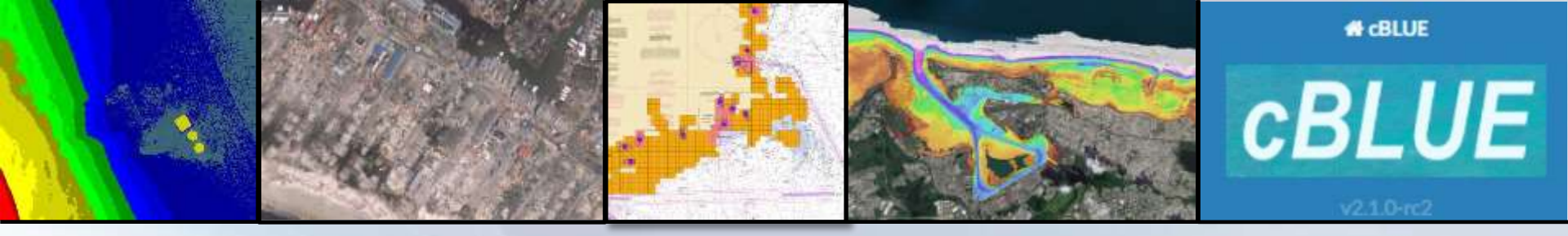


NOAA's National Geodetic Survey, Remote Sensing Division and Quantum Spatial

Hurricane Florence Supplemental

National Oceanic and Atmospheric Administration

quantum SPATIAL AN NV5 COMPANY

National Geodetic Survey

Mission: Define, maintain and provide access to the National Spatial Reference System.

RSD Primary Programs:

Aeronautical Survey Program

Coastal Mapping Program

Emergency Response

National Oceanic and Atmospheric Administration

The RSD Coastal Mapping Program

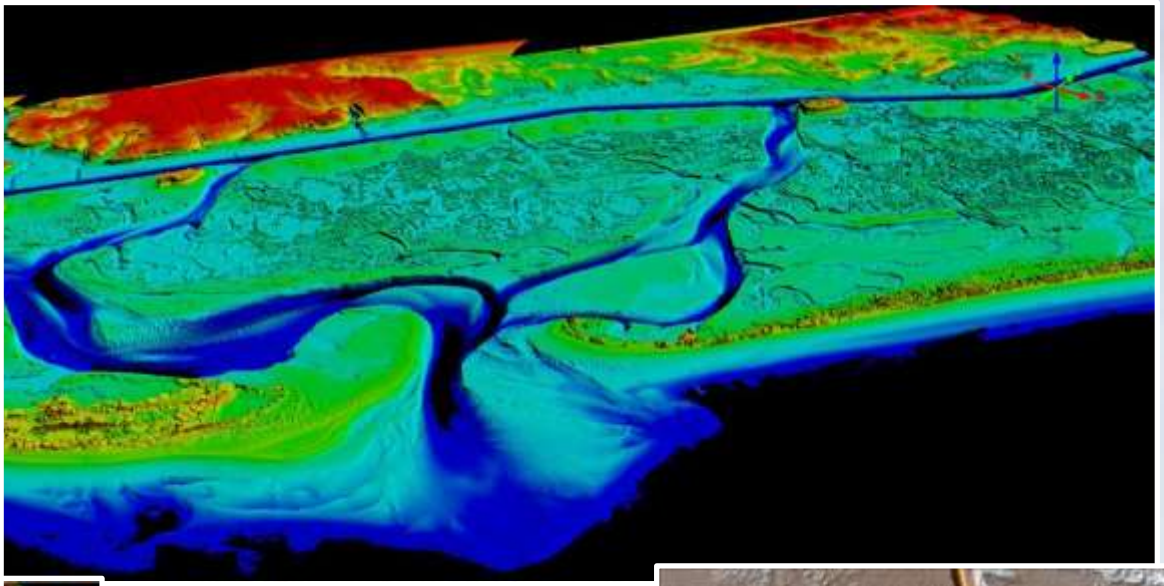
- **A congressional mandate to conduct remote sensing surveys of coastal regions of the United States and its possessions for demarcating the nation's legal coastline.**

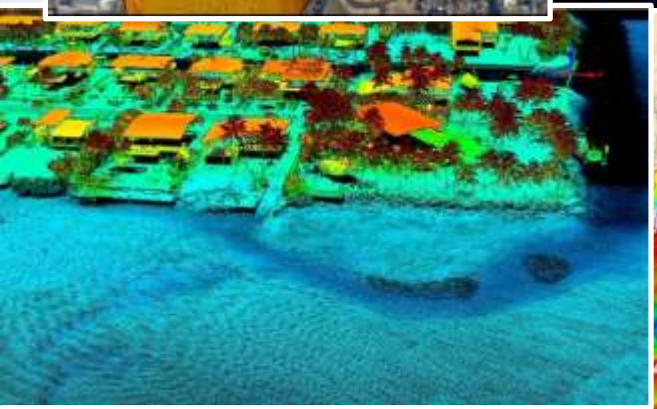
- **Goals:**
  - Provide the Nation With Accurate, Consistent, Up-to-Date National Shoreline
  - Acquire Nearshore Elevation Data

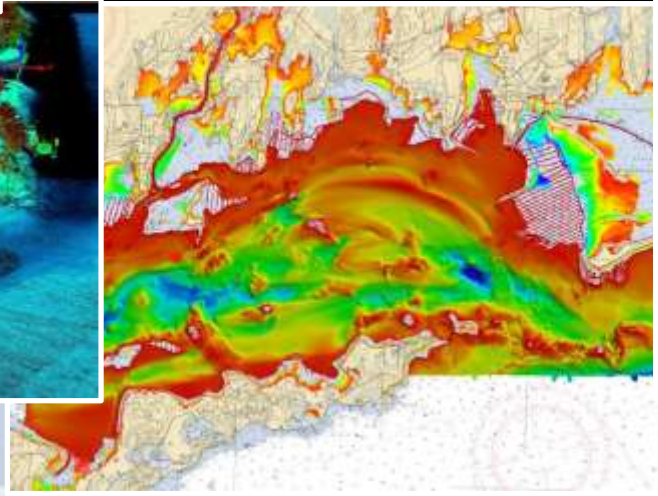
- **Sources:**
  - **Lidar**
  - **Digital Cameras**
  - **High Resolution Satellites**

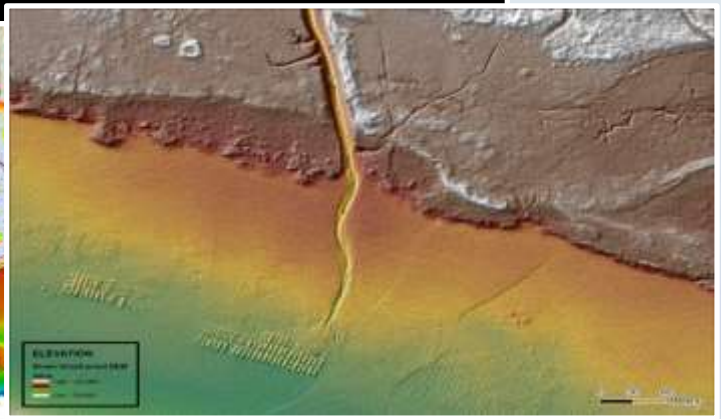
National Oceanic and Atmospheric Administration

NGS's Topobathy lidar data









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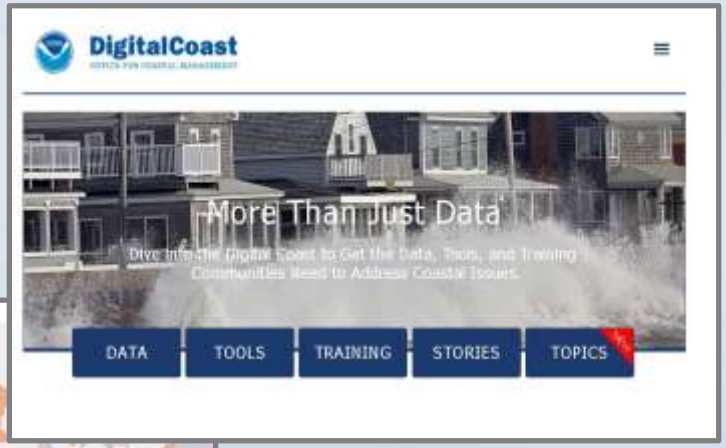
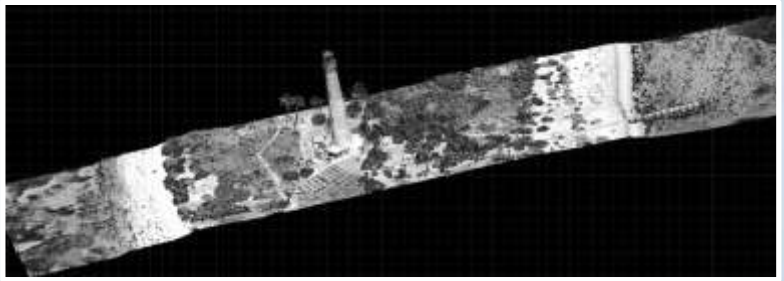
Distribution of Data

Shoreline (http://www.ngs.noaa.gov/NSDE/)





Lidar and Imagery:

https://coast.noaa.gov/digitalcoast/

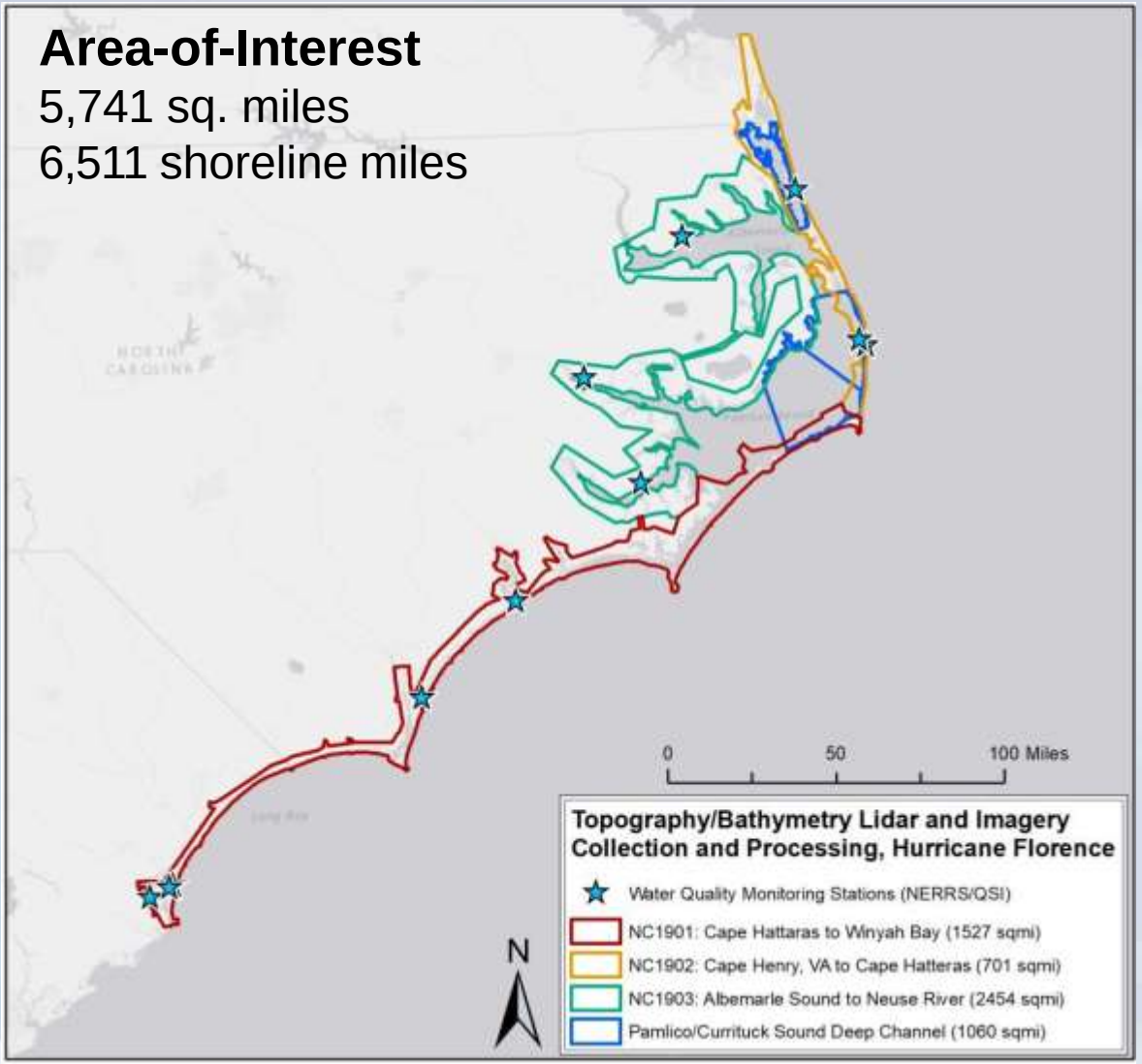
National Oceanic and Atmospheric Administration

Florence Project Overview

Project consists of collecting topobathymetric lidar and imagery to enable accurate and consistent measurement of the national shoreline for NOAA NGS

Additional applications:

- Nautical charting
- Geodesy services
- Territorial limits
- Marine debris surveys
- Marine resource management
- Inundation modeling
- Coastal resiliency
- Benthic habitat



National Oceanic and Atmospheric Administration

NOAA Topobathymetric LiDAR Collection

Goal: To obtain clean, seamless topographic-bathymetric data across the intertidal zone and shallow nearshore zone.

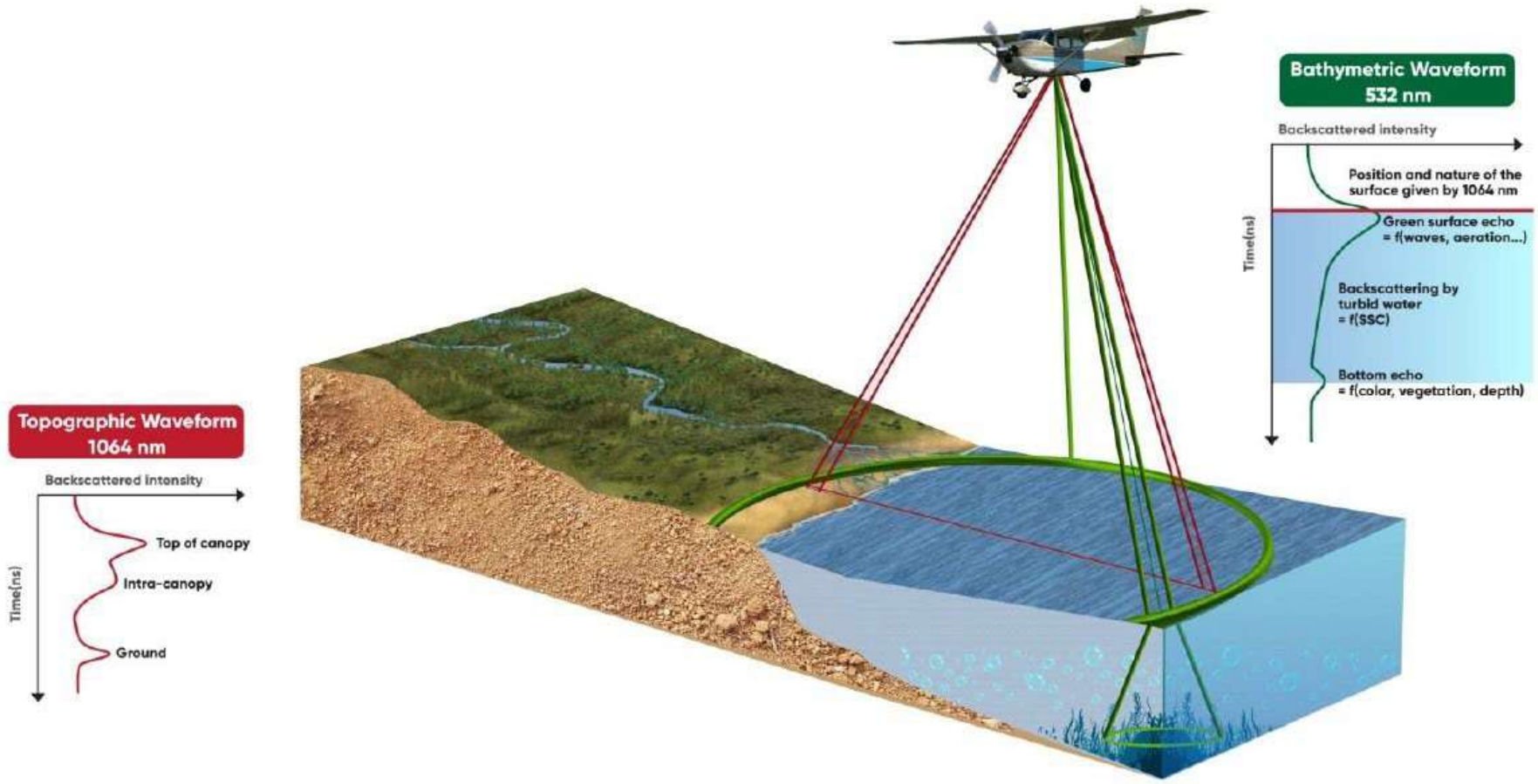
- Shallow/Nearshore goal is **0-4m** depth.
- Flown during **optimal conditions:** low wind and good water clarity
- Flights are **tide-coordinated, ±2 hours of MLLW**
- Repeat passes are used to attempt to fill in data voids due to poor water clarity, or waves and/or white water.
- Bathymetric lidar points **meet vertical RMSE of QL2b**
- **Imagery collected within 30 days** of the topobathymetric lidar.

Topobathymetric Lidar Parameters

Topobathymetric lidar sensors:

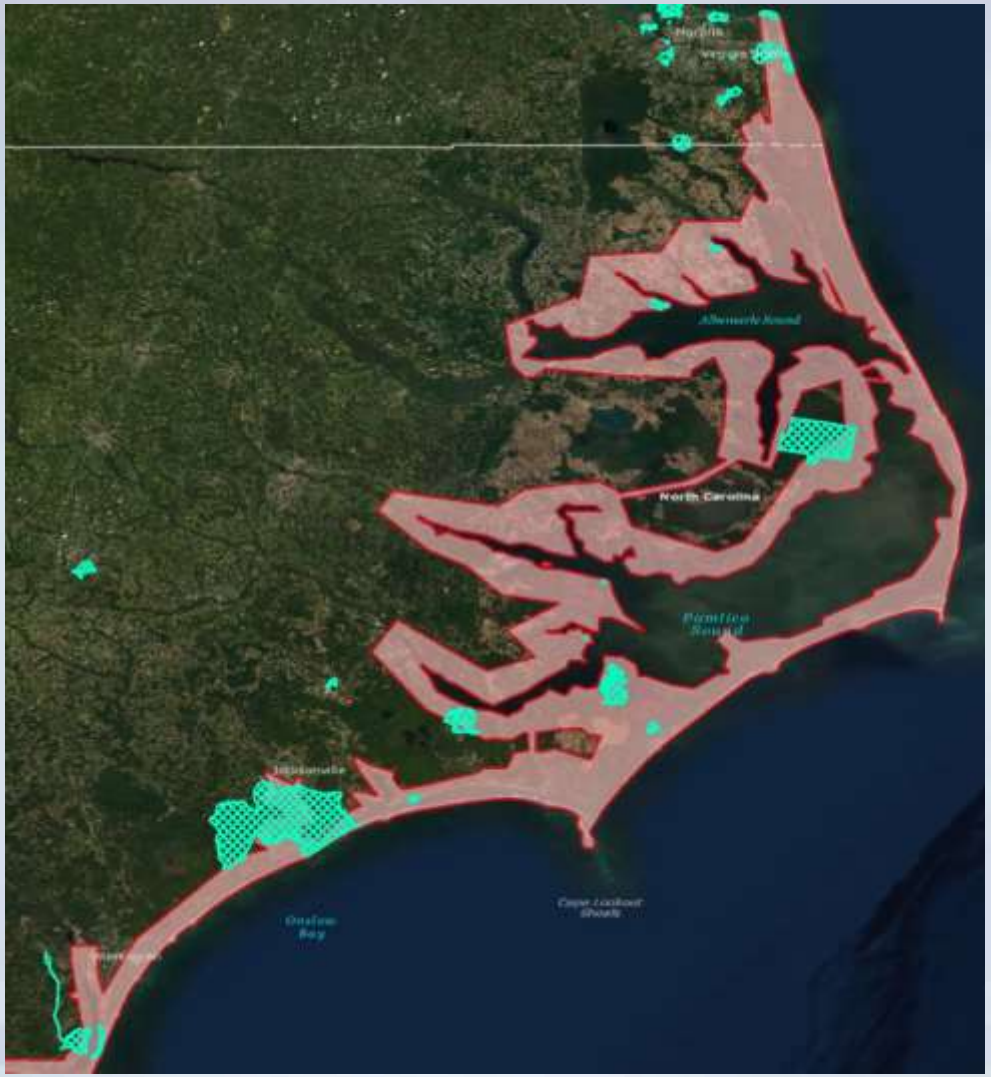
- Riegl VQ-880-GII (2); VQ-880-G+ (1)
- Leica CH4X/Hawkeye (1)

Survey Altitude = 400 m
Swath Overlap = 20%
Pulse rate = 200 khz (Green); 300 khz (NIR)
Cross line Interval = every 30Km



Acquisition Considerations

- Tides
- Weather
- Water clarity
- Restricted airspace
- Wind speed and wave height
- Aircraft/sensor availability



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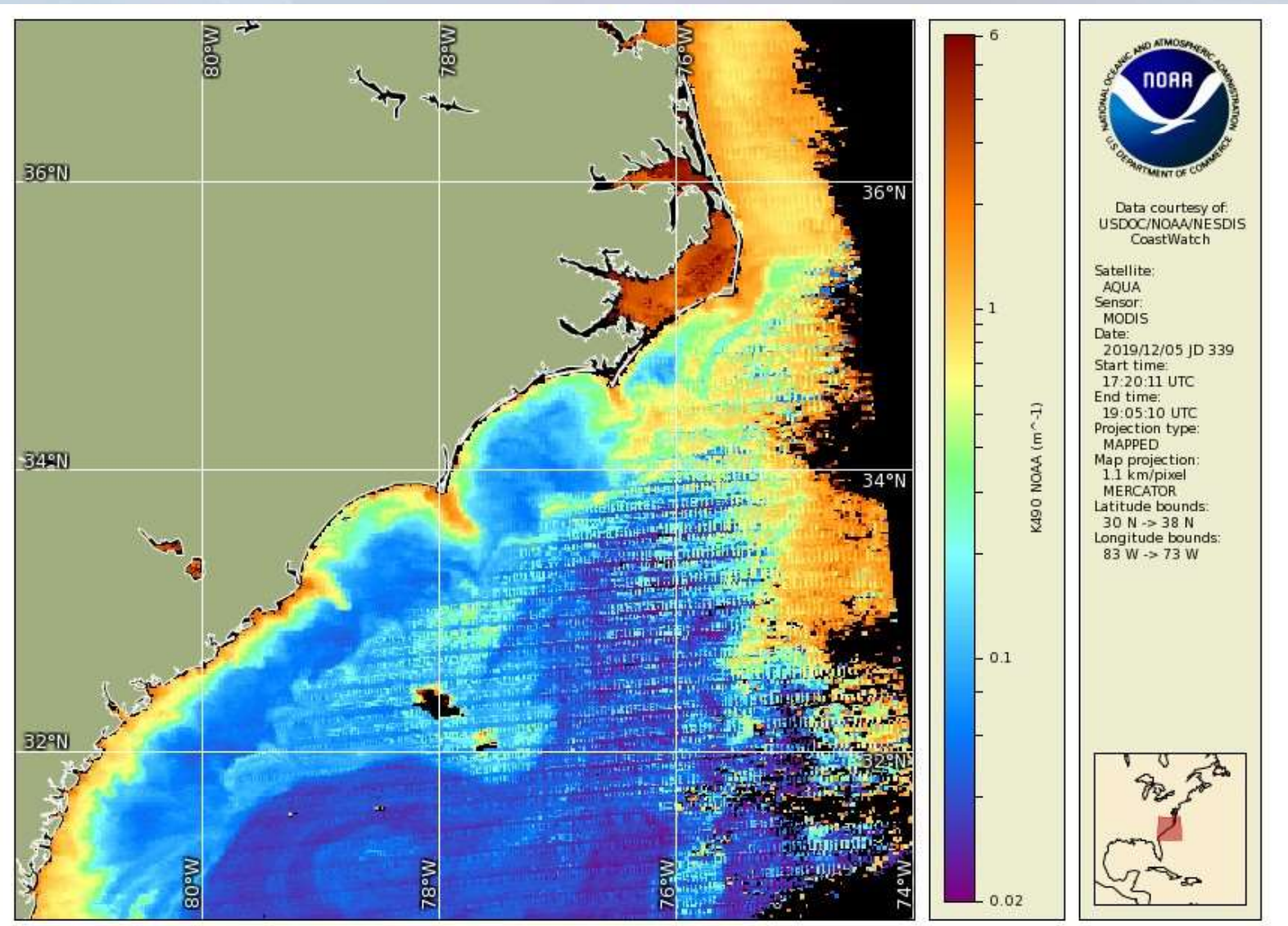
Acquisition Planning – Water Clarity



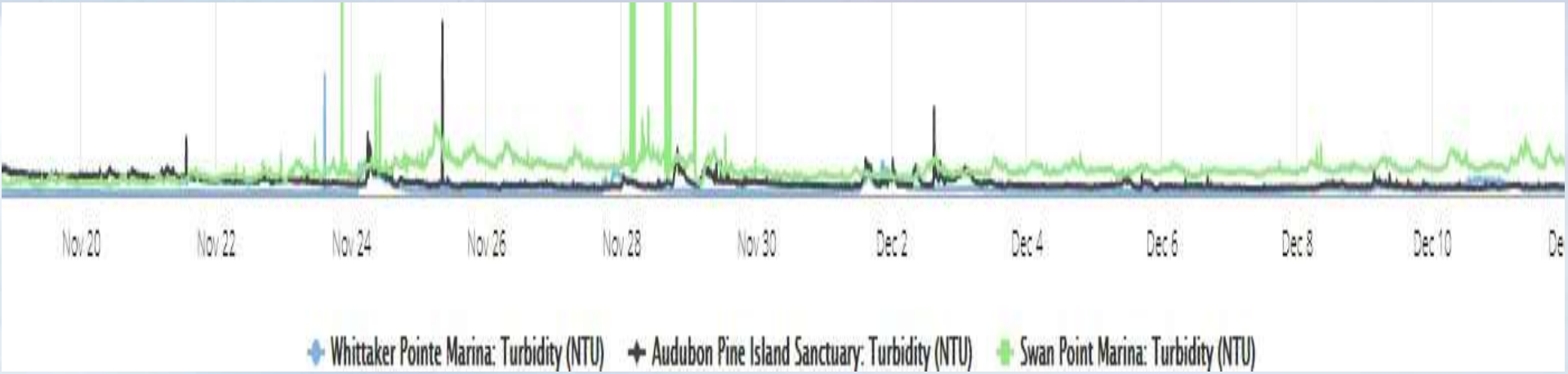
In situ Water Clarity Measurements

- Temporally continuous monitoring stations
  - QSI YSI Stations
  - NOAA NERRS Stations

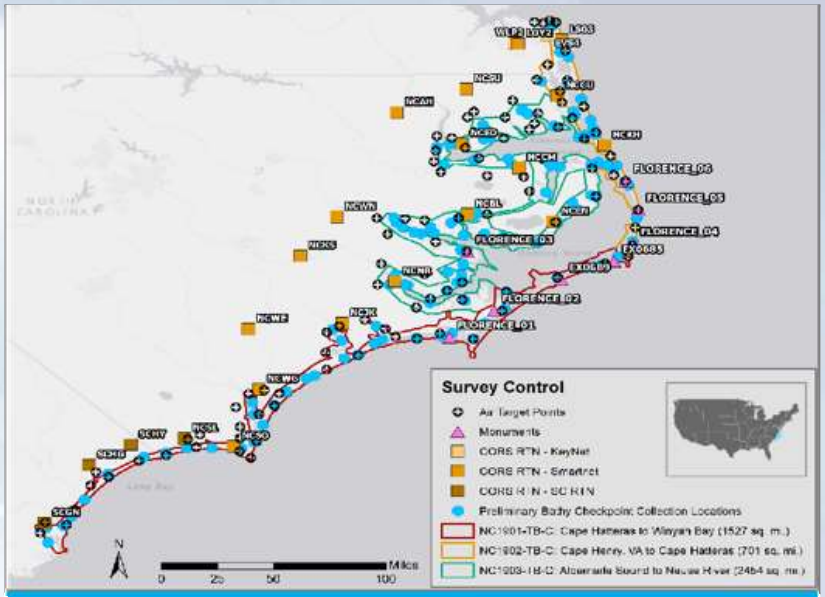
- Secchi disk measurements at the time of flight

Acquisition Planning

QSI Turbidity Stations - Florence



Acquisition – Ground Survey



NC1902
Ground Survey Point Summary

Type	Class	% Area	# Points
NVA	Bare Earth	80.52%	19
	Urban	19.48%	7
VVA	Forested	19.11%	4
	Shrub	10.80%	3
	Tall Grass/Weeds	70.09%	7
Not Applicable	Swamp/Wetland*	--	0
	Open Water**	--	
* Not used as a land class per USGS specs ** Not included in topographic project area	Total Land Project Area Km²		1333.41
	# Points Total		59
	Air Targets		19
	NVA		26
	VVA		14

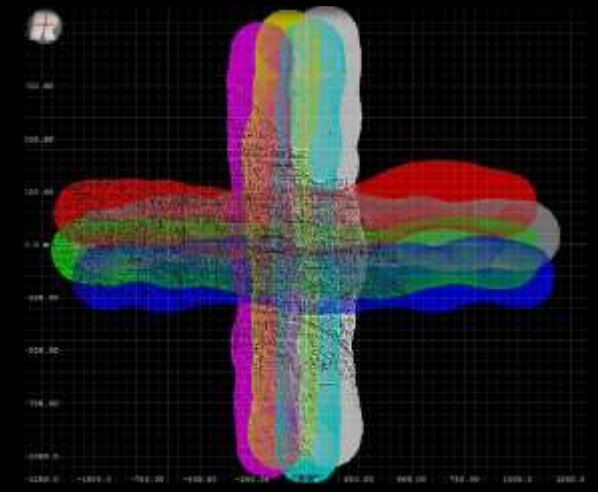
NC1901
Ground Survey Point Summary

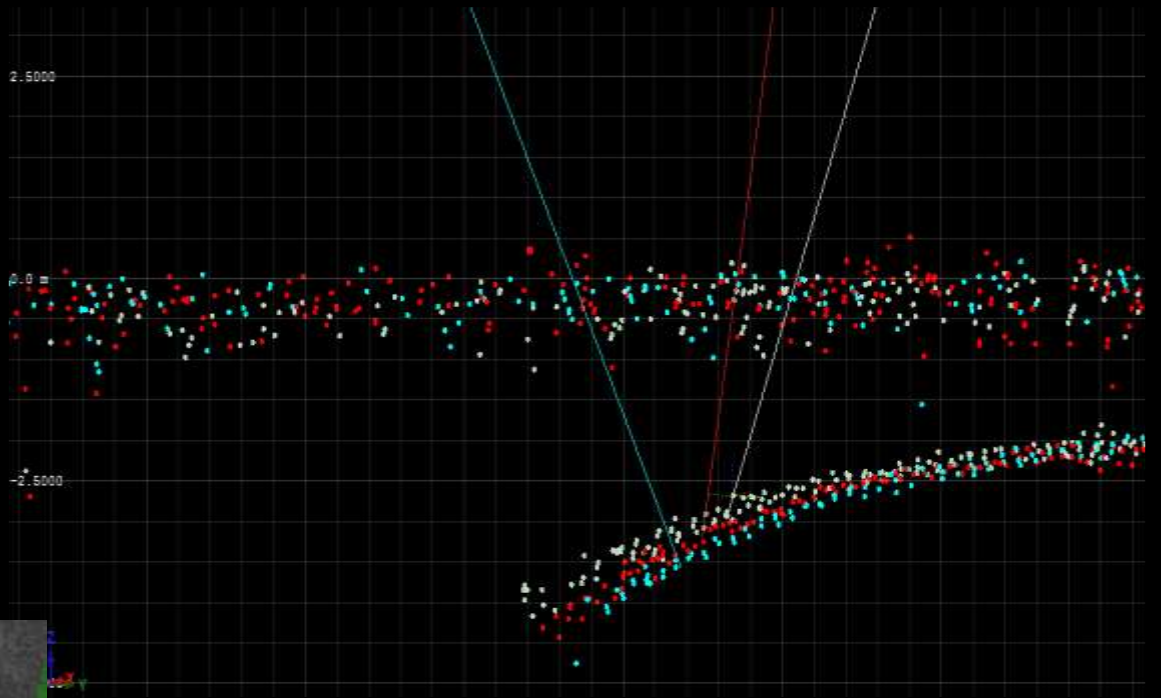
Type	Class	% Area	# Points
NVA	Bare Earth	83.13%	50
	Urban	16.87%	11
VVA	Forested	47.35%	20
	Shrub	24.51%	13
	Tall Grass/Weeds	28.14%	16
Not Applicable	Swamp/Wetland*	--	0
	Open Water**	--	
* Not used as a land class per USGS specs ** Not included in topographic project area	Total Land Project Area Km²		2311.39
	# Points Total		150
	Air Targets		40
	NVA		61
	VVA		49

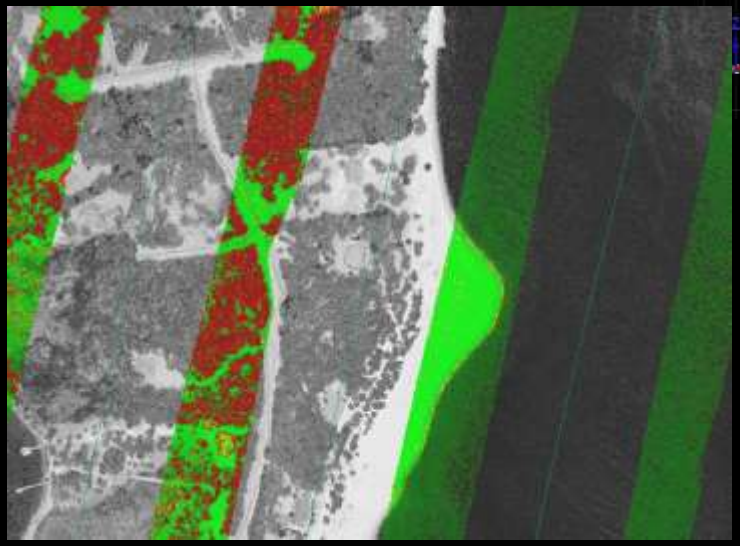
NC1903
Ground Survey Point Summary

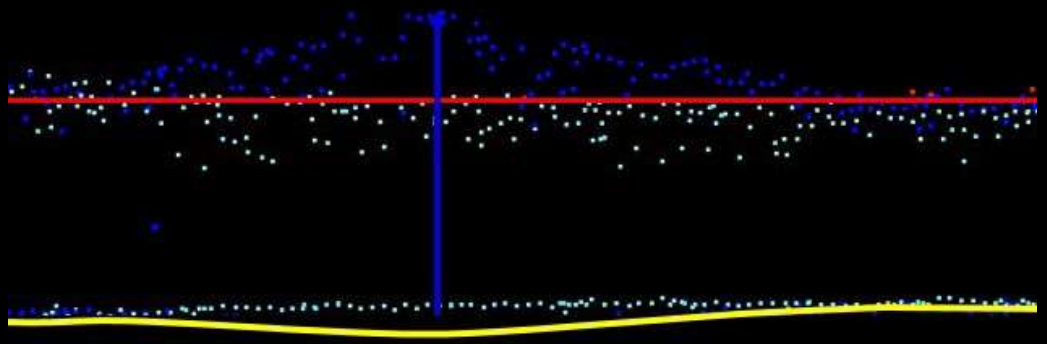
Type	Class	% Area	# Points
NVA	Bare Earth	90.39%	65
	Urban	9.61%	11
VVA	Forested	24.90%	13
	Shrub	18.64%	9
	Tall Grass/Weeds	56.46%	36
Not Applicable	Swamp/Wetland*	--	0
	Open Water**	--	
* Not used as a land class per USGS specs ** Not included in topographic project area	Total Land Project Area Km²		4968.97
	# Points Total		176
	Air Targets		42
	NVA		76
	VVA		58

Data Processing and Products



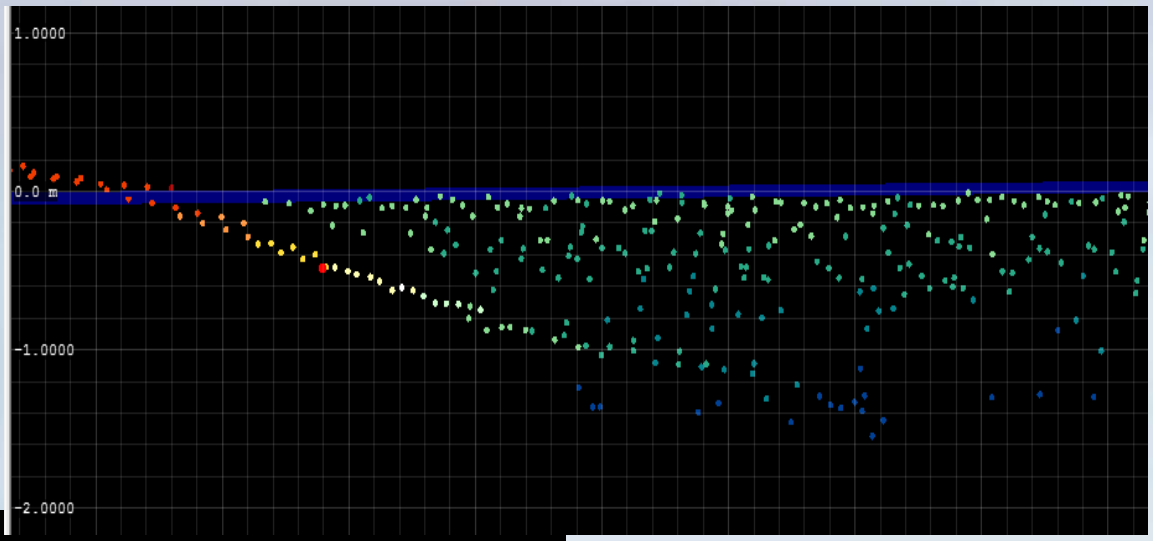


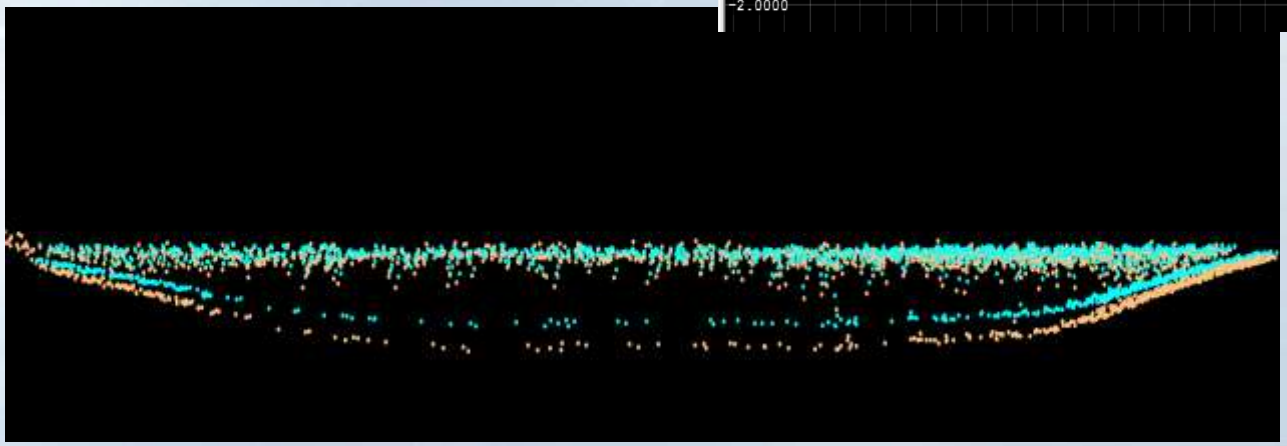




Topobathymetric LiDAR Processing

- Refraction
  - Water Surface Model
    - Classification and accuracy





- Classification
  - Noise removal and bottom surface classification
  - Auto detection techniques

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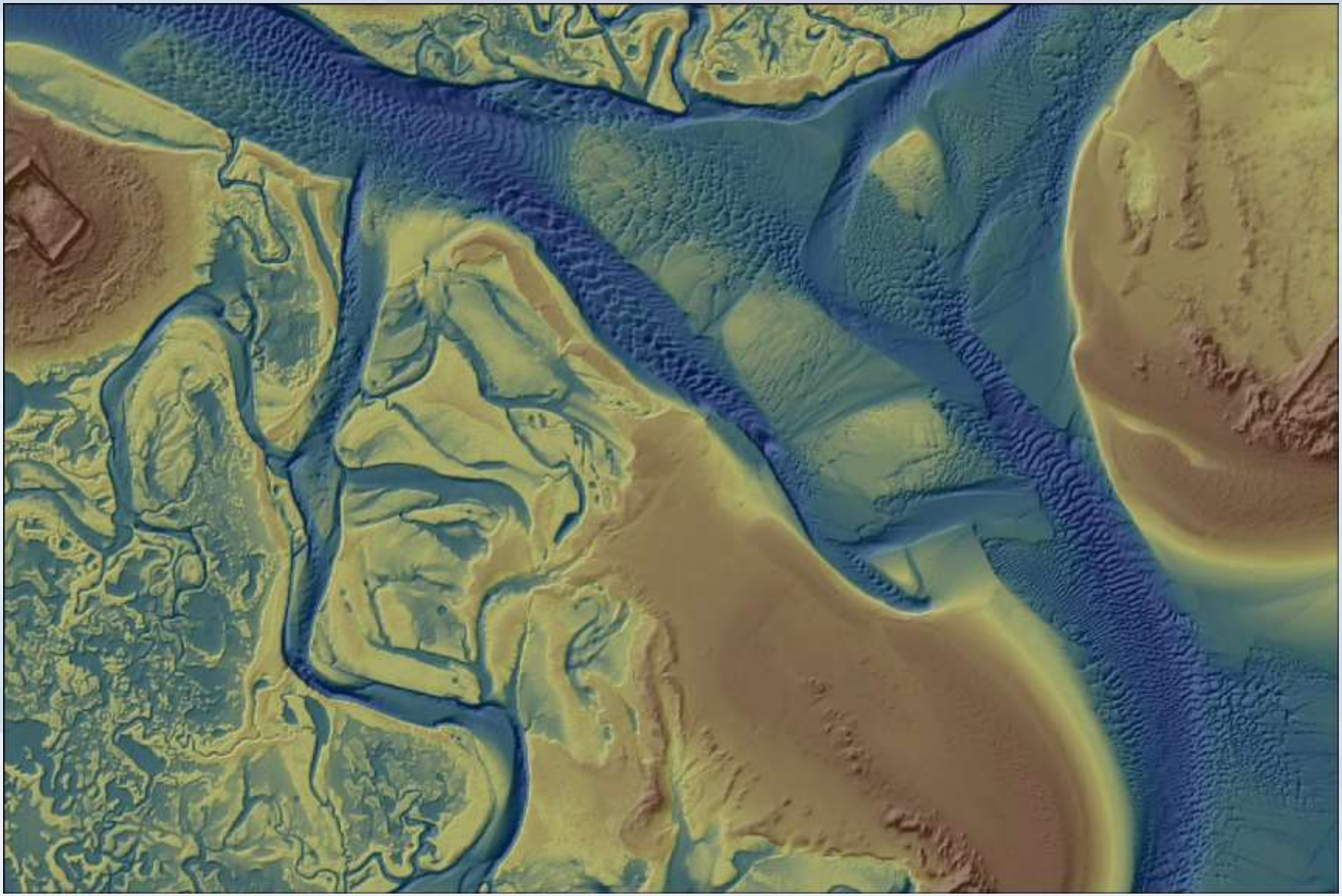
LAS 1.4 Point Classifications

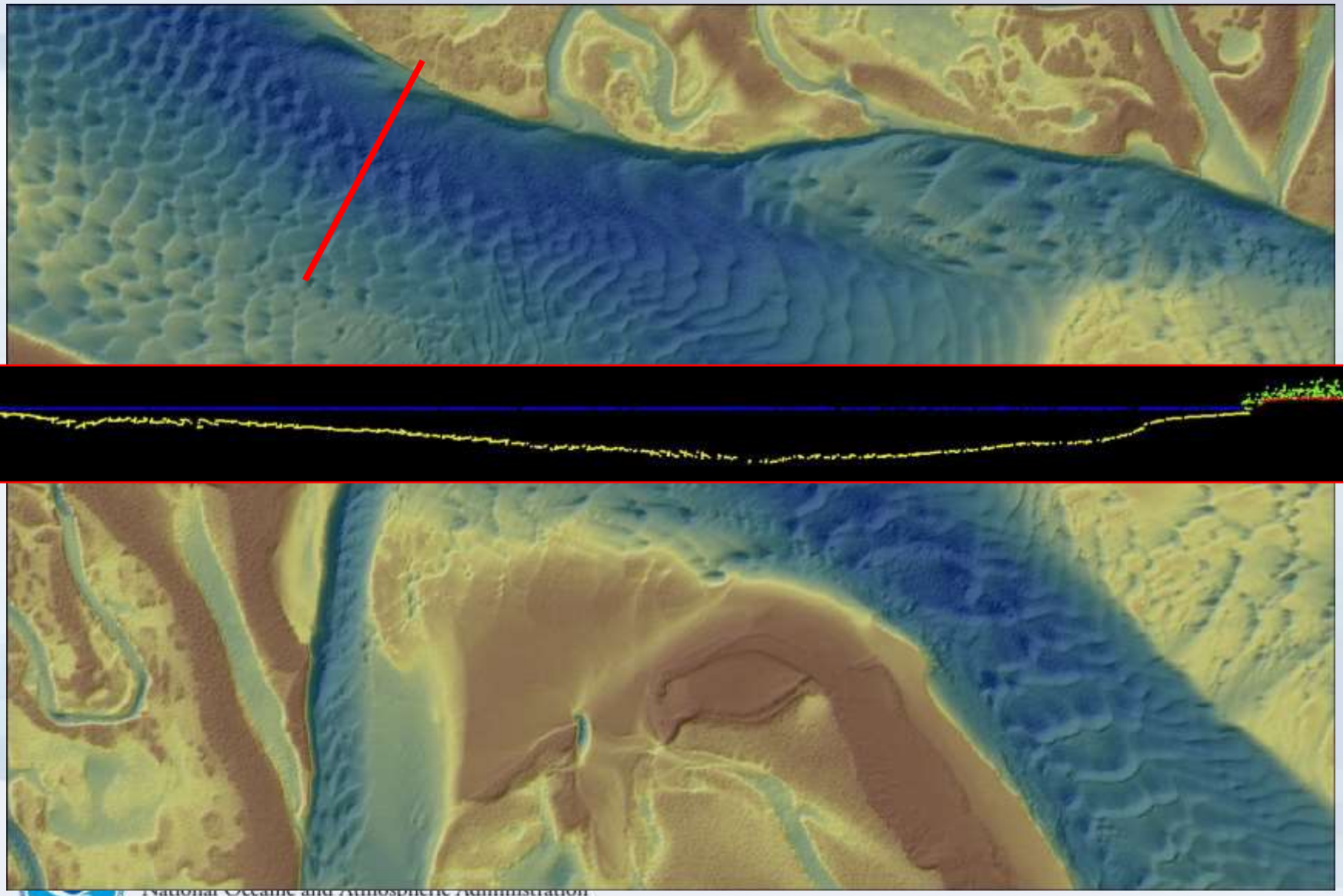
Classification Number	Classification Name	Classification Description
1	Unclassified	Processed, but unclassified
2	Ground	Bare-earth ground
7	Noise	Noise (low or high; manually identified)
40	Bathymetric Bottom	Bathymetric point (e.g., seafloor or riverbed; also known as submerged topography)
41	Water Surface	Water's surface (sea/river/lake surface from topographic-bathymetric LiDAR.
42	Derived Water Surface	Synthetic water surface location used in computing refraction at water surface
43	Submerged Feature	Submerged object, not otherwise specified (e.g., wreck, rock, submerged piling)
44	S-57 Object	International Hydrographic Organization (IHO) S-57 object, not otherwise specified
45	Water Column	Refracted returns not determined to be water surface or bathymetric bottom
46	Overlap Bathymetric Bottom	Denotes bathymetric bottom temporal changes from varying lifts, not utilized in the bathymetric point class

Original SOW classification scheme	Delivered in LAS files
Additional classification codes	Delivered in LAS files
Original SOW classification code not used	Not delivered in LAS files

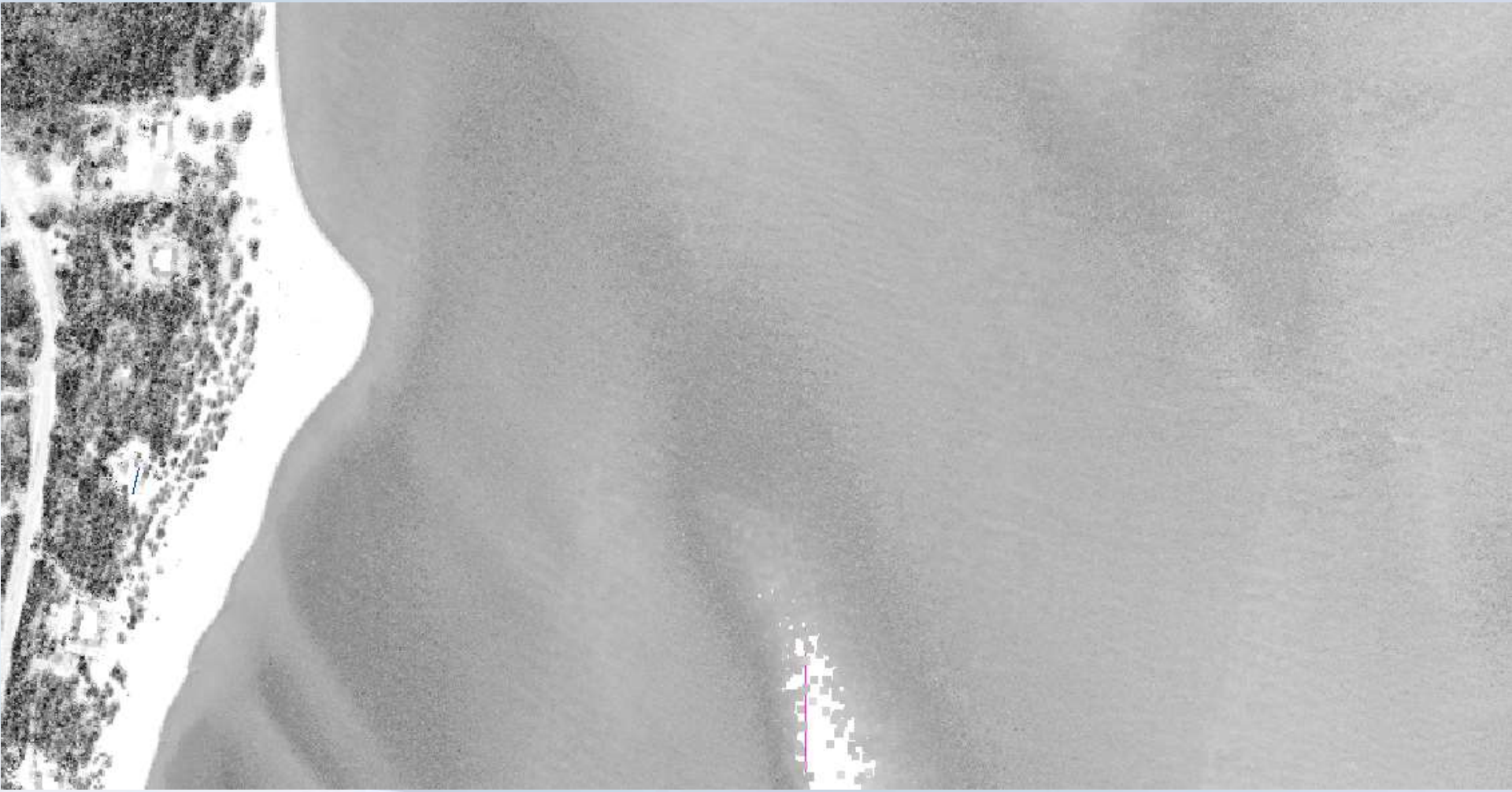
Florence Data Example



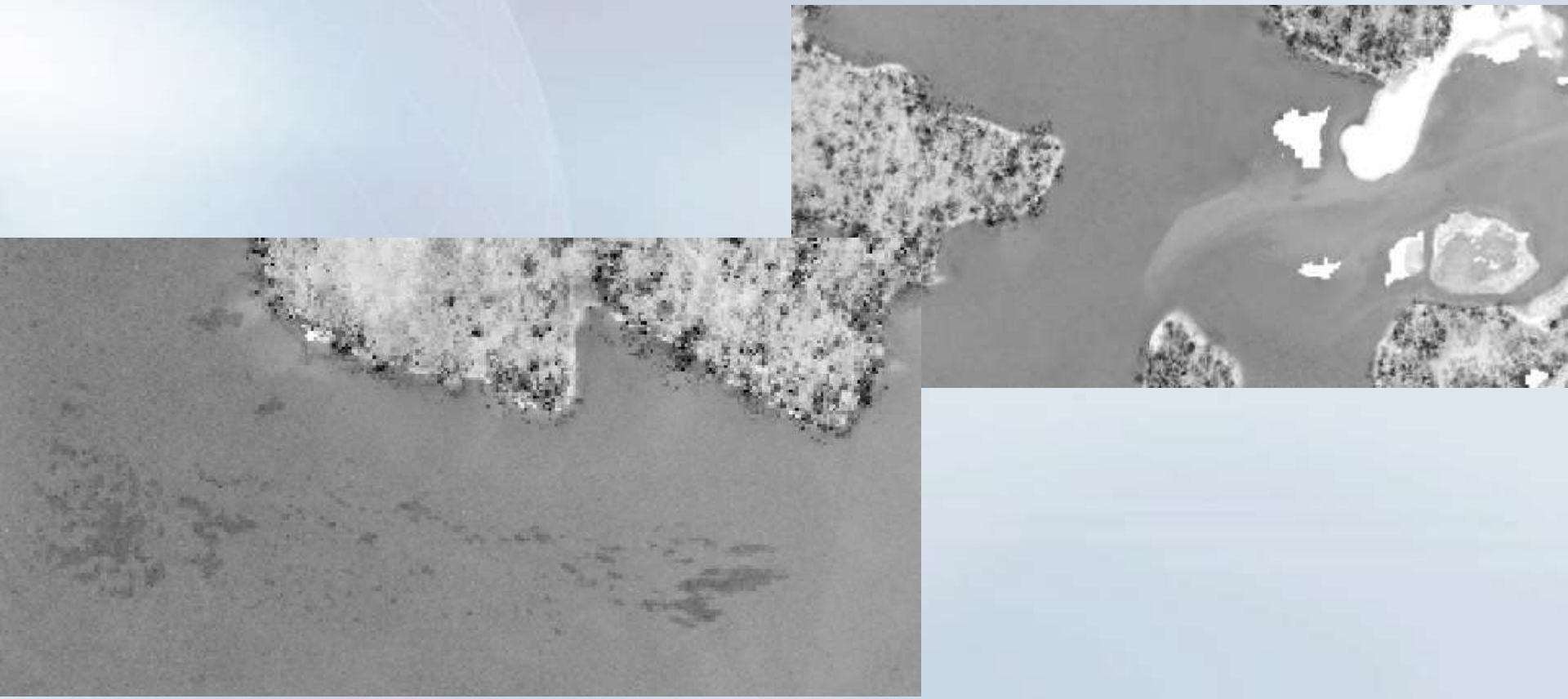
Florence Data Example



Chesapeake Bay Sandy Bottom (calibration)



Chesapeake Bay Seagrass & Seafloor



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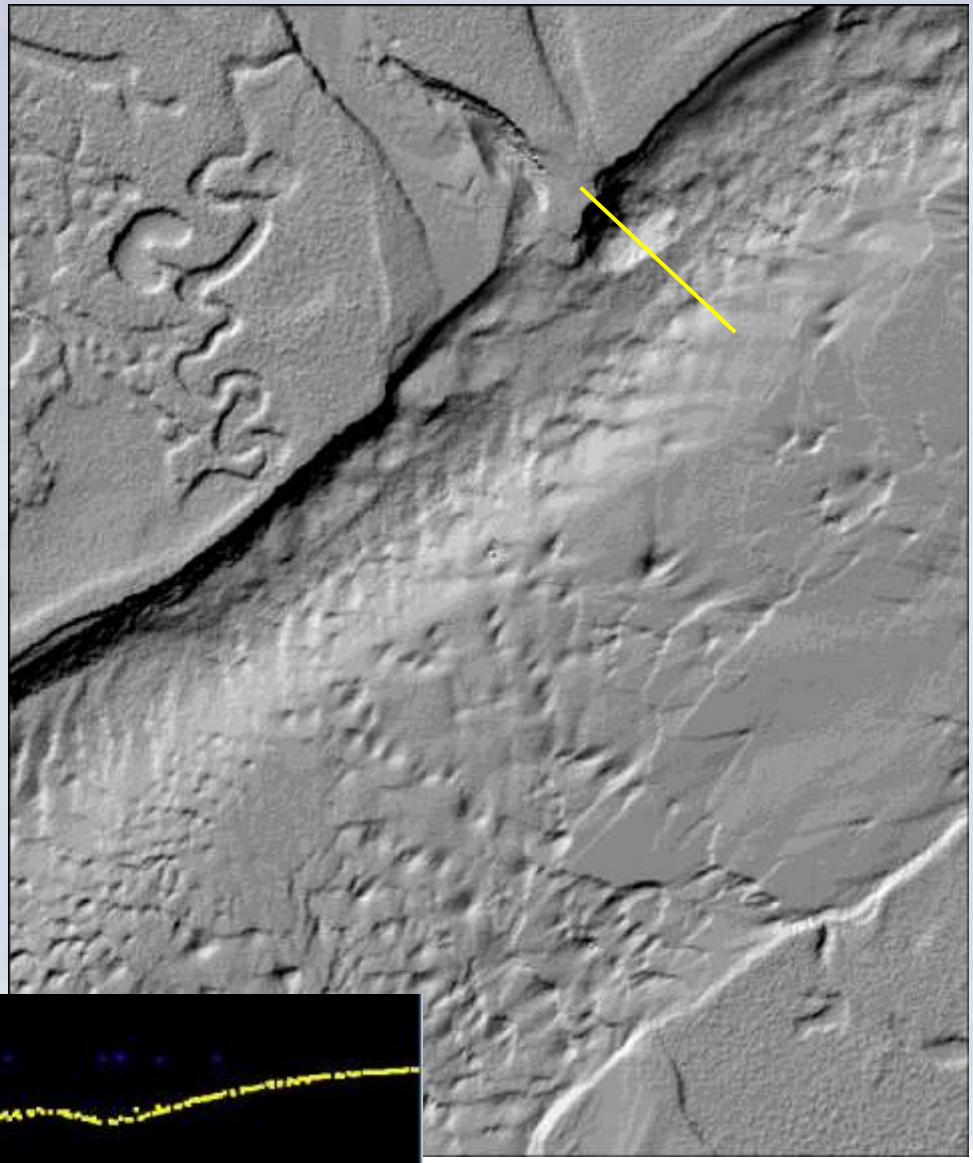
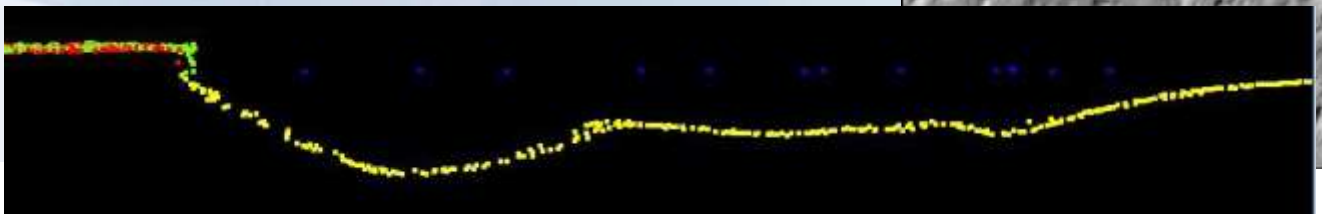
Topobathymetric Lidar Deliverables

Points	• Classified Point Cloud LAS 1.4 – QL1 spec **- Intensity values normalized for depth** • Calibrated Swaths
Rasters	1.0 Meter cloud optimized geotiffs (*.tif) • Clipped Bare Earth DEM • Interpolated Bare Earth DEM • DEM Standard Deviation • **TPU total sigma Z**
Vectors	• Site Boundary and Indices • Bathymetric Voids • Lidar Trajectory • Flight Date Coverage Polygon
Metadata	• DEM • Lidar • **TPU**



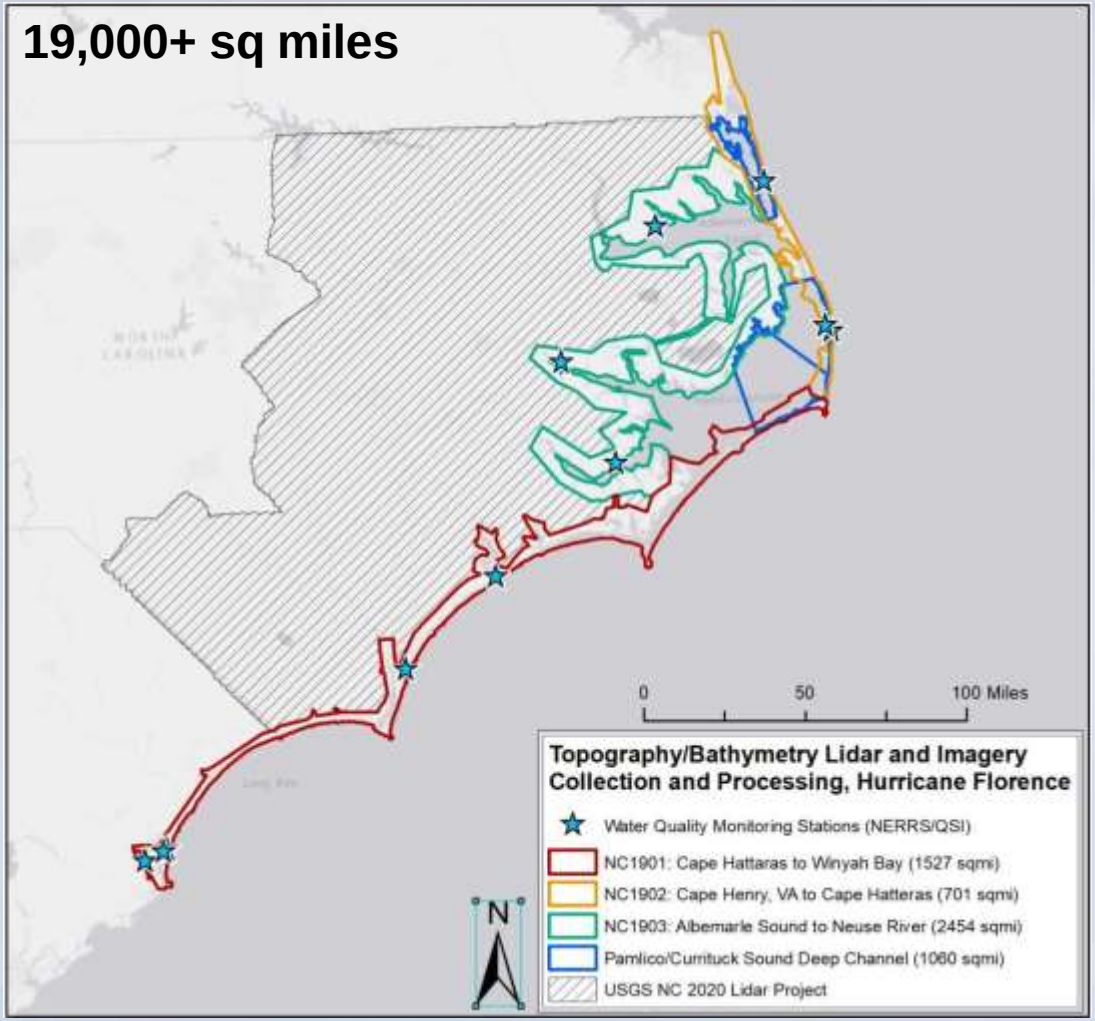


Imagery Deliverables

- RGB/NIR stereo imagery with metadata
- Ground control report and shapefiles
- Acquisition reports
- APOR/AT reports
- Ortho-mosaic imagery with metadata

USGS and NOAA NC LiDAR Integration

- USGS QL1 Tasking is moving in parallel.
- NOAA topographic data will be integrated with QSI USGS deliverables.
- NVA/VVA points will be collected to ensure accuracy testing.
- Collect necessary hydro-flattening break lines.
- USGS data acquisition was completed on Feb 21, 2020 using QSI Riegl 1560i topographic lidar.



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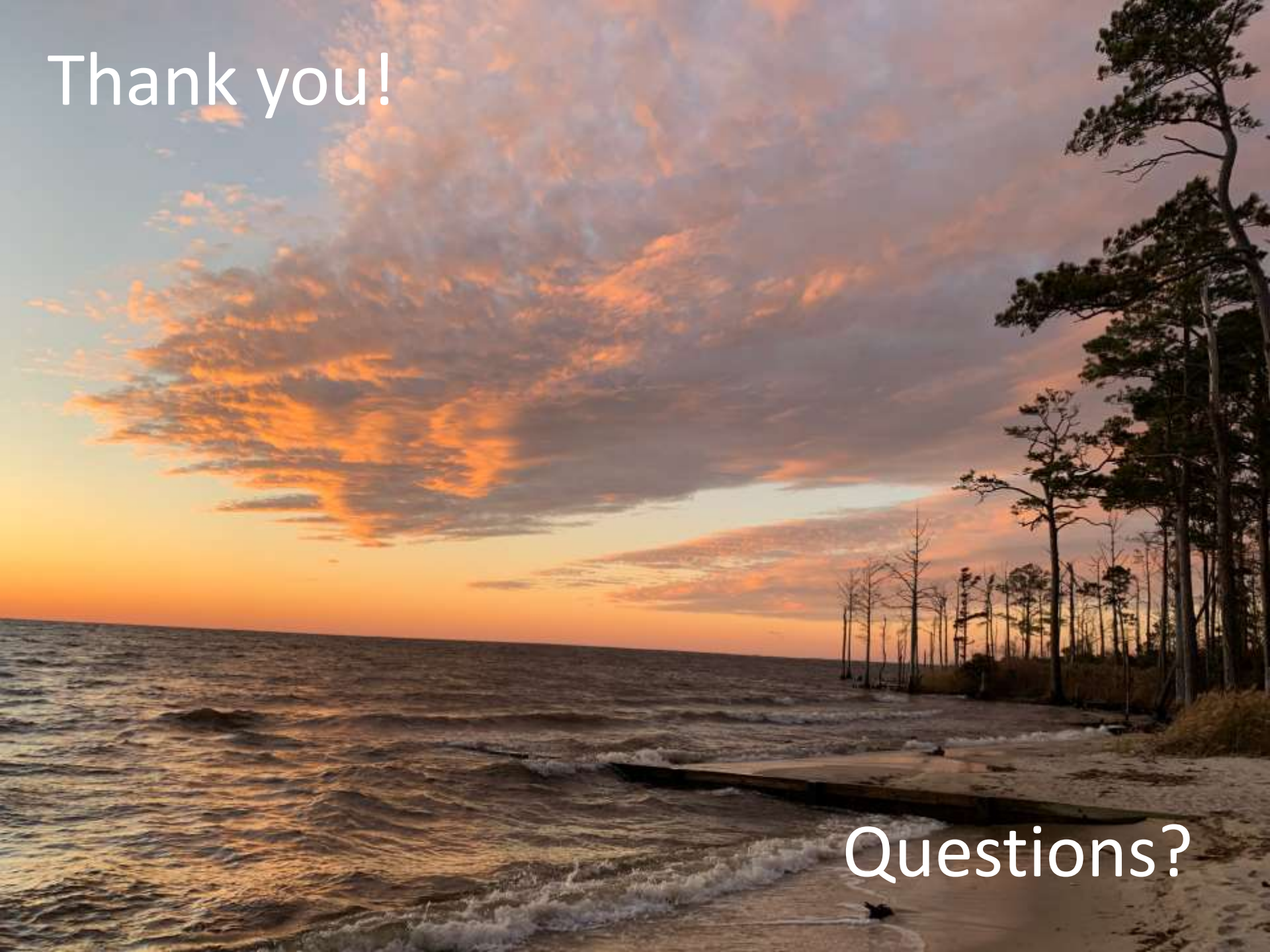
Thank you!
Questions?