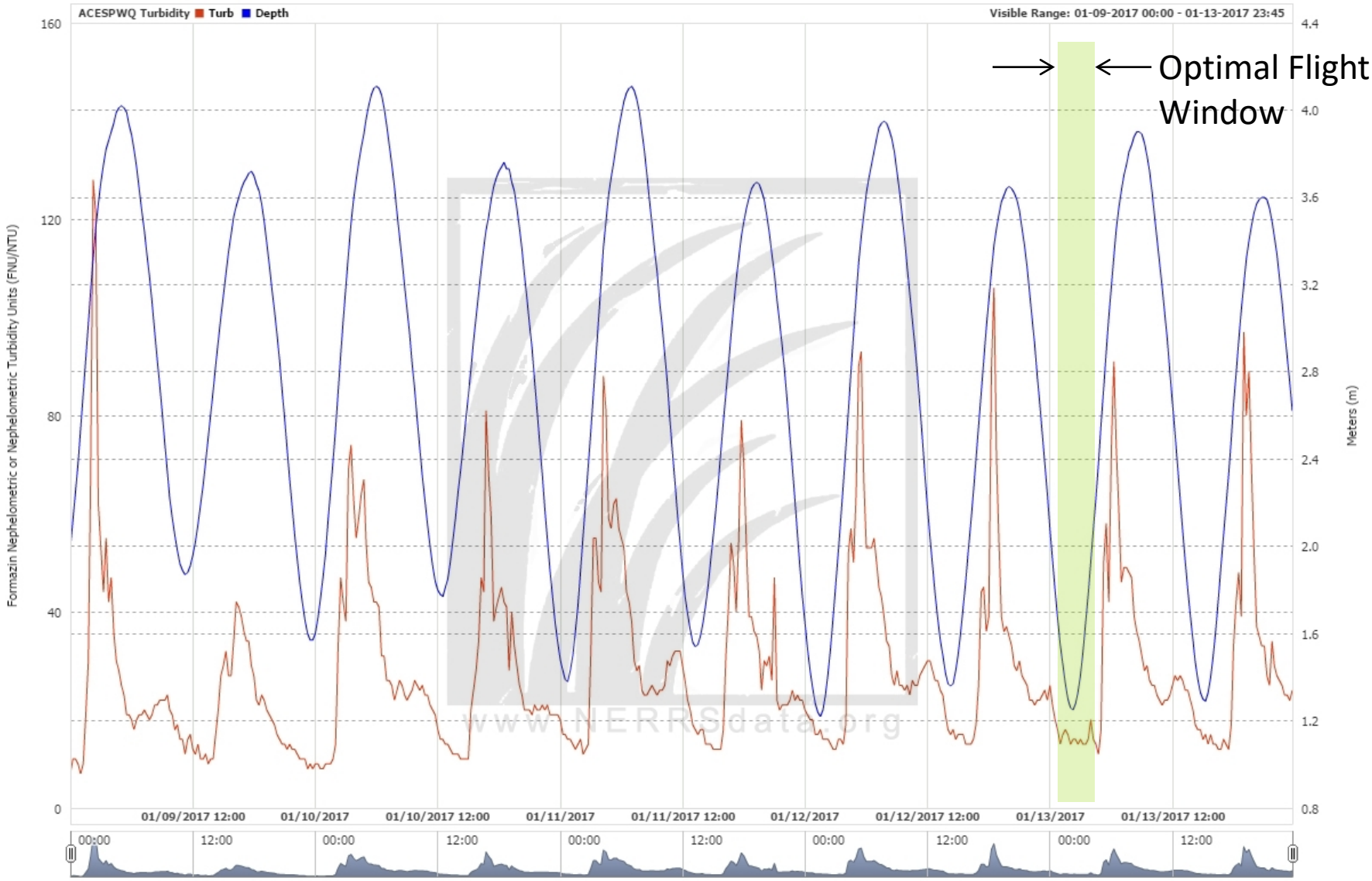

Wind Speed & Direction
South Carolina 1/29/2017

Predicting Water Quality

National Estuarine Research Reserve System (NERRS)

Water Quality Monitoring Stations

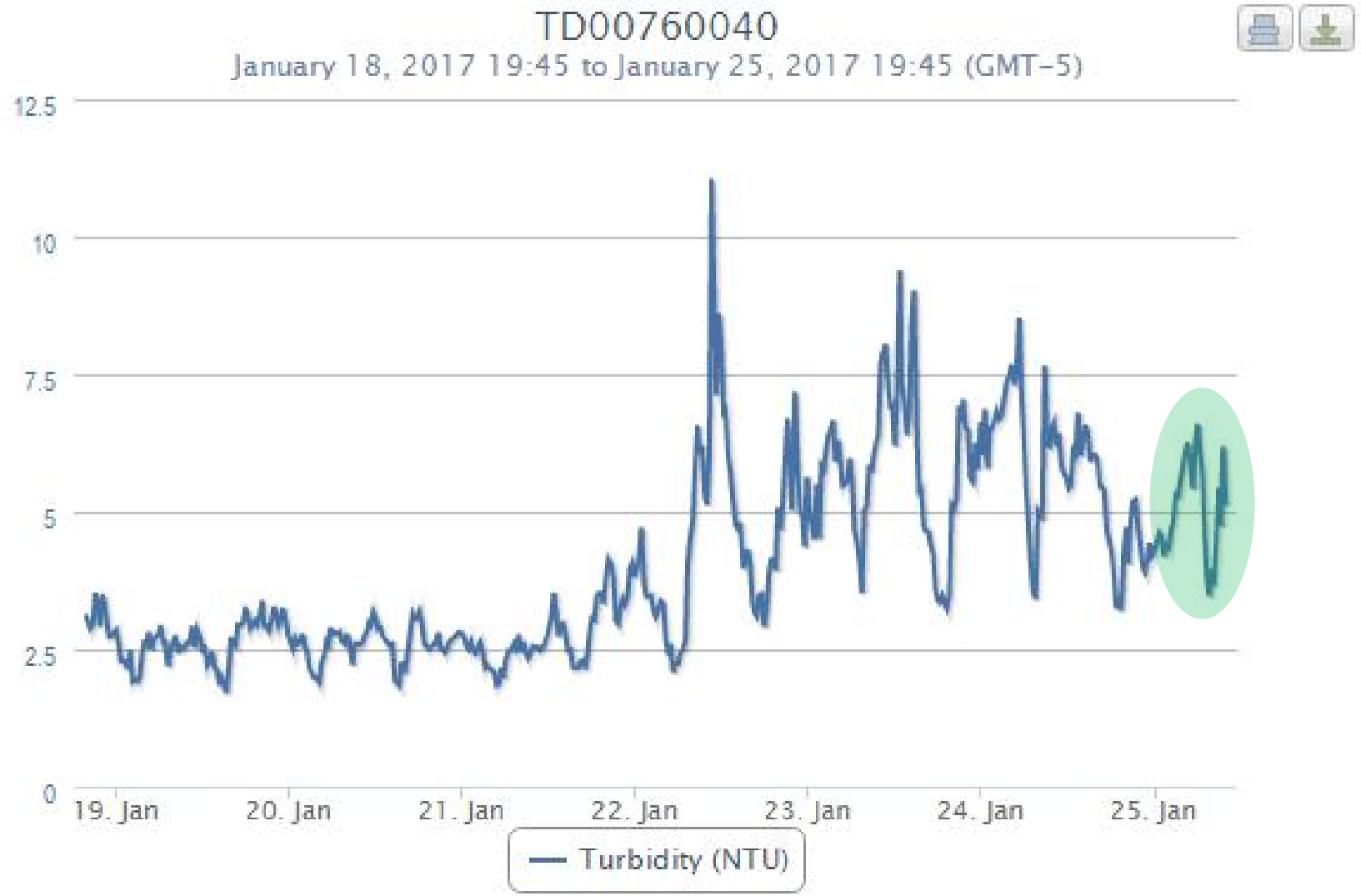


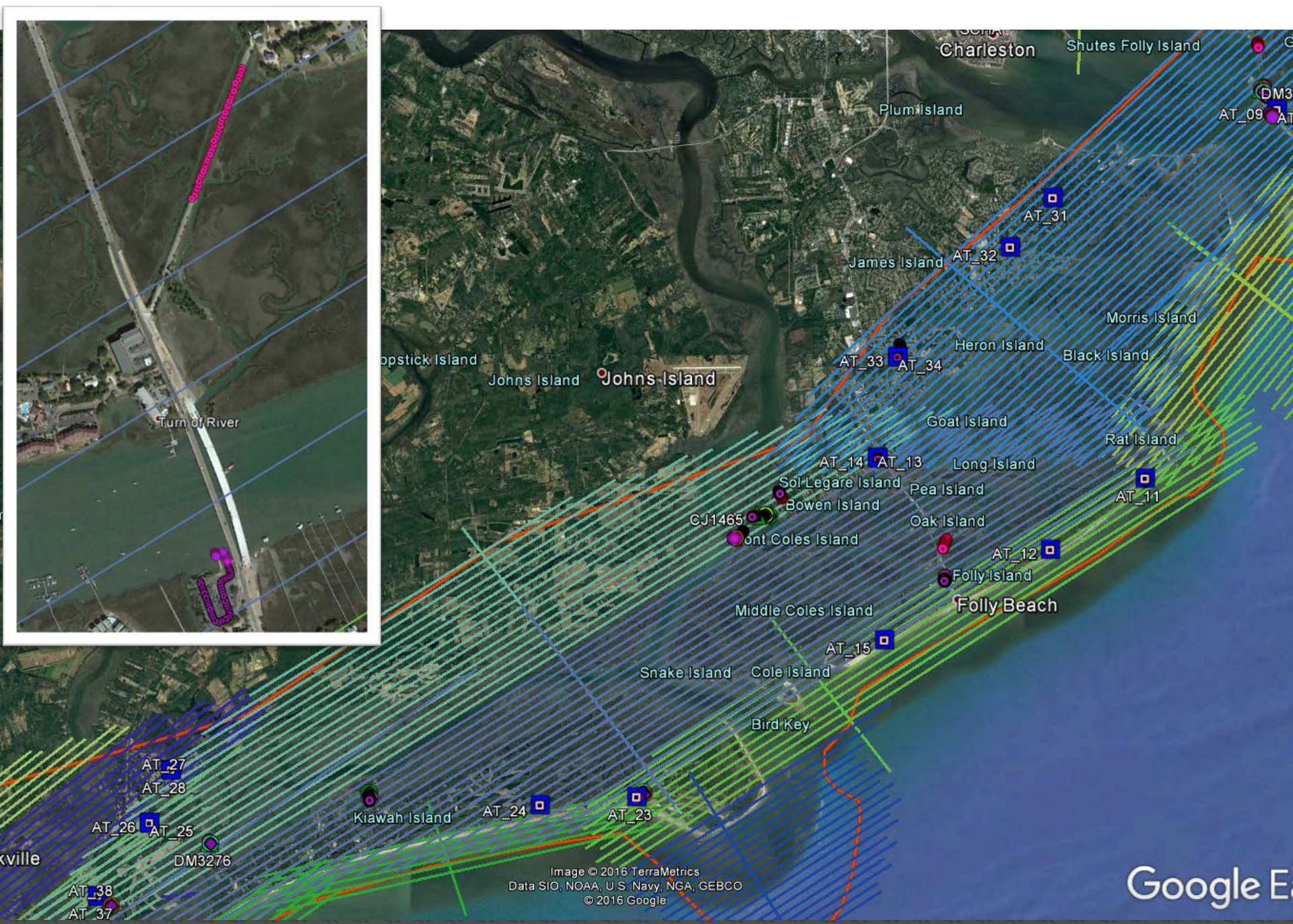

ACESPWQ Turbidity Turb Depth
Visible Range: 01-09-2017 00:00 - 01-13-2017 23:45
Optimal Flight Window
Formazin Nephelometric or Nephelometric Turbidity Units (FNU/NTU)
Meters (m)
160
120
80
40
0
4.4
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
01/09/2017 12:00
01/10/2017
01/10/2017 12:00
01/11/2017
01/11/2017 12:00
01/12/2017
01/12/2017 12:00
01/13/2017
01/13/2017 12:00
00:00
12:00
www.NERRSdata.org

Expanded Monitoring

- NERRS Stations
  - Primarily inland of LiDAR Area-of-Interest
  - Valuable temporal insights, but spatially limited
- QSI Expanded Water Clarity Monitoring
  - Deployment of semi-portable real-time station - more proximate to flight areas
  - Secchi disc and handheld turbidimeter measurements in the flight area
- Improved predictability and bathymetric coverage

Go/No Go(?)


TD00760040
January 18, 2017 19:45 to January 25, 2017 19:45 (GMT-5)
12.5
10
7.5
5
2.5
0
19. Jan
20. Jan
21. Jan
22. Jan
23. Jan
24. Jan
25. Jan
Turbidity (NTU)


Charleston
Shutes Folly Island
Plum Island
AT_09
DM3
AT_31
AT_32
James Island
Morris Island
Heron Island
Black Island
AT_33
AT_34
opstick Island
Johns Island
Johns Island
Turn of River
Goat Island
Rat Island
AT_14
AT_13
Long Island
Sol Legare Island
Pea Island
AT_11
Bowen Island
CJ1465
Oak Island
ont Coles Island
AT_12
Folly Island
Folly Beach
Middle Coles Island
AT_15
Snake Island
Cole Island
Bird Key
AT_27
AT_28
AT_26
AT_25
DM3276
Kiawah Island
AT_24
AT_23
AT_38
AT_37
Image © 2016 TerraMetrics
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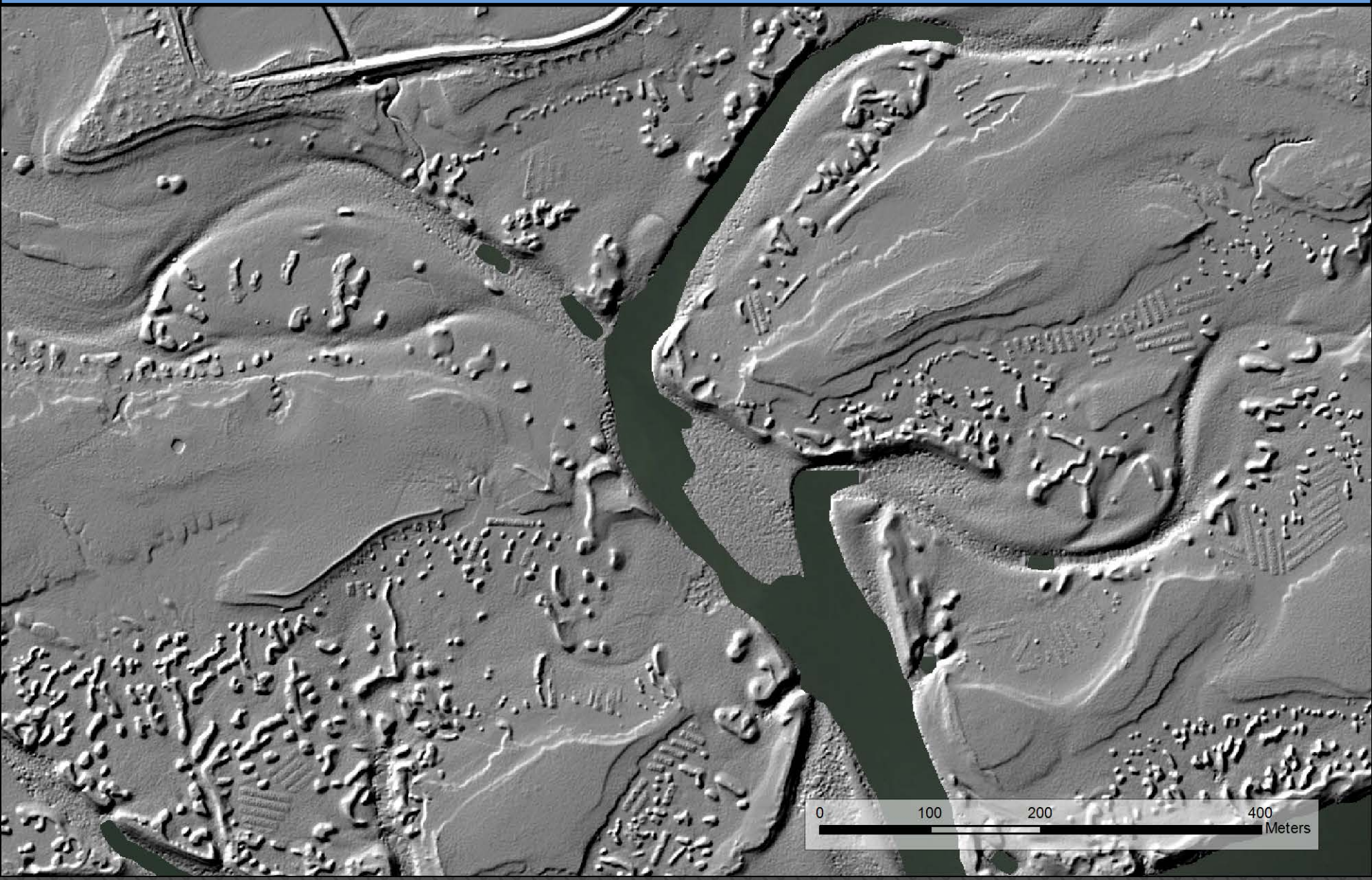
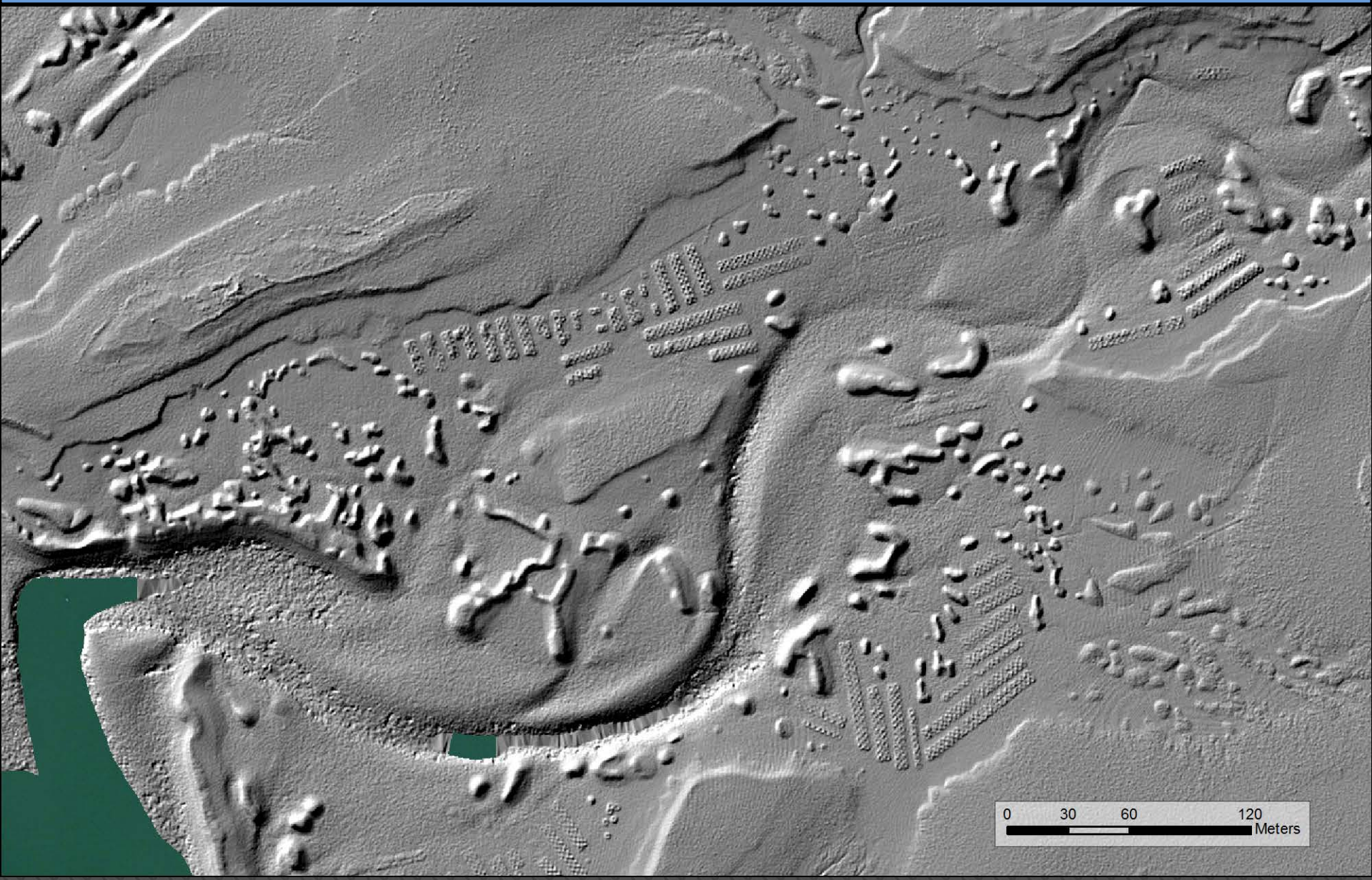
Back bay marshes and mudflats behind Kiawah Island, SC : **2016 NOAA NGS topobathy lidar**

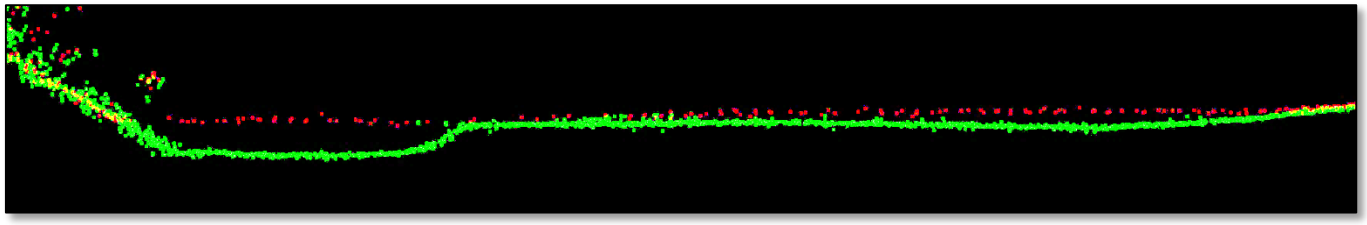


Back bay marshes and mudflats behind Kiawah Island, SC : **2016 NOAA NGS topobathy lidar**

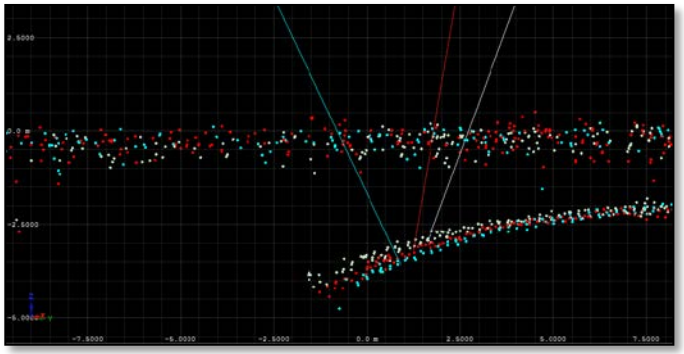


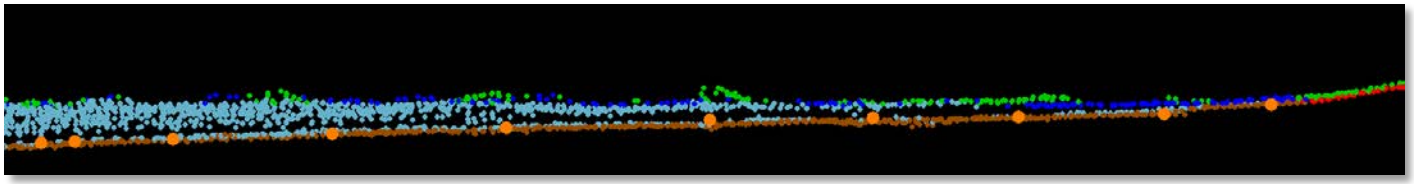
Refraction

- Water surface classification
  - Classify waters surface from NIR points (in static environments) or green surface points in ocean environments



- Refraction
  - Refract points based on distance from waters surface and angle of incidence





- QAQC
  - Verify refracted point alignment between swaths, and against ground control points

Summary

- Topo-bathymetric LiDAR is providing foundational data to support coastal resilience and coastal intelligence.

- QSI has deployed next generation LiDAR technology (Riegl VQ-880-G) in a range of riverine and coastal environments.
  - Increased depth performance, resolution, and collection/processing efficiency.

- QSI is actively acquiring data along the South Carolina Coast.
  - Water clarity is highly variable – field monitoring has helped increase precision of LiDAR collections
  - Terrain models will vastly improve the currency and resolution of existing data.

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