Processing and Accuracy of Topographic Lidar Data in Coastal Marshes and Their Use in Sea Level Rise Studies

Coastal GeoTools 2009

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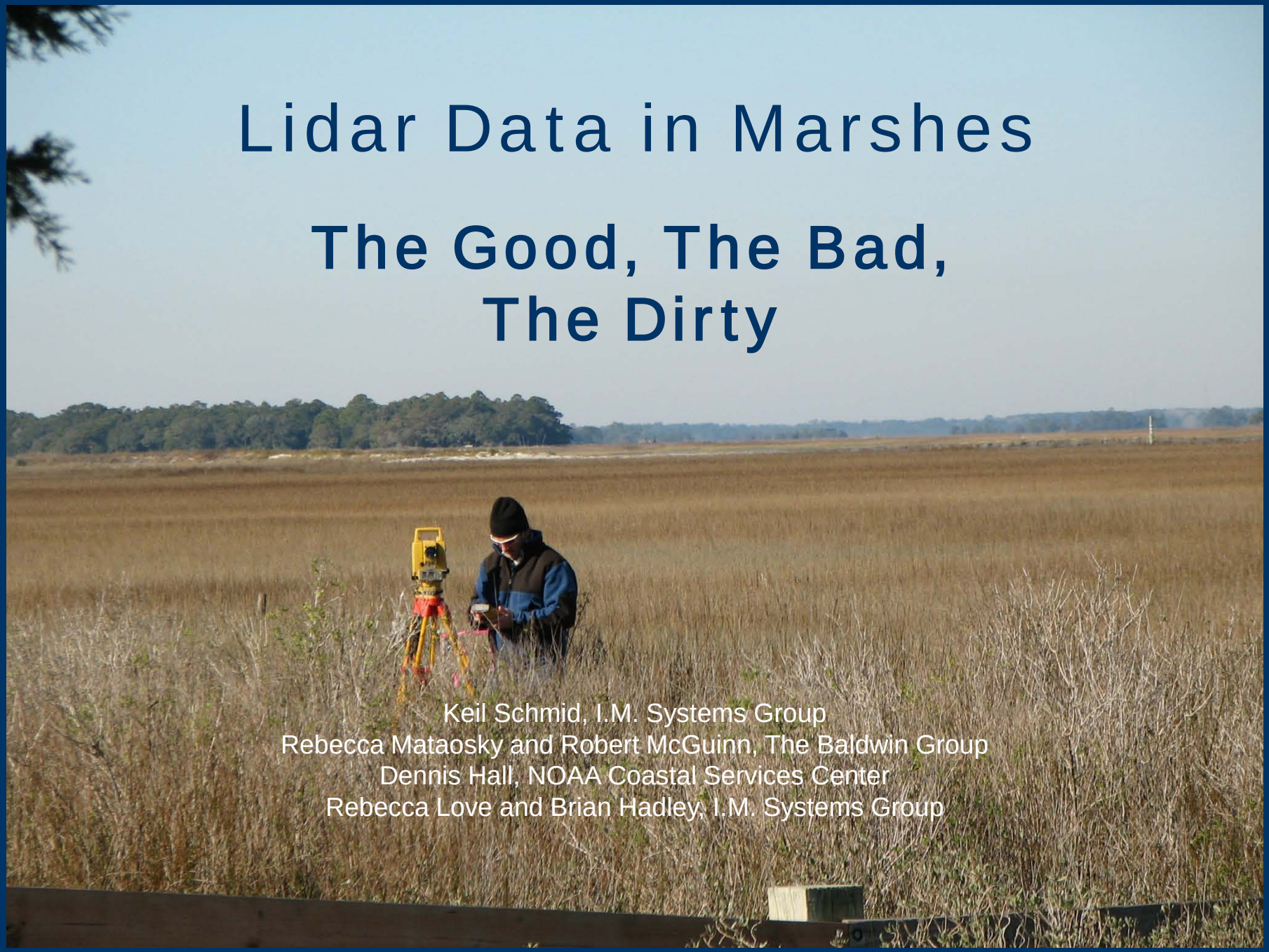
Lidar Data in Marshes

The Good, The Bad, The Dirty



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Rebecca Love and Brian Hadley, I.M. Systems Group

Overview

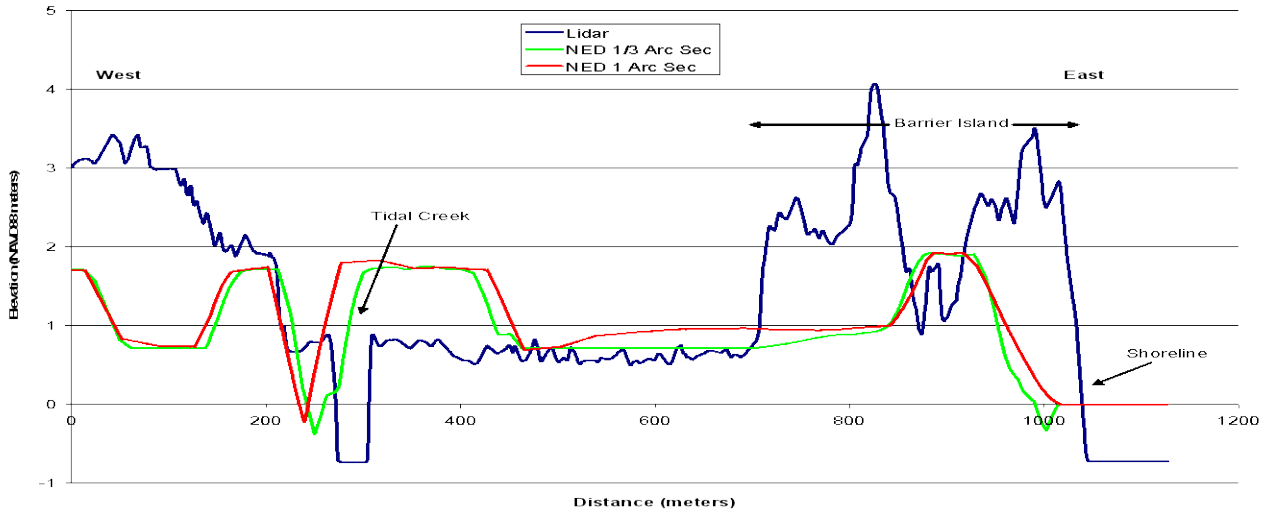
- Why Do This?
- Lidar and Lidar Data
- Why Do This? Remind Me Again
- Marsh Applications
- Measurement – Real World
- Results
- Initial Recommendations

Why?

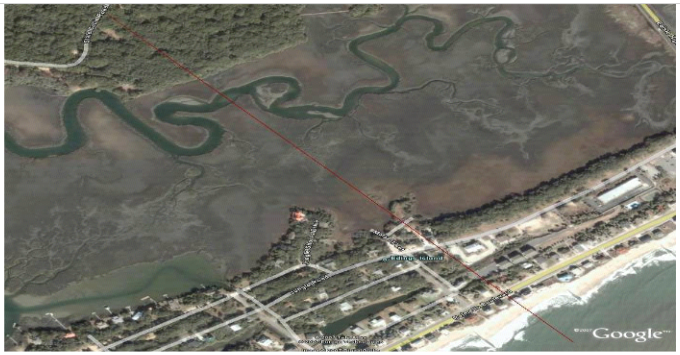
- Lidar is generally trusted – the “truth”

Lidar vs. Previous Data

Edisto Island Coastal Example



E. Results of the profile data across the marsh and barrier island.



NED 30 m NED 10 m Lidar 2 m

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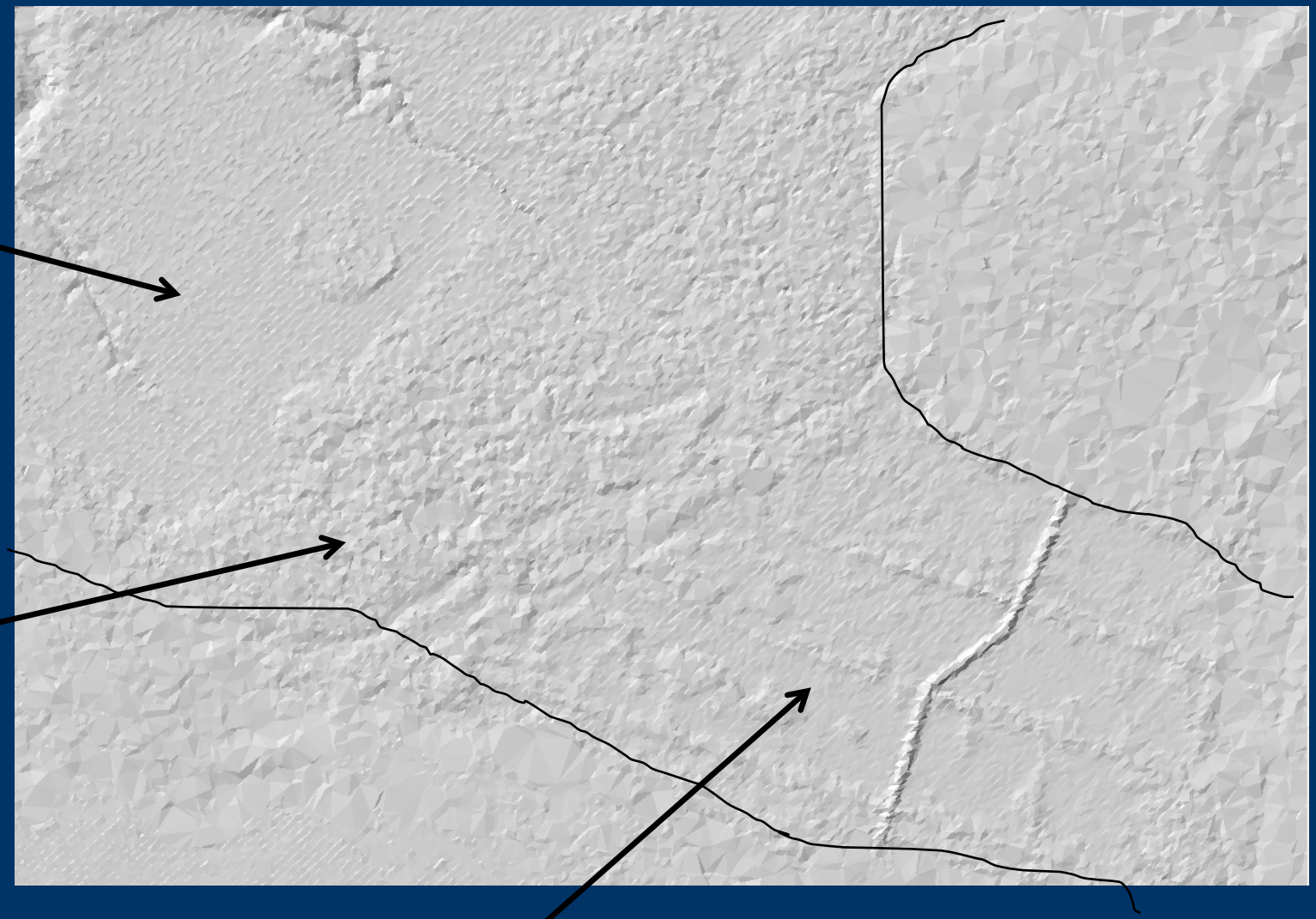
Why?

- Lidar is generally trusted – the “truth”
- More and more people are looking closely and seeing strange things (present company included)



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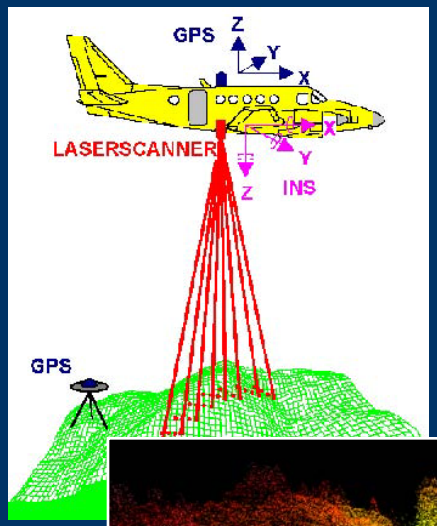
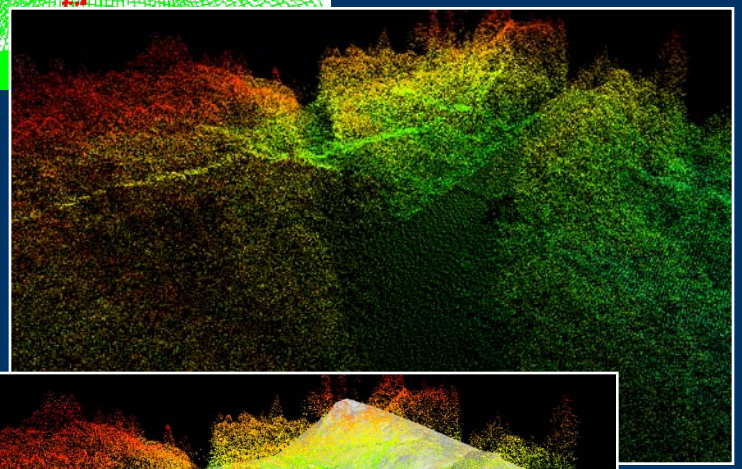
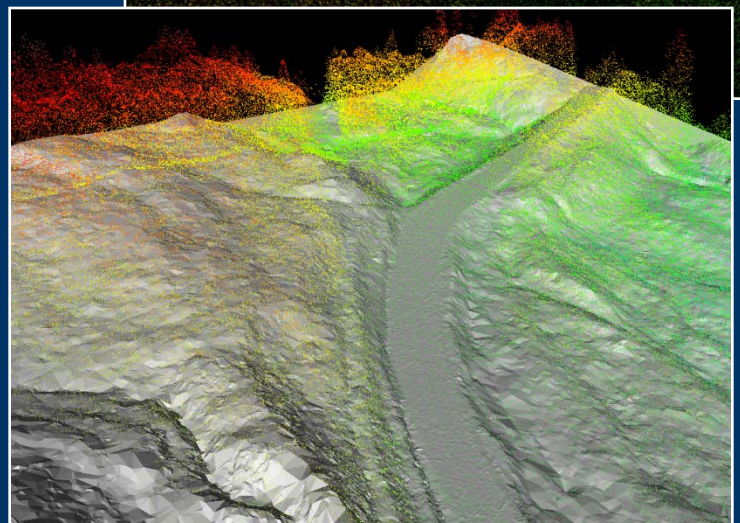
Why?

- Lidar is generally trusted – the “truth”
- More and more people are looking closely and seeing strange things (present company included)
- Understand that maybe lidar is not the “truth” but that it can attain a level of “trust”
- Once (or If) trust is restored – how can we make it better or have it serve our needs?

Overview – Technology







- Laser light for measurement
- Global Positioning System (GPS) and inertial measurement unit (IMU) for positioning
- Produces a dense point data set
- Post-processing used to define point types (i.e., points on vegetation, ground, and buildings)

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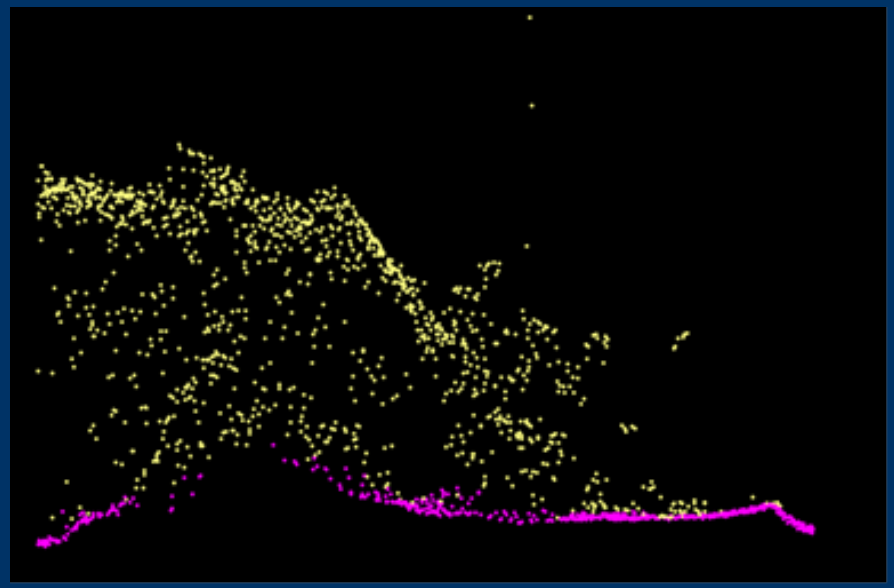
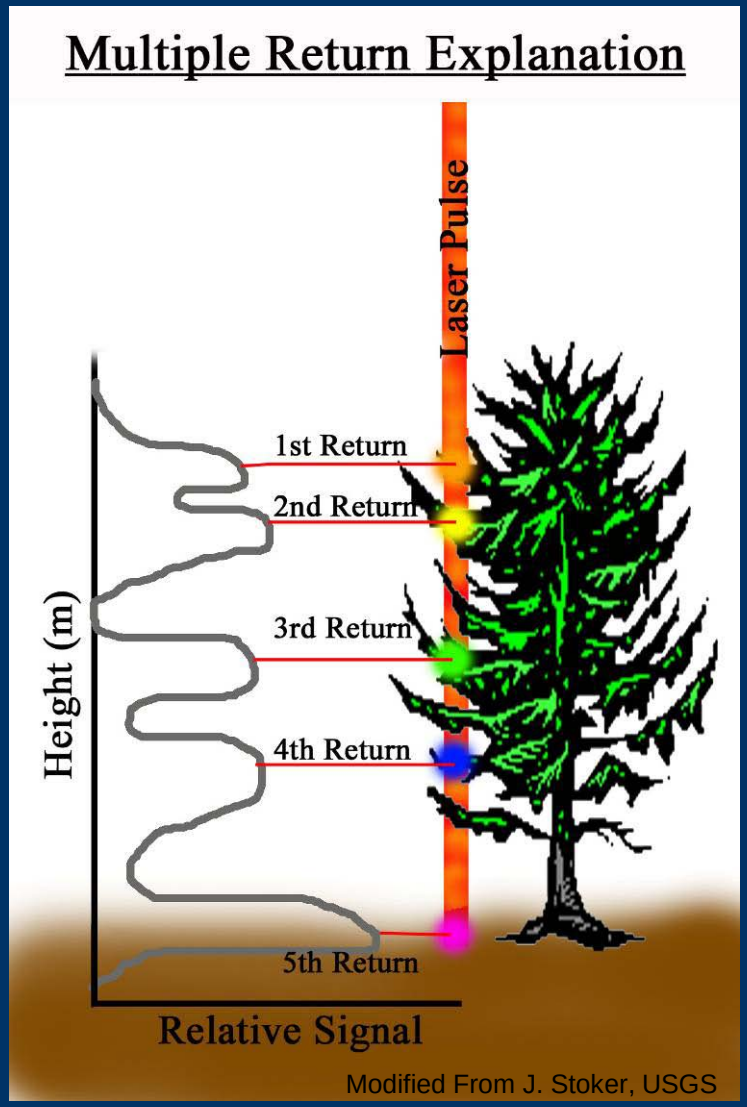
Lidar Points (Product)

- Multiple returns (typically up to five)
- Spot size of lidar
  - About 1 to 1.5 feet in diameter
  - Must meet eye safety standards

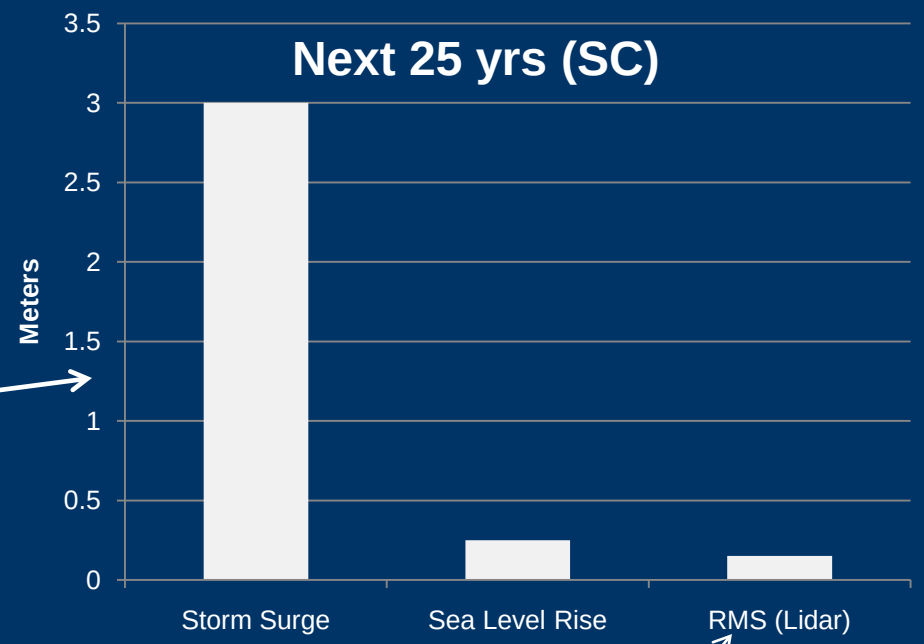


Edisto Island, South Carolina



Why? Remind Me

- Magnitude of processes mapped using lidar
  - Storm Surge vs. Sea Level Rise
- Habitat (vegetation structure)
  - 1- to 3-foot tall dense vegetation vs. 30-foot tall open vegetation



Bare Earth (not marsh)

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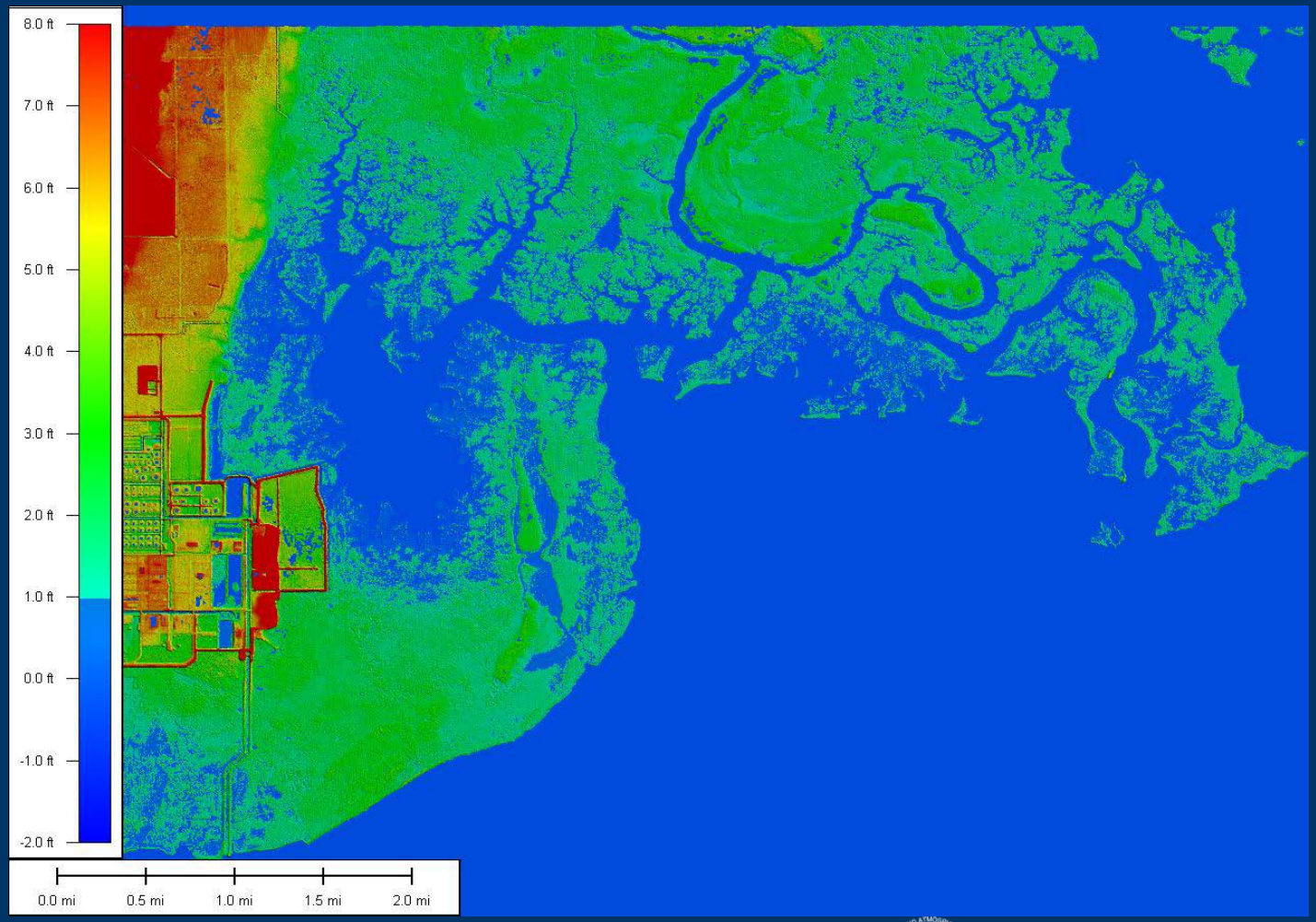
Magnitude

All of the “modeled” change is within the envelop of data accuracy



Coastal Marsh Loss – 0.25 foot change

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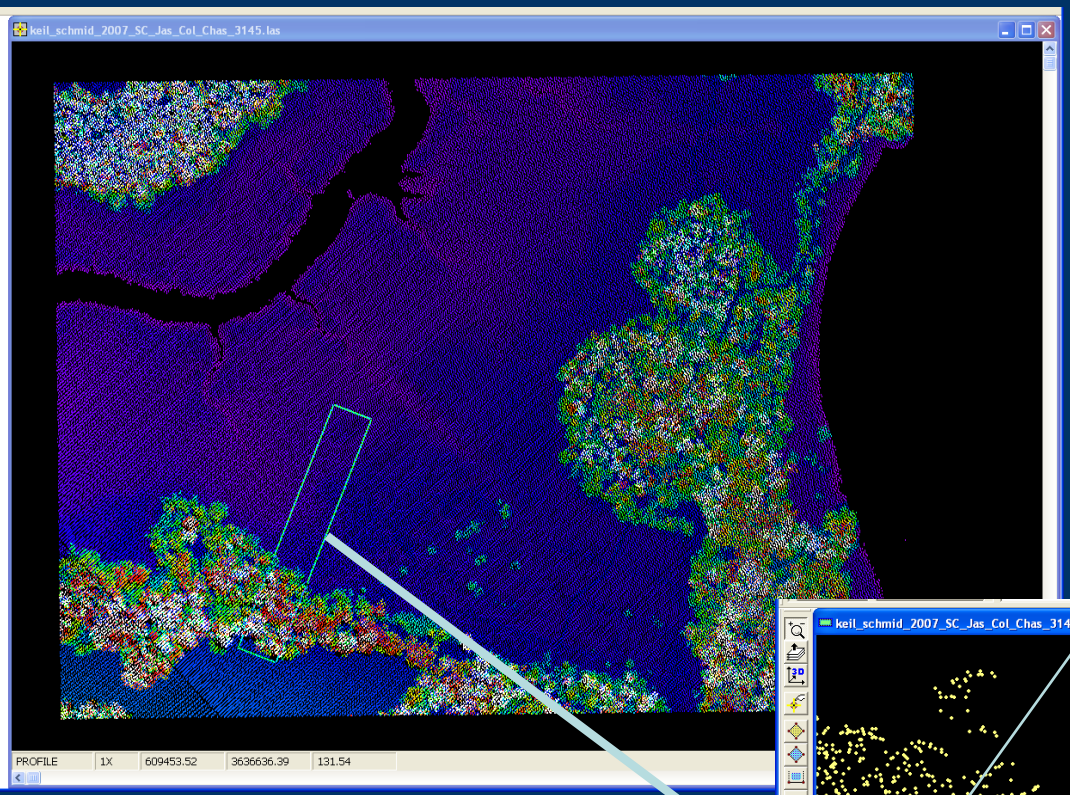
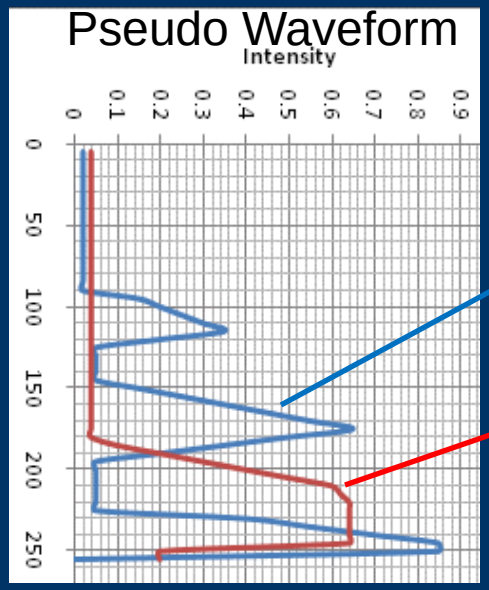
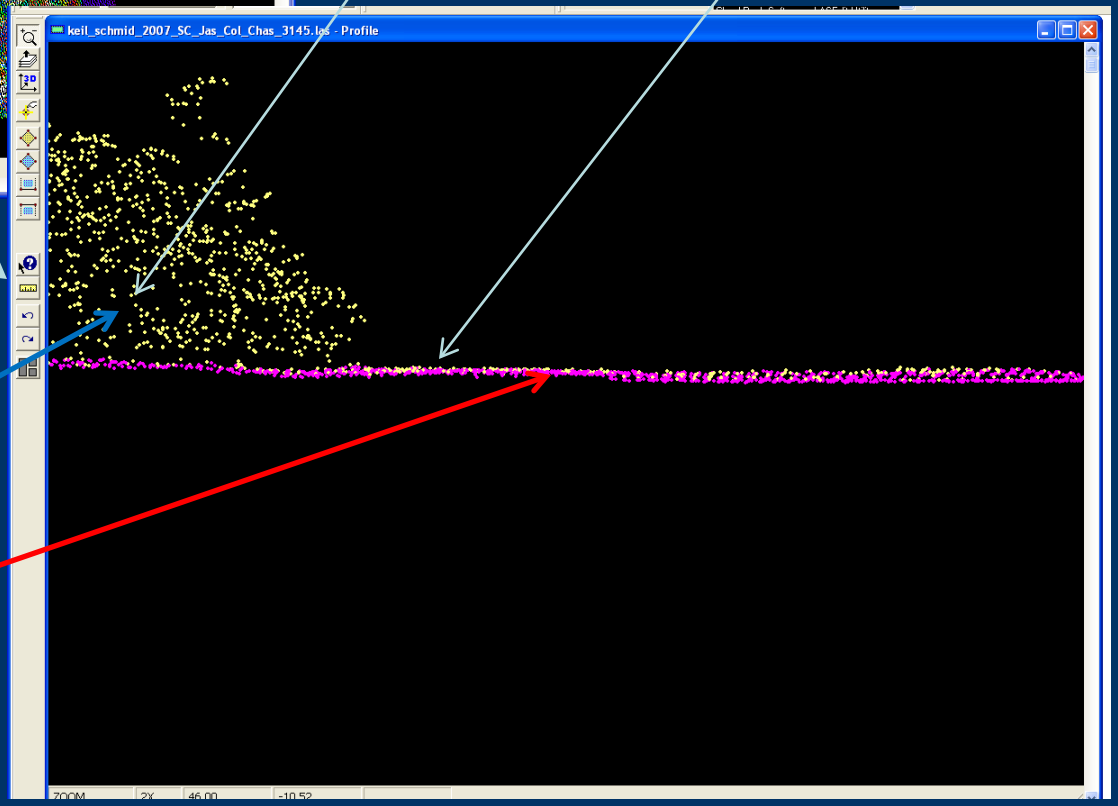
Vegetation Structure



Trees
(upland)

Marsh
(higher than upland?)

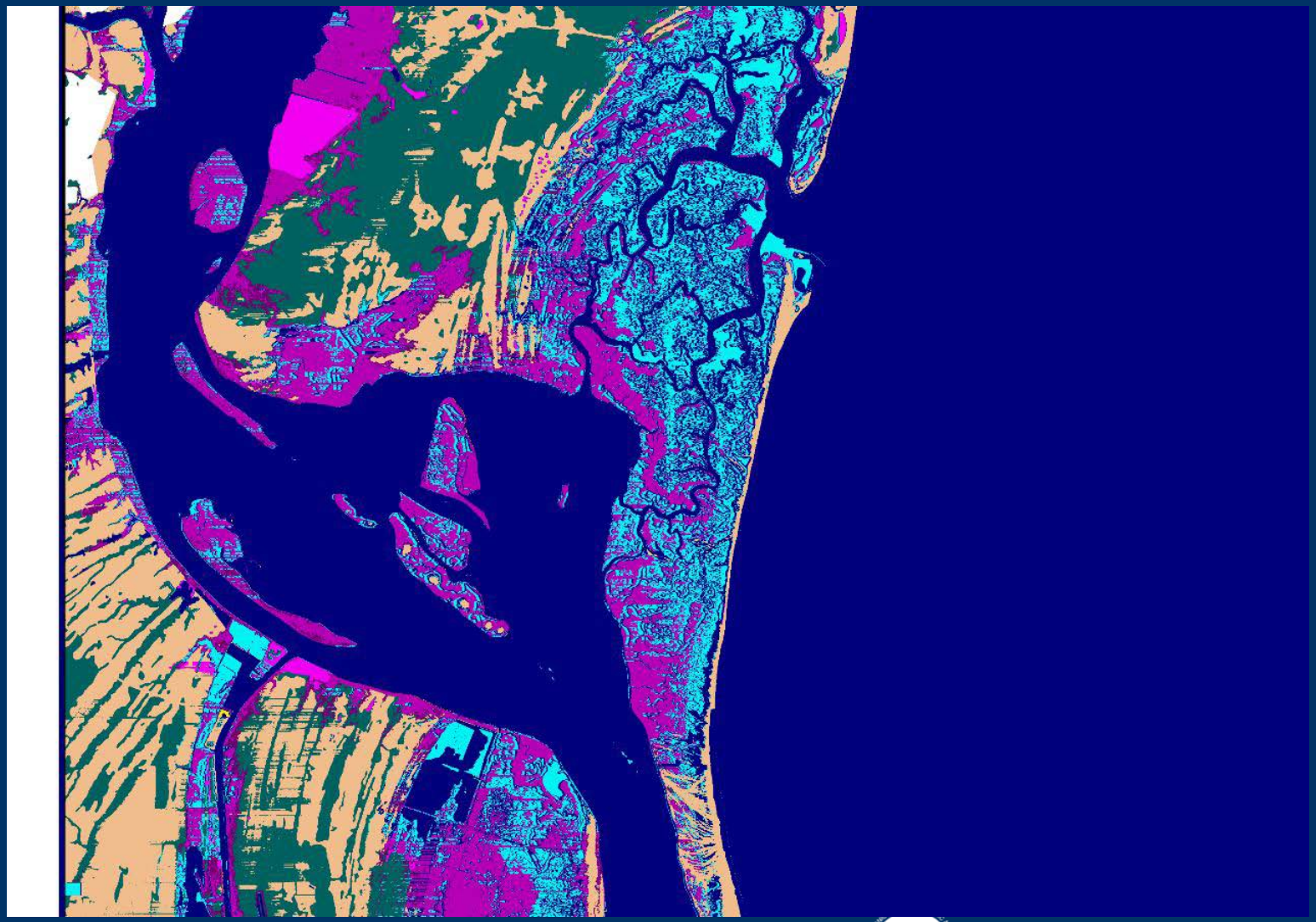




Example Marsh Applications

- Sea Level Affecting Marshes Model (SLAMM) – habitat changes
- Sea level rise inundation
- Shoreline mapping
- Coastal vegetation (invasive) mapping

SLAMM



2025 2050

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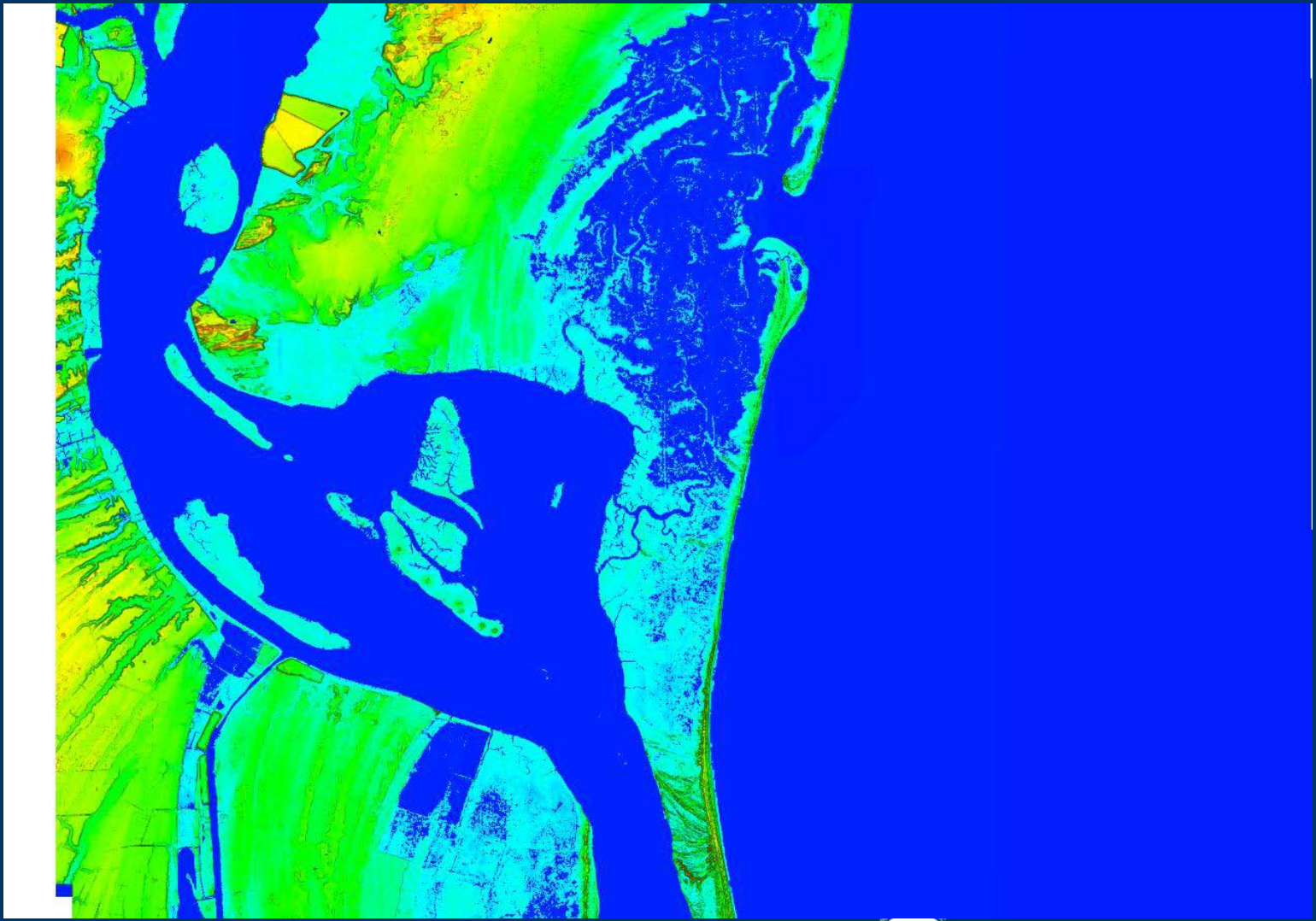
Inundation Extents



Present 2025

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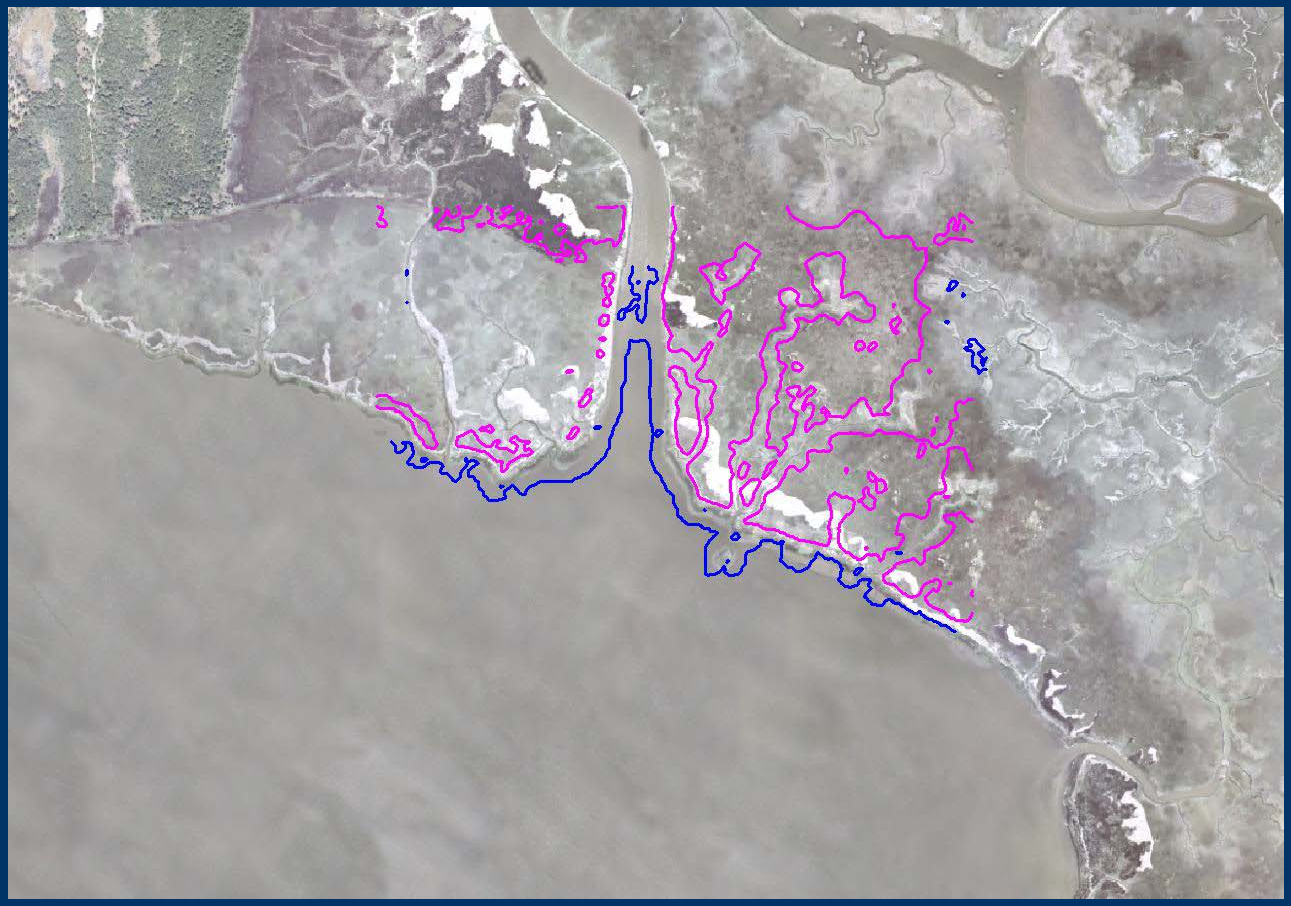
Shoreline Mapping

High variability – where is the shoreline?



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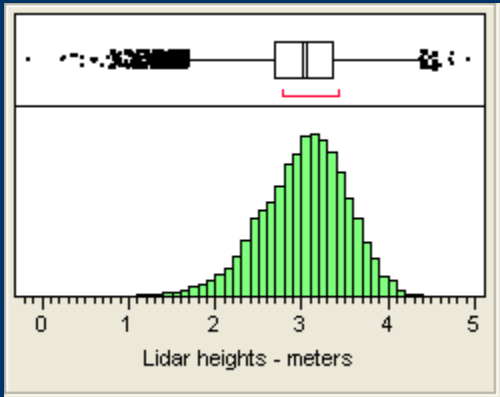
Coastal Vegetation Mapping

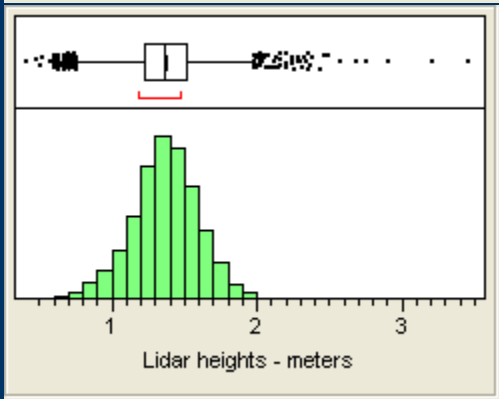


Quantiles

100.0%	maximum	4.920
99.5%		4.180
97.5%		3.910
90.0%		3.630
75.0%	quartile	3.370
50.0%	median	3.060
25.0%	quartile	2.700
10.0%		2.350
2.5%		1.860
0.5%		1.250
0.0%	minimum	-0.160

Moments

Mean	3.0133465
Std Dev	0.5209815
Std Err Mean	0.0036141
upper 95% Mean	3.0204304
lower 95% Mean	3.0062626
N	20780

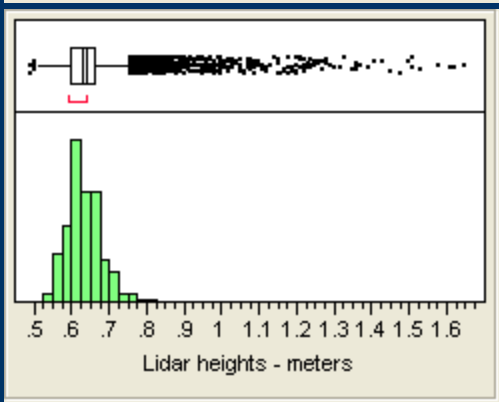


Quantiles

100.0%	maximum	3.4600
99.5%		2.0300
97.5%		1.8200
90.0%		1.6600
75.0%	quartile	1.5200
50.0%	median	1.3700
25.0%	quartile	1.2200
10.0%		1.0700
2.5%		0.8735
0.5%		0.7200
0.0%	minimum	0.4200

Moments

Mean	1.3670306
Std Dev	0.2391253
Std Err Mean	0.0024595
upper 95% Mean	1.3718517
lower 95% Mean	1.3622095
N	9453



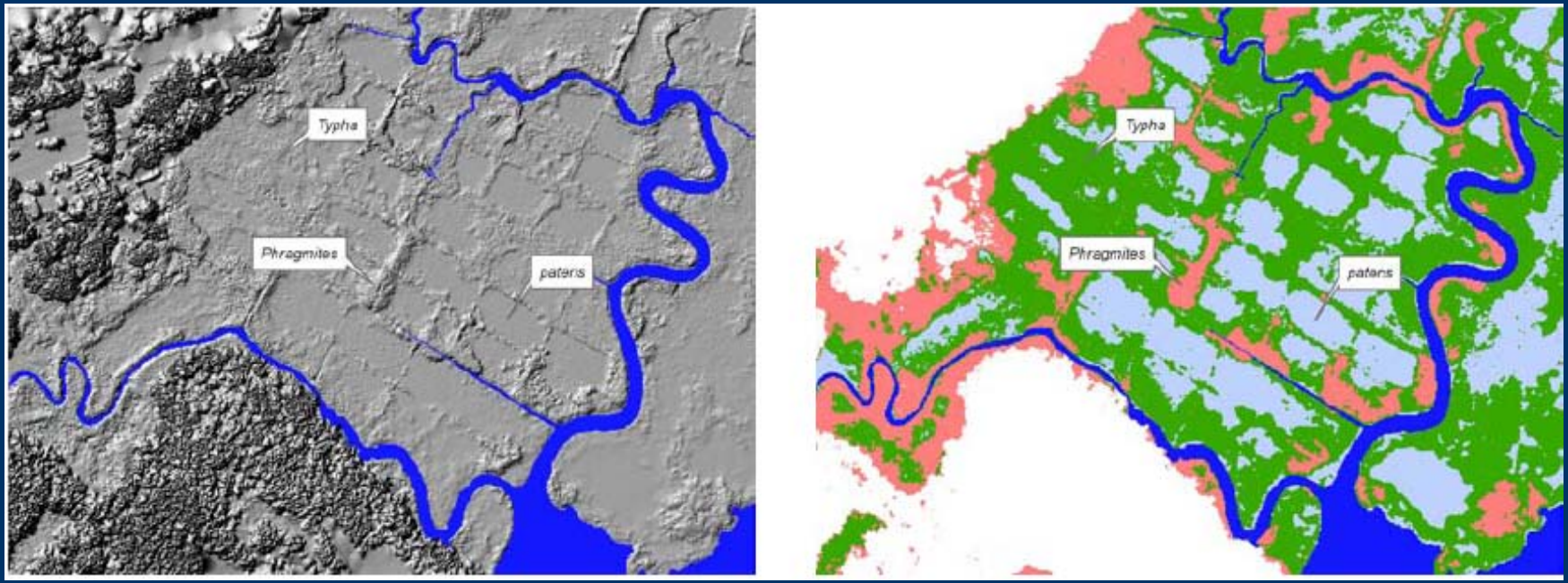
Quantiles

100.0%	maximum	1.6500
99.5%		1.1000
97.5%		0.8000
90.0%		0.7000
75.0%	quartile	0.6600
50.0%	median	0.6300
25.0%	quartile	0.6000
10.0%		0.5800
2.5%		0.5500
0.5%		0.5300
0.0%	minimum	0.4900

Moments

Mean	0.6390156
Std Dev	0.0762845
Std Err Mean	0.0006519
upper 95% Mean	0.6402934
lower 95% Mean	0.6377377
N	13693

Coastal Vegetation Mapping



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What We Looked At

- 5 sites sampled by the Center in Charleston County
- Data from National Geodetic Survey in Georgetown County, South Carolina, and Currituck, North Carolina
- Center data captured with GPS and Total Station
- Profiles taken across marsh
  - Elevations – Ground, Tops, Middle
  - Vegetation Type (species)
  - Density Estimate

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Site Example

Dominantly Fringing Spartina Marsh

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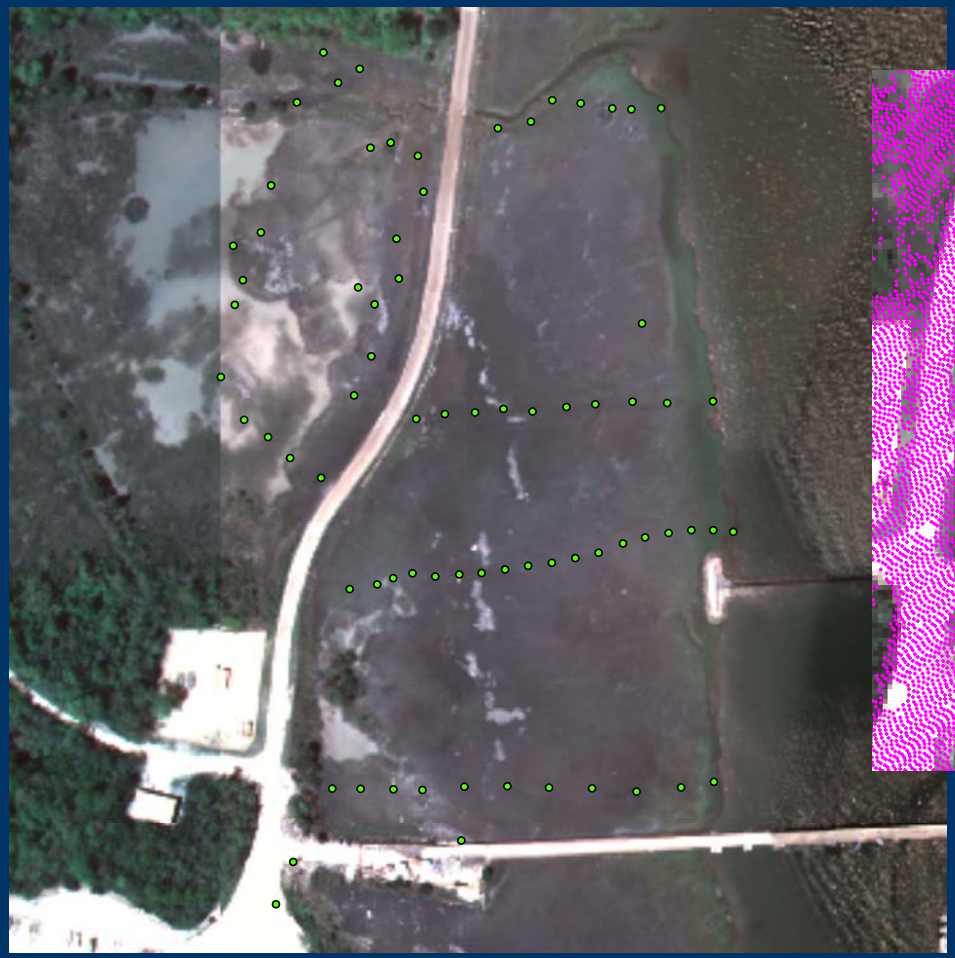
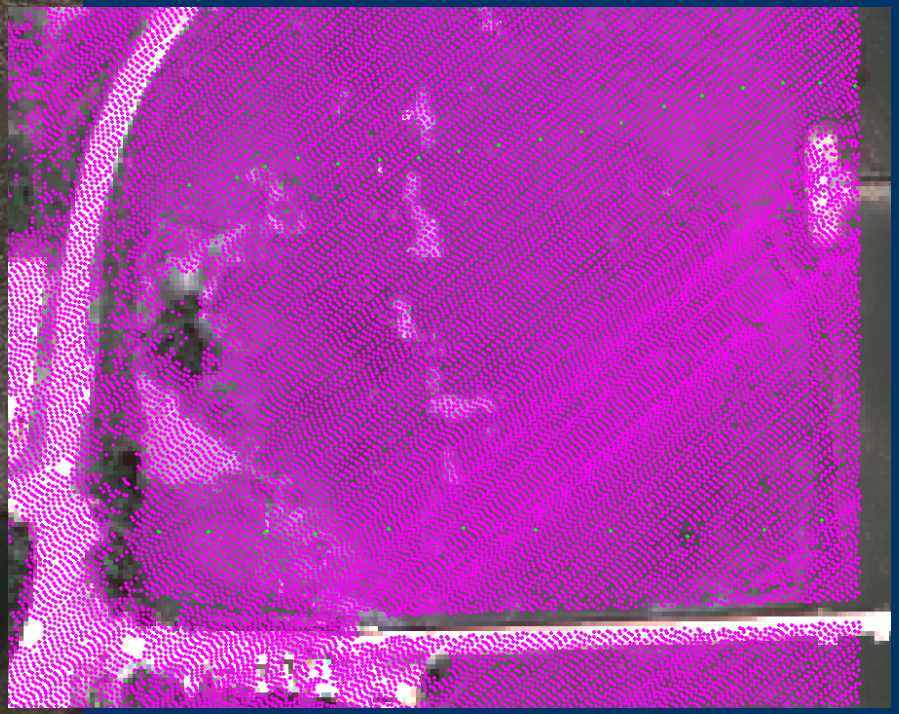
Example Site





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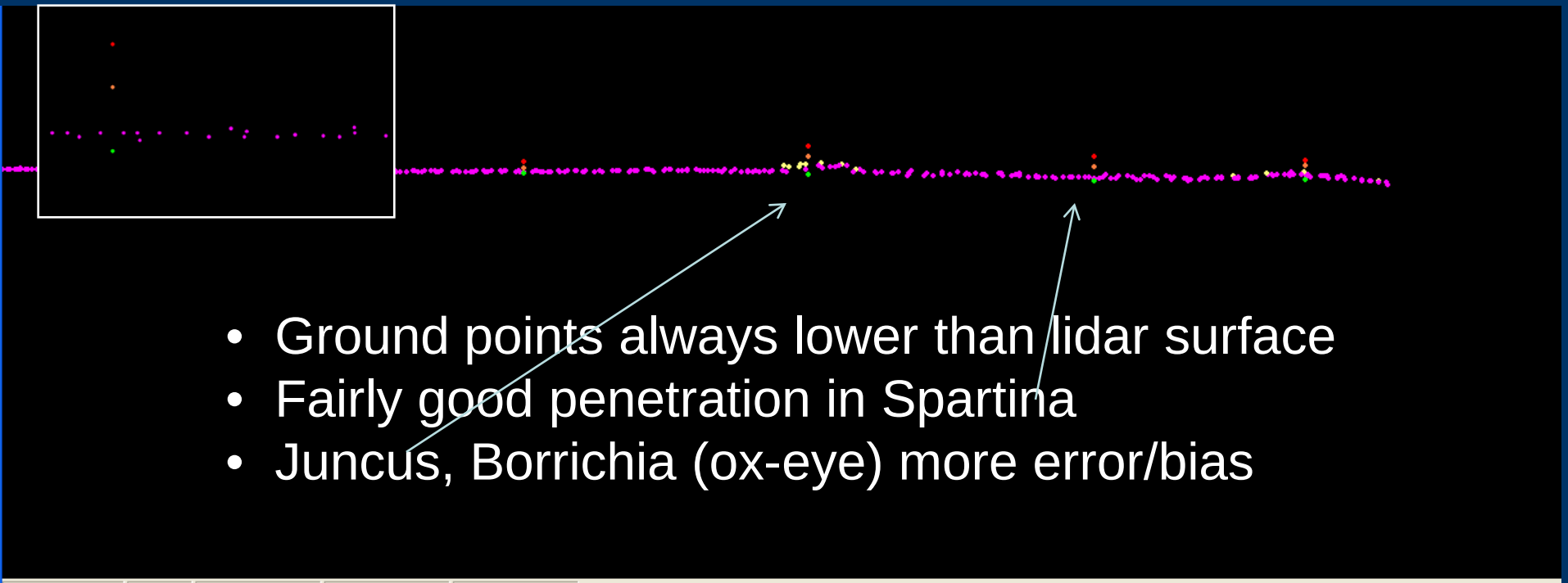
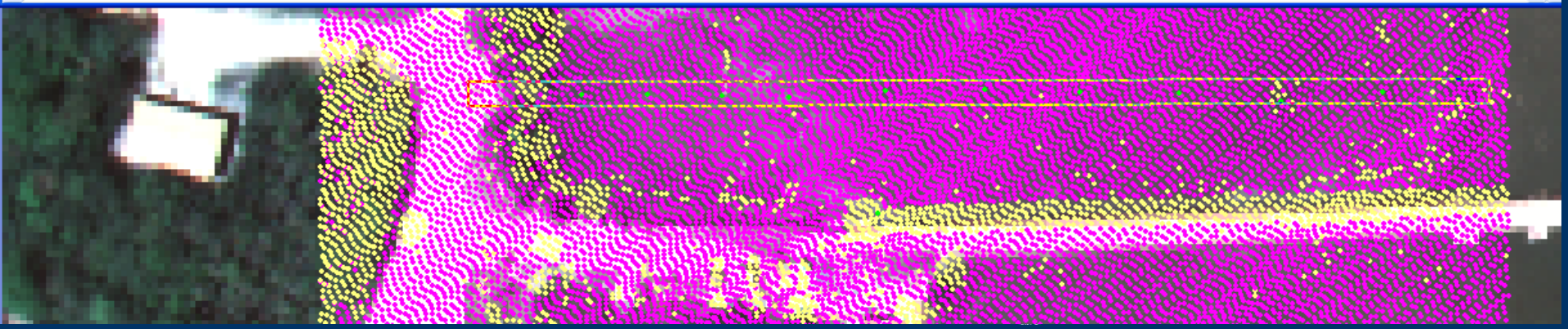
What We Are Finding (in progress)

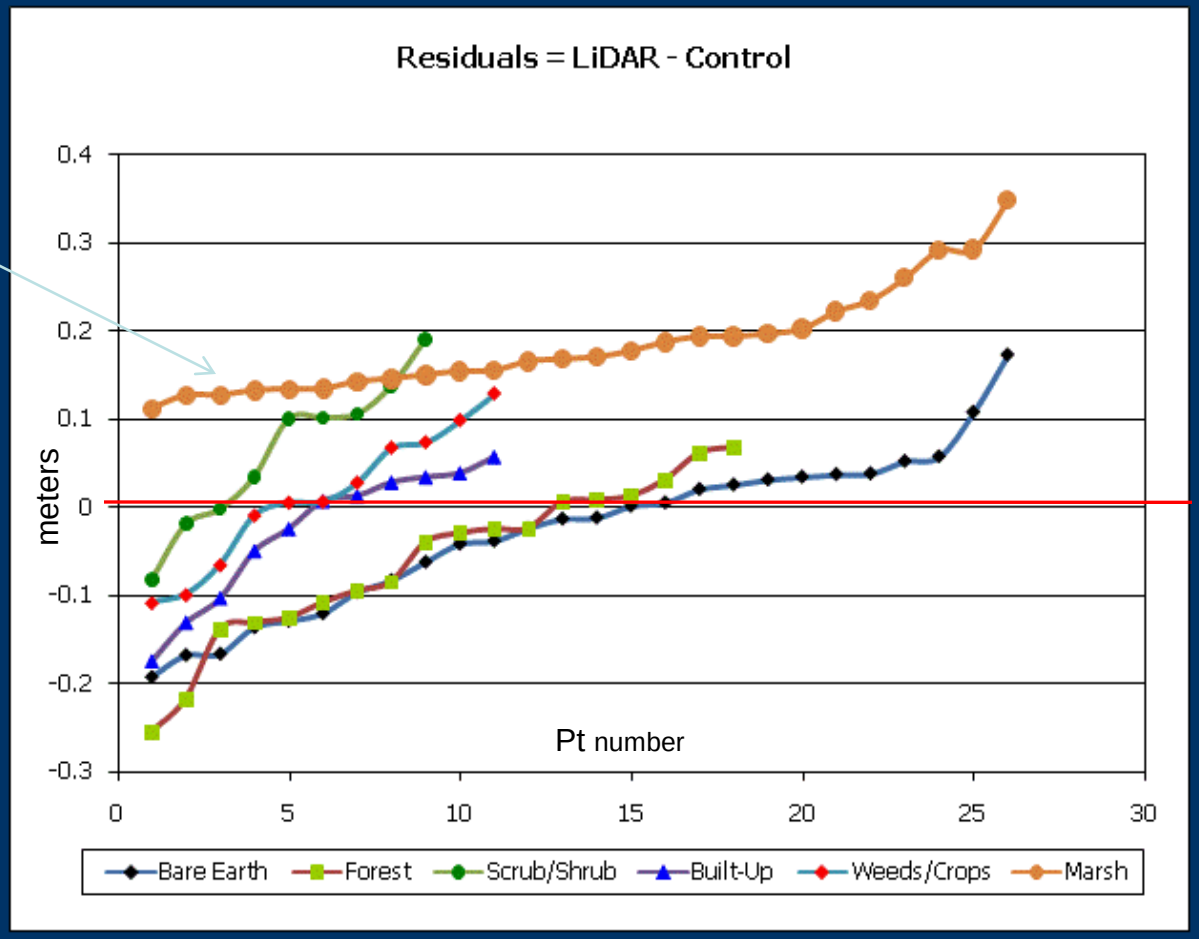


- Ground points always lower than lidar surface
- Fairly good penetration in Spartina
- Juncus, Borrichia (ox-eye) more error/bias



Marsh Data – A Different Animal

- Random selection of marsh points (spartina marsh)
- "Upland" land cover distributed around zero
- Marsh points have a global bias !



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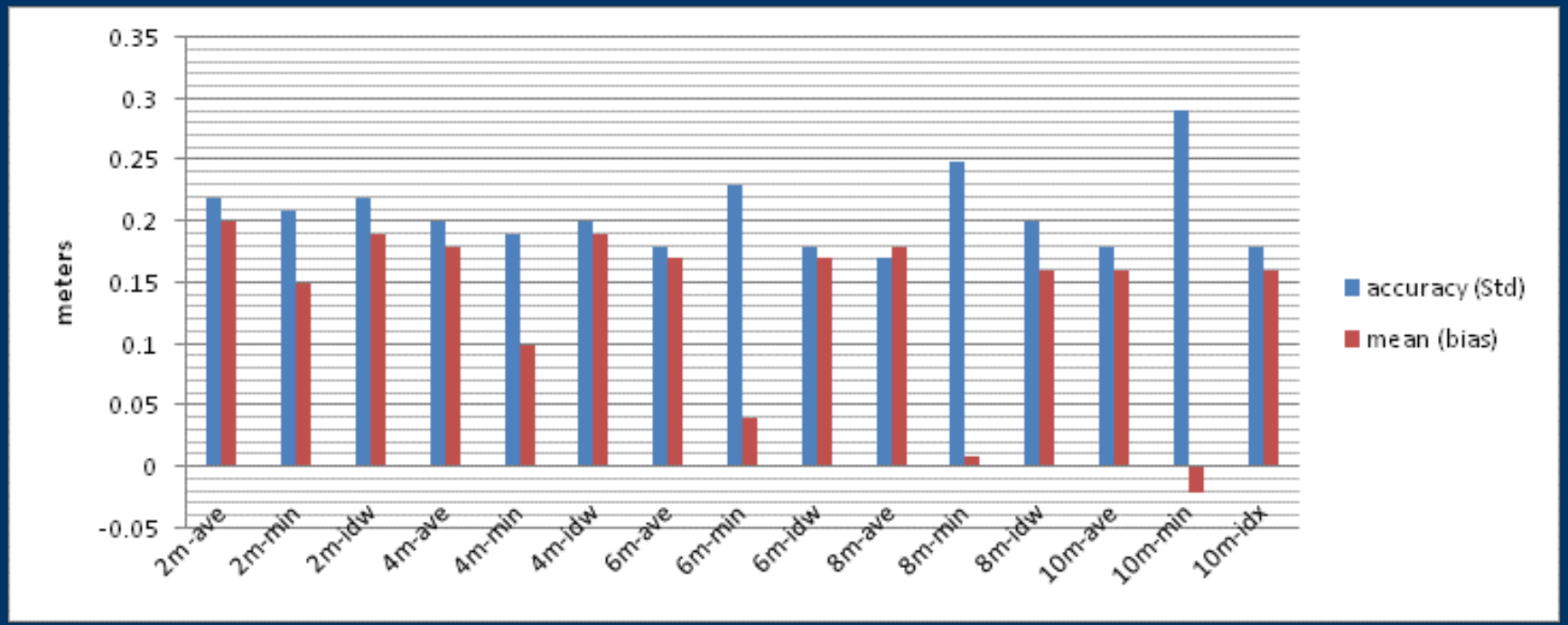
Digital Elevation Model (DEM) Creation and Comparison

- Multiple techniques available
  - TIN, Bins (average, Min, Max), inverse distance weighting (IDW)
- Different resolutions
- Best choices may vary (results may vary) by marsh type (vegetation types)



Quick Example of DEMs

2m TIN

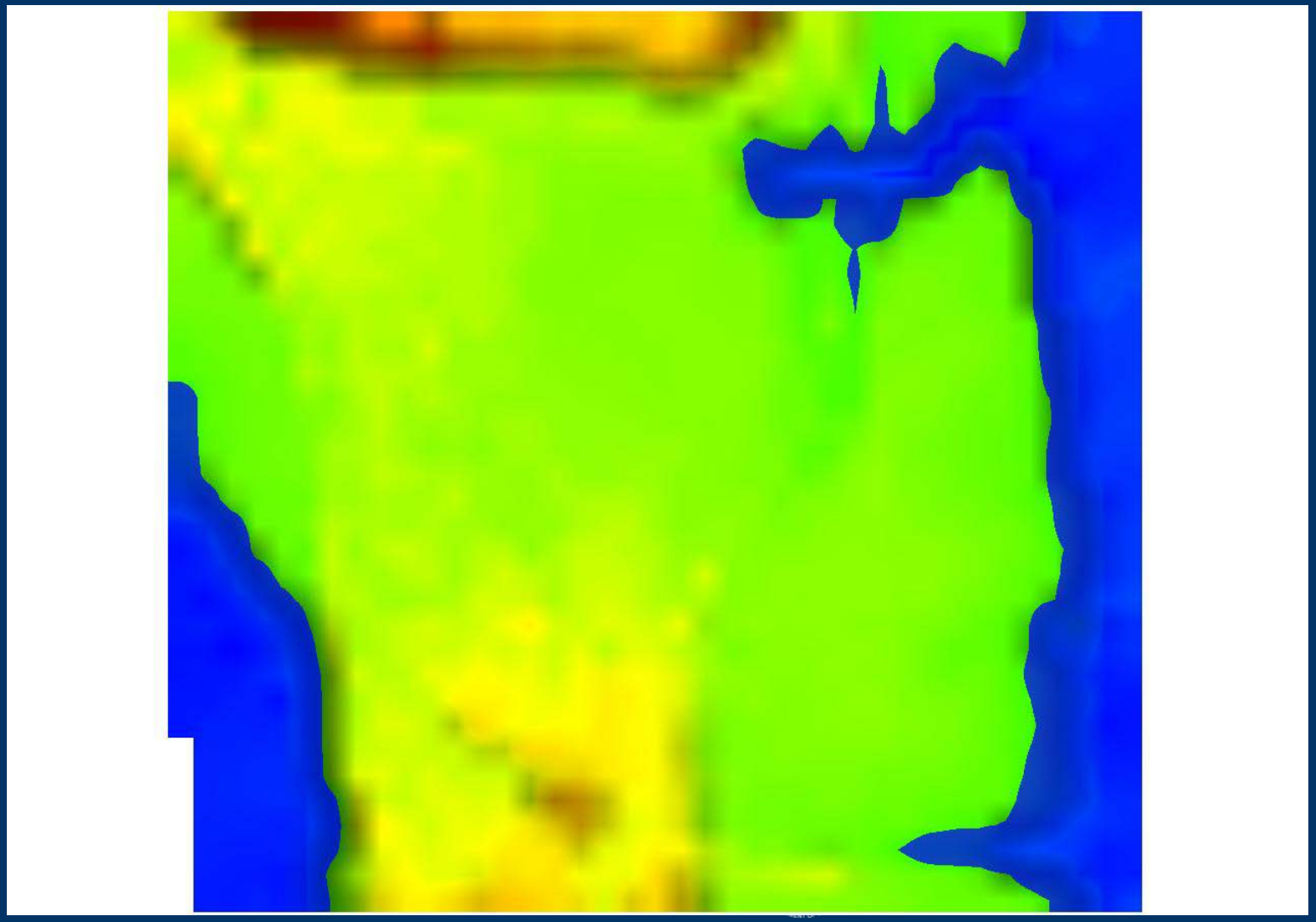
2m IDW

4m MIN

6m MIN

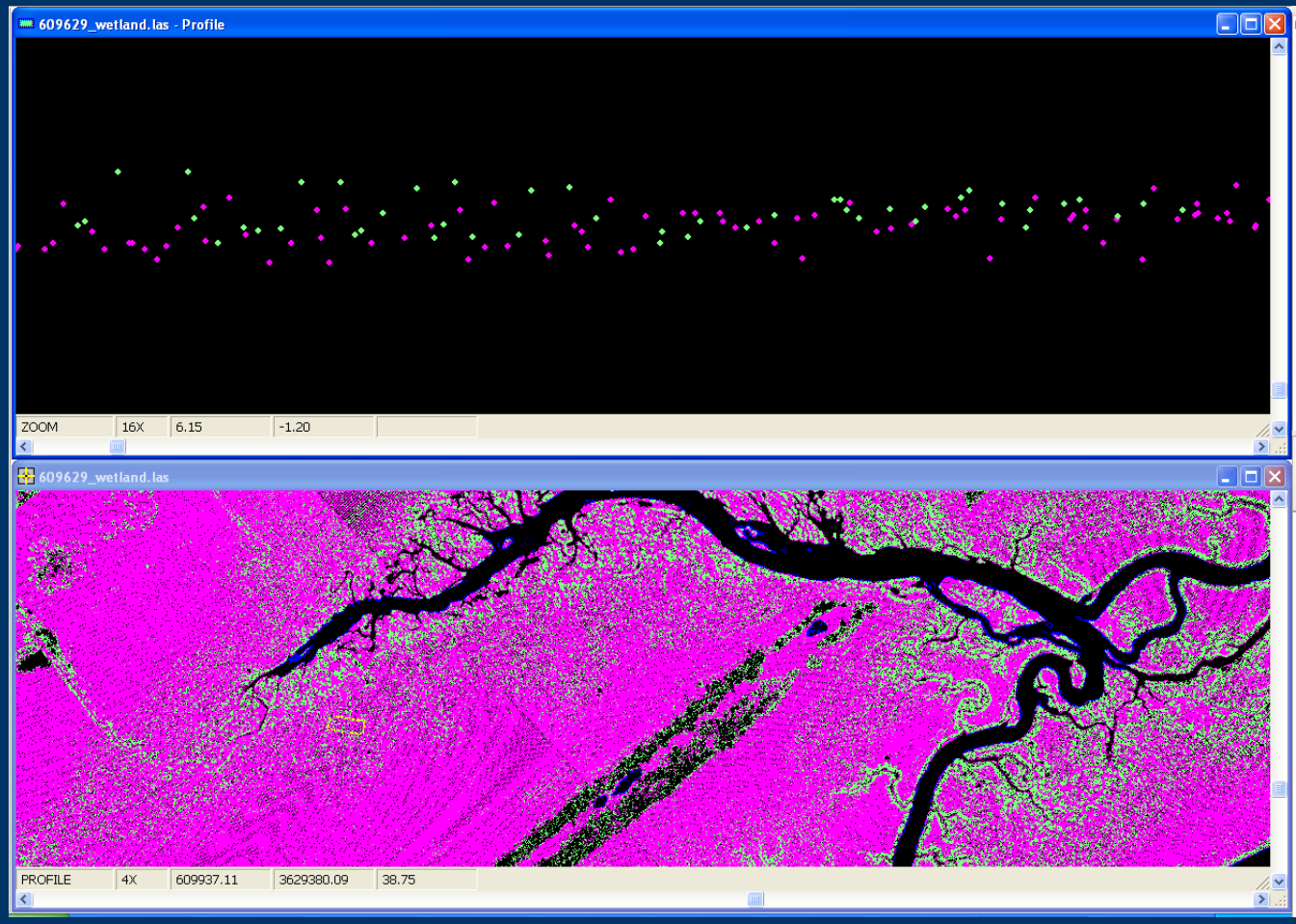
8m MIN

10m MIN



Upon Closer Inspection . . .
(Lidar Data in Coastal Marshes)

- Bare Earth Points?
- Marsh vegetation – primary elevation variable
- What is the marsh surface?



Additional classification (green points) to remove marsh vegetation is one fix

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Interim Conclusions (not the final word!)

- Lidar data in marshes have different “qualities” than in typical settings (what we commonly associate lidar with)
- Marsh elevation changes (and sea level changes) are subtle as compared with traditional uses
- Take Away: Resolution may have to be sacrificed for “real accuracy”

The Cast – Thanks

Questions?

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