Drone LiDAR for Coastal Topography and 3D Marsh Mapping

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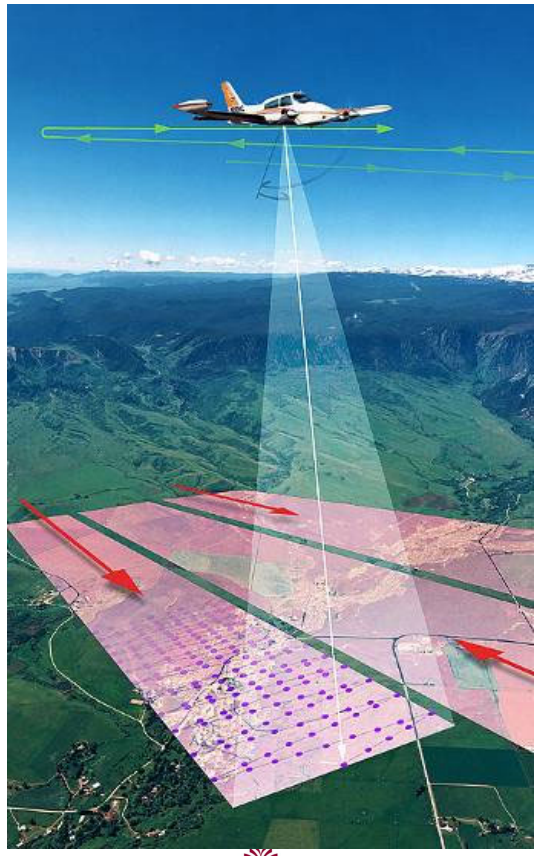
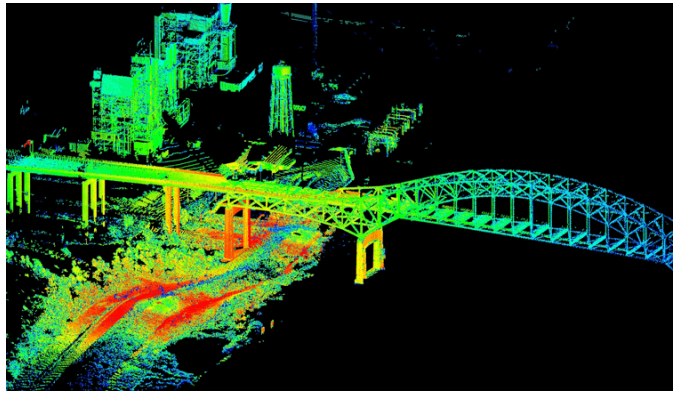
❑ Background

LiDAR: a “non-imaging” technology to measure distance by submitting discrete laser beams and receiving multiple returns.

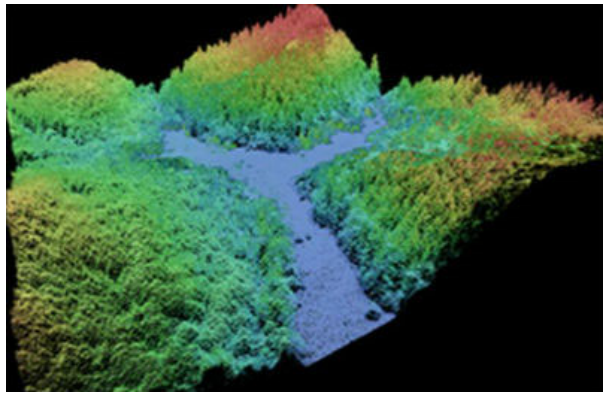
3D point cloud
(cm-level elevation & height)



Successful stories in many fields…



(GIS LOUNGE)



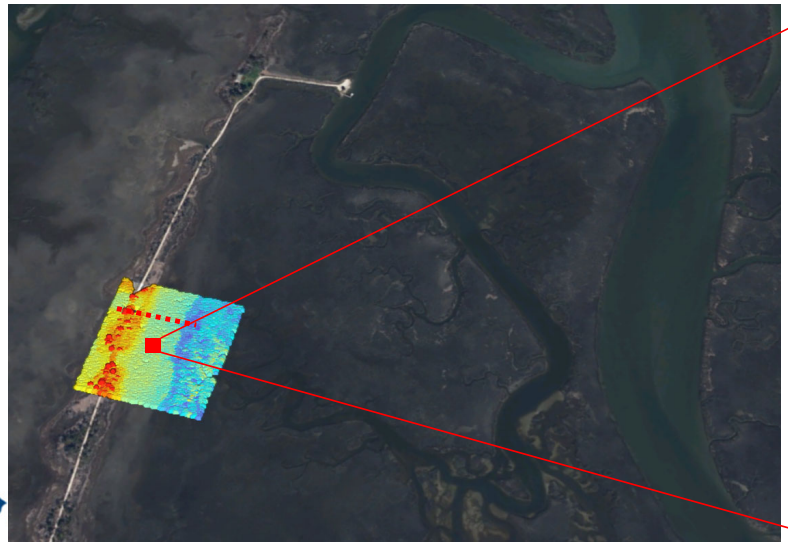
USGS Lidar Point Cloud (National Map 3DEP)

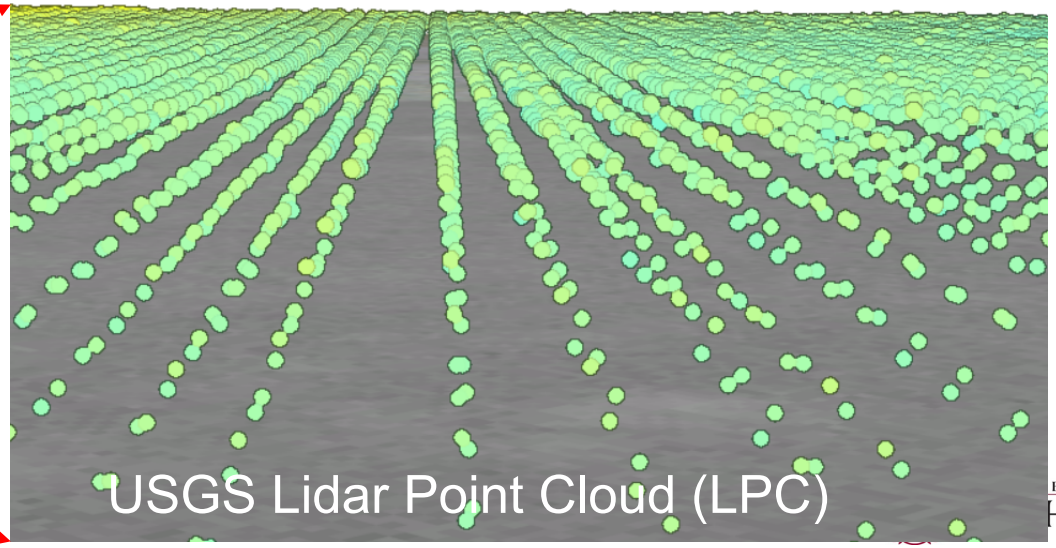
Airborne Lidar in coastal marshes: not so fortunate...

- ✓ *Tidal effects*
- ✓ *Gentle topography*
- ✓ *Short, sparse marsh plants*

Question: Could Drone Lidar play a better role in marshes?

- ✓ *Affordable*
- ✓ *Flexible*
- ✓ *Much denser point cloud*





❑ **Field experiment**: August – September 2022, North Inlet

(Baruch Marine Field Laboratory, USC)

ROCK Robotic R2A
(Livox Avia + RGB camera)

✓ **Drone Lidar missions**: 08/31 – 09/01

Vendor: Back Forty Aerial Solutions, Columbia, SC
(*Eric Harkins*)

✓ **Multispectral drone missions and field survey**: 09/20 – 09/24

NASA EPSCOR Project team:
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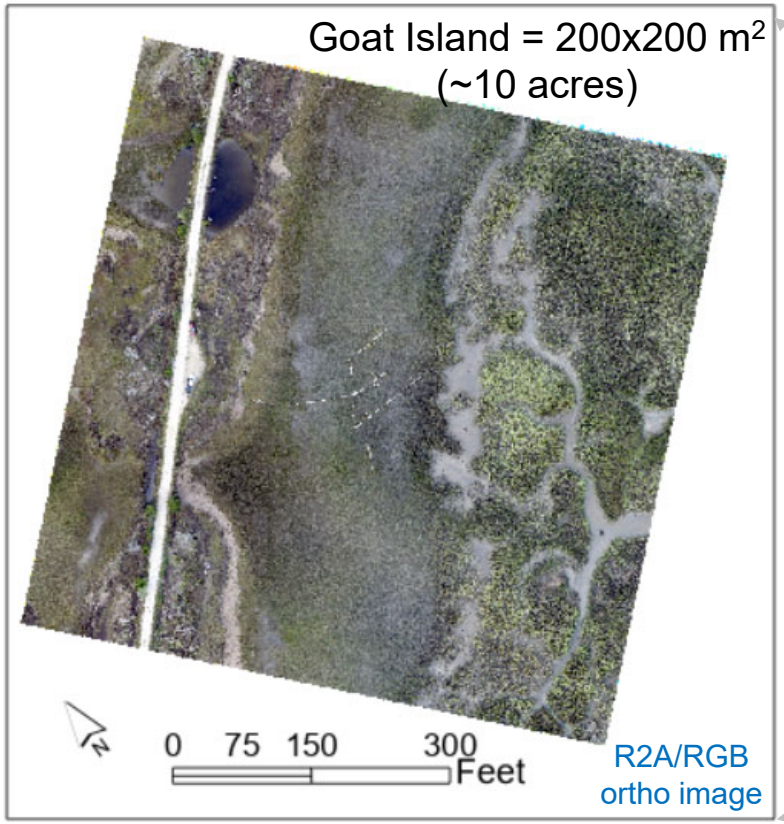
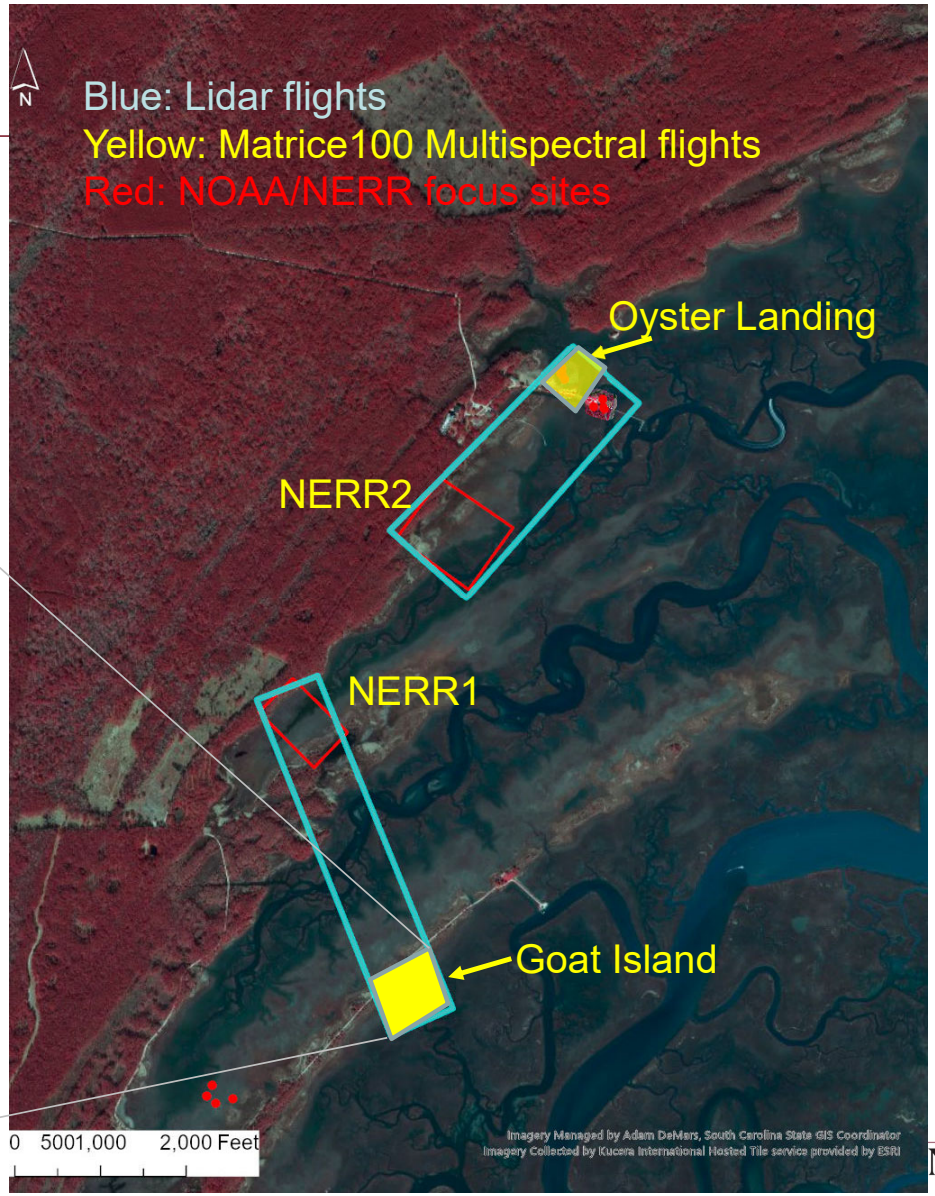
Study area

- ✓ Two Lidar flights: 80 acres each;
- ✓ Four field plots: 36 Ground Control Targets
- ✓ 65 in-field biomass samples

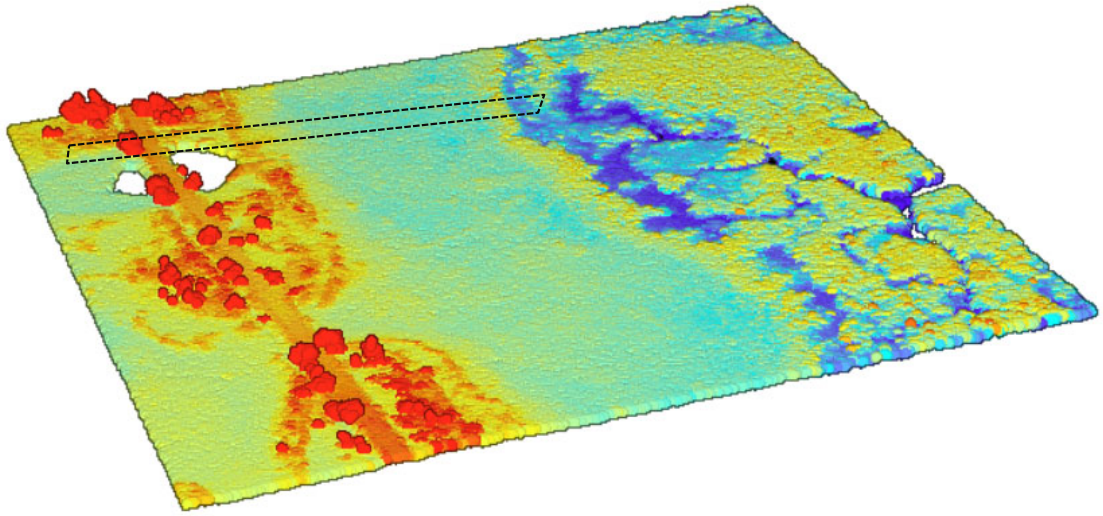




R2A/Lidar point cloud

Goat Island subset	Drone Lidar	USGS Lidar
Point count	29,561,422	95,269
Spacing	0.036 m	0.639 m
Point density (#/m^2)	771	2.43

Caution: R2A Lidar points only have one returns in marsh fields!

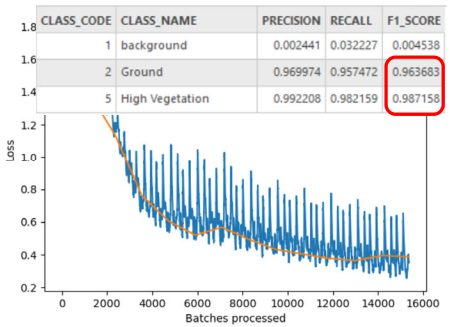


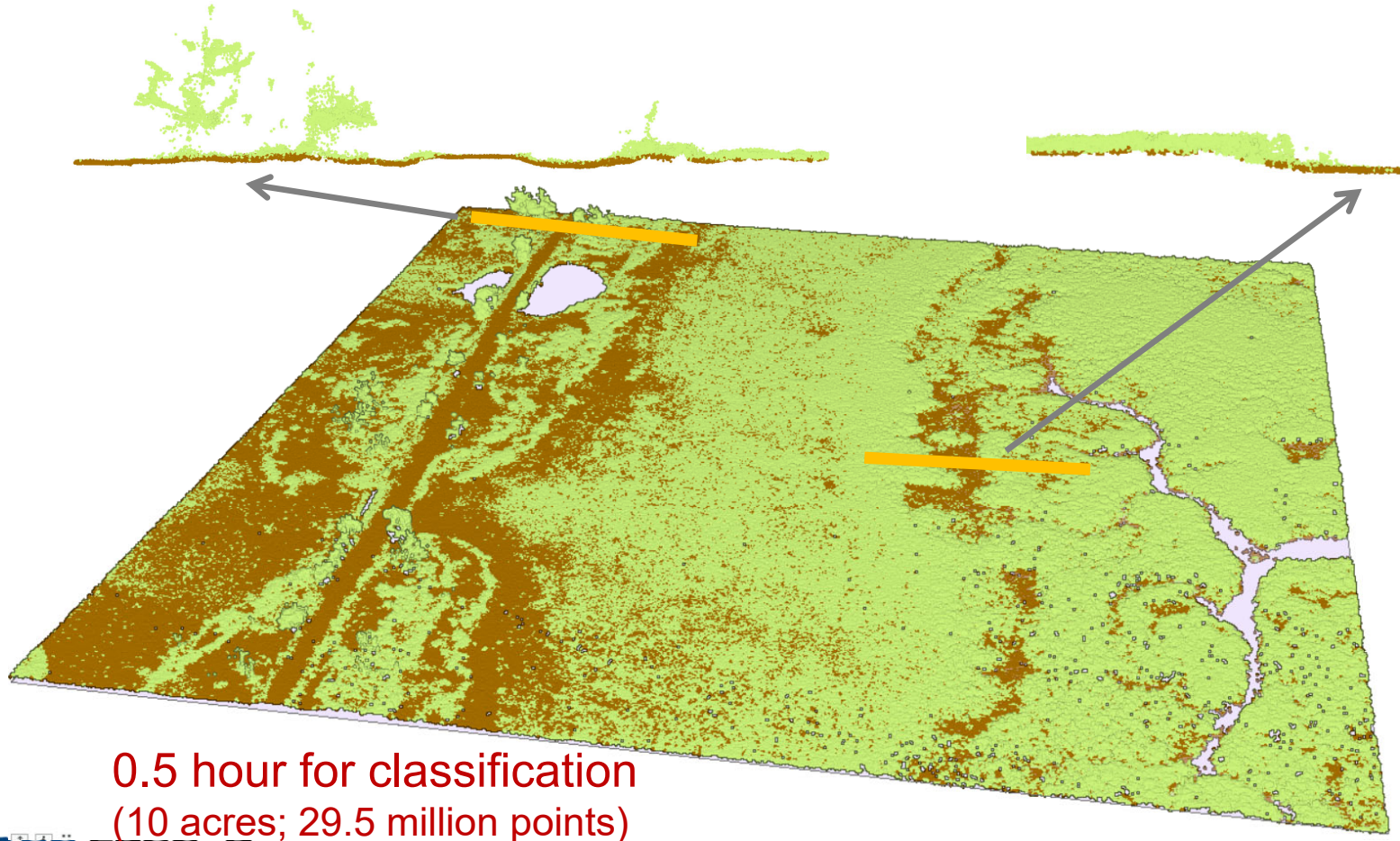
R2A Drone Lidar profile:

USGS Lidar profile:

❑ **PointCNN:** Deep learning for point classification

CLASS_CODE	CLASS_NAME	PRECISION	RECALL	F1_SCORE
1	background	0.002441	0.032227	0.004538
2	Ground	0.969974	0.957472	0.963683
5	High Vegetation	0.992208	0.982159	0.987158





Classification
- 1 Unassigned
- 2 Ground
- 5 High Vegetation

0.5 hour for classification
(10 acres; 29.5 million points)

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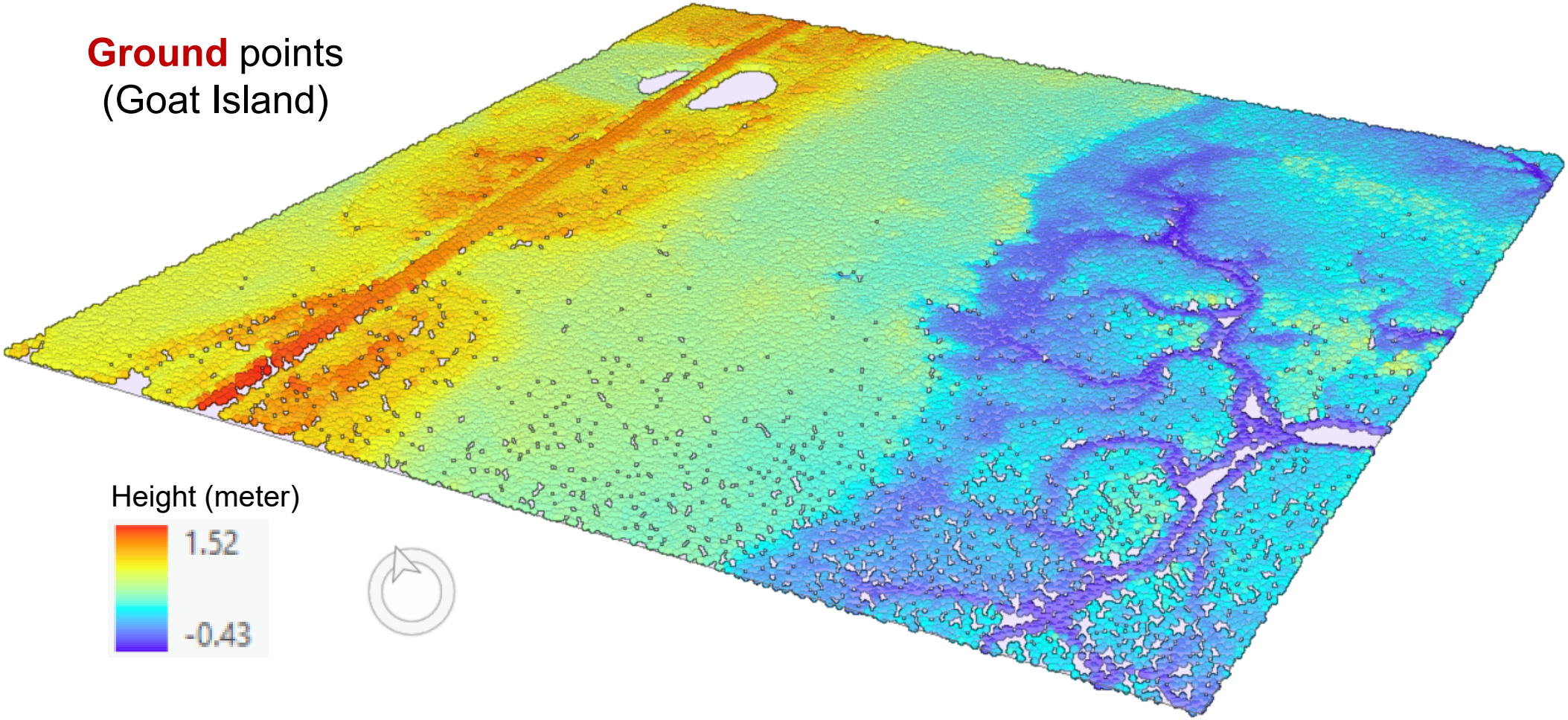
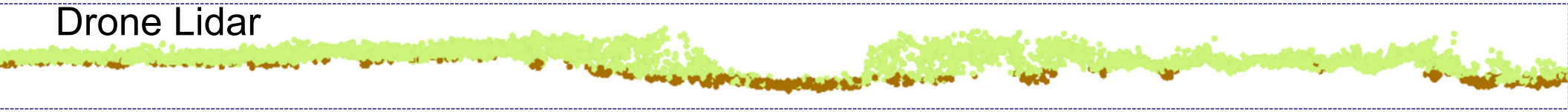
Ground points to extract Bare Earth Surface

Ground points
(Goat Island)



Comparison with USGS LiDAR

Drone Lidar



USGS Airborne Lidar

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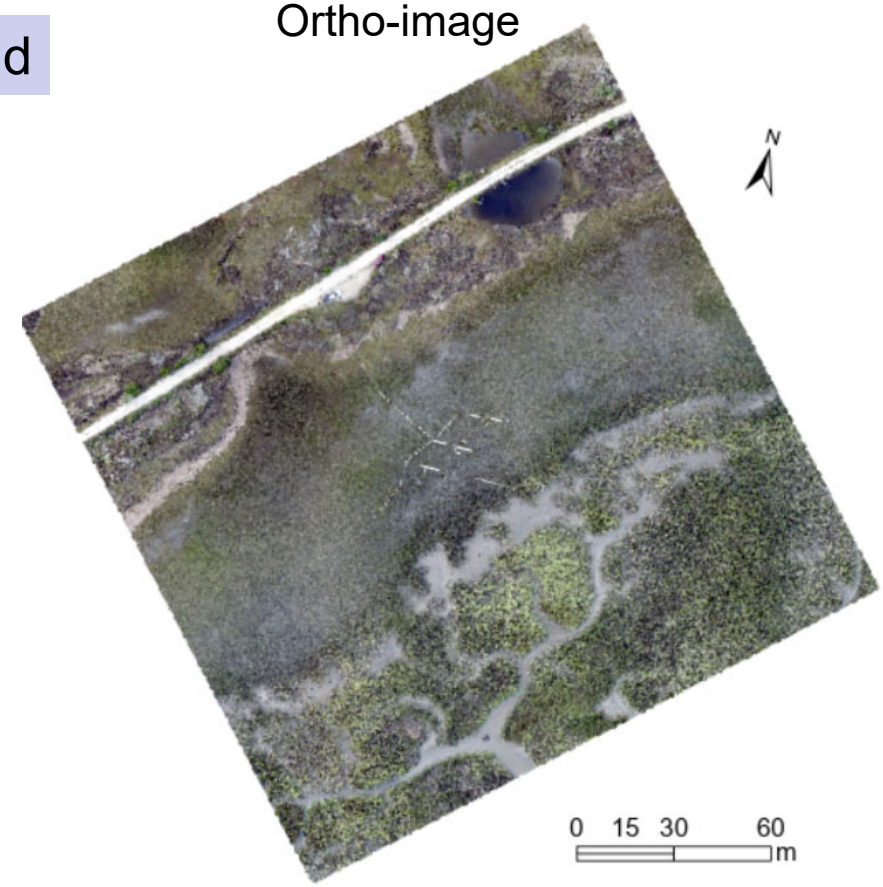
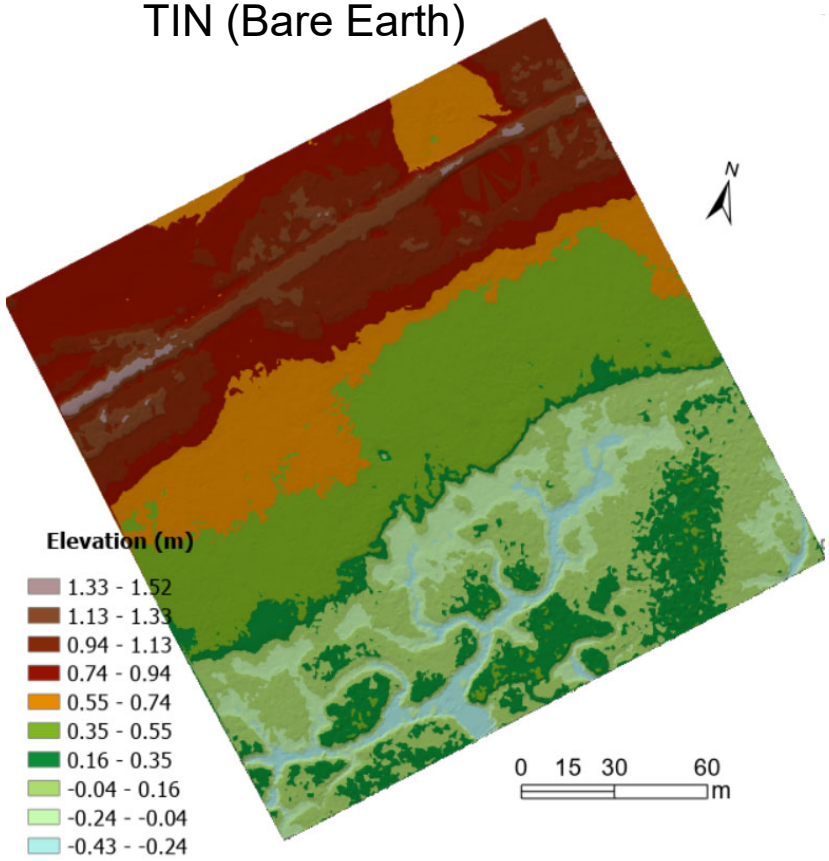
❑ Topography in marshes: bare Earth surfaces

Goat Island

Ortho-image

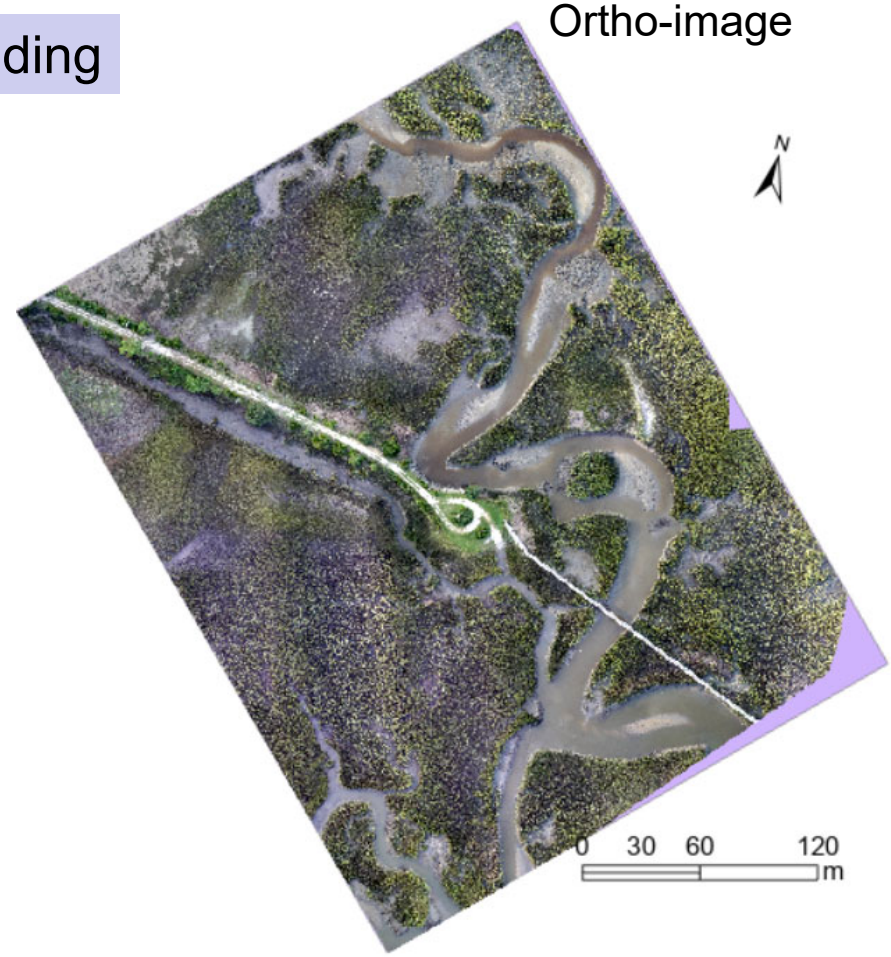


TIN (Bare Earth)



Oyster Landing

Ortho-image



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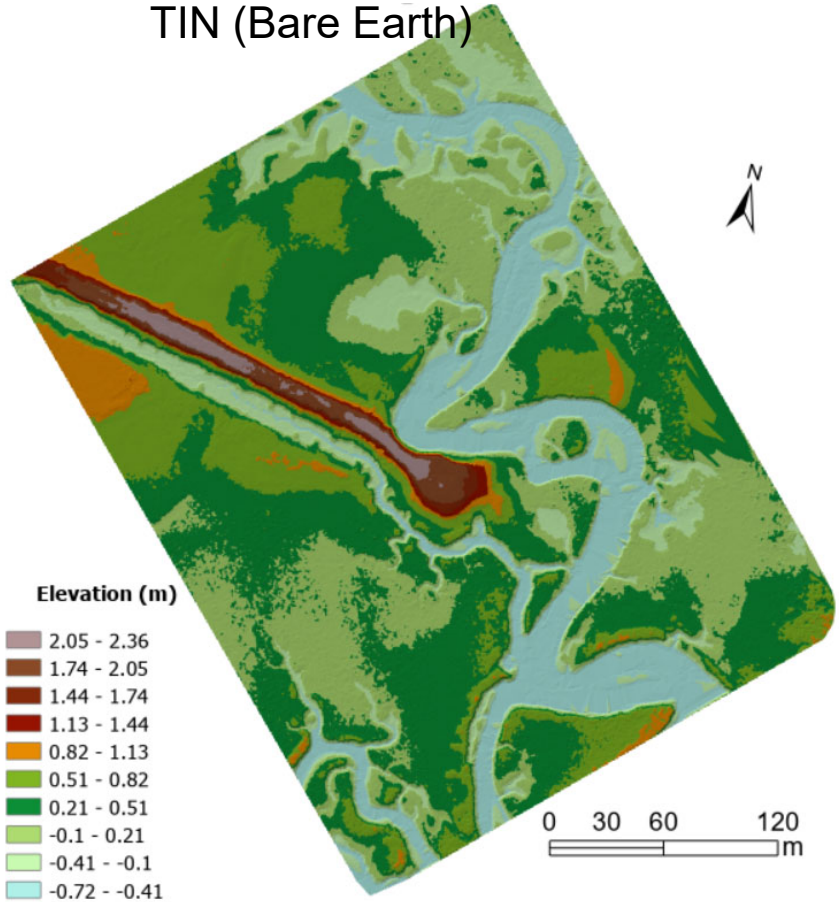

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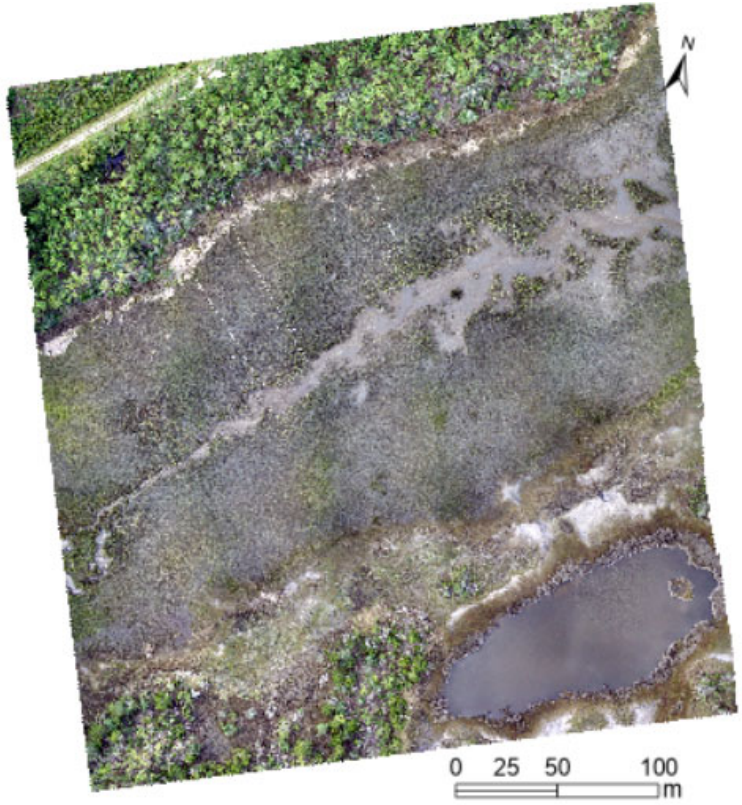
NERR1

Ortho-image



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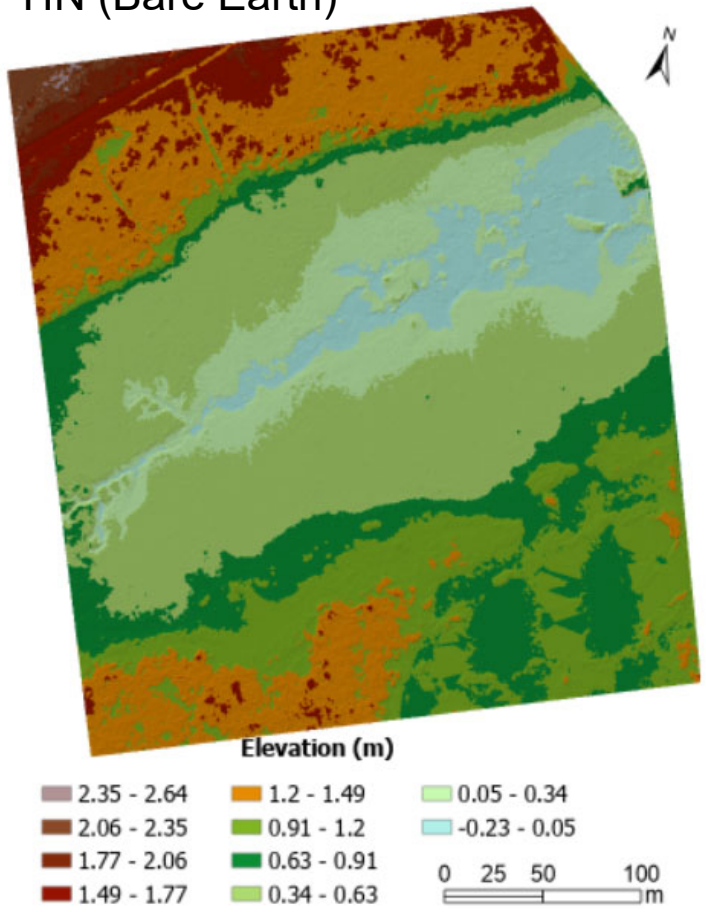

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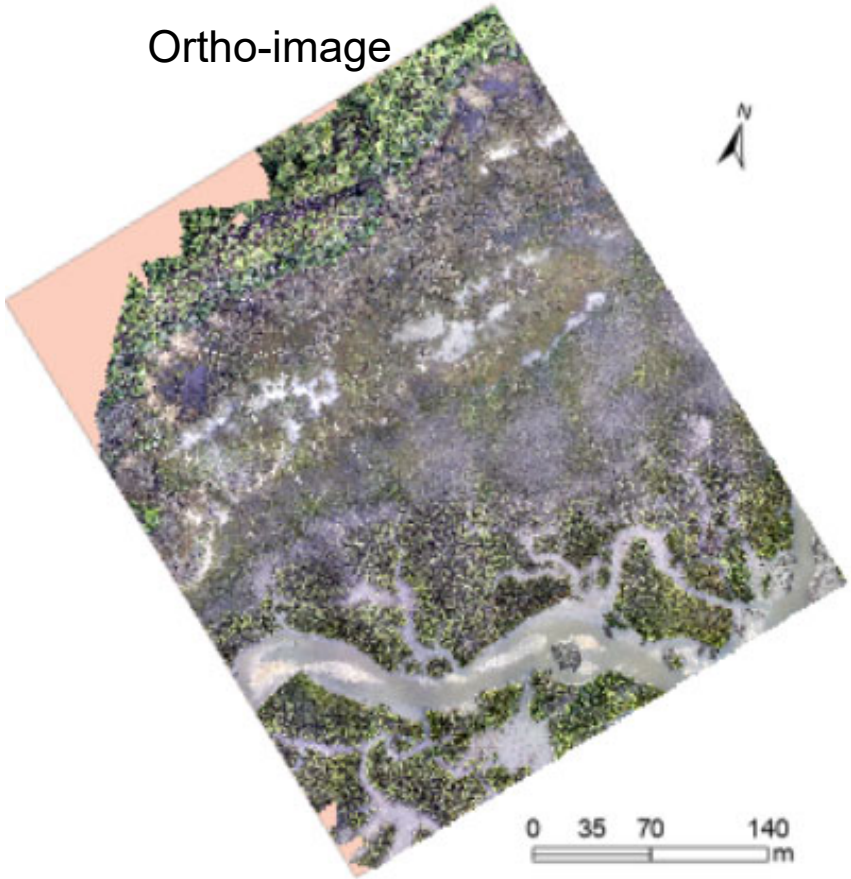

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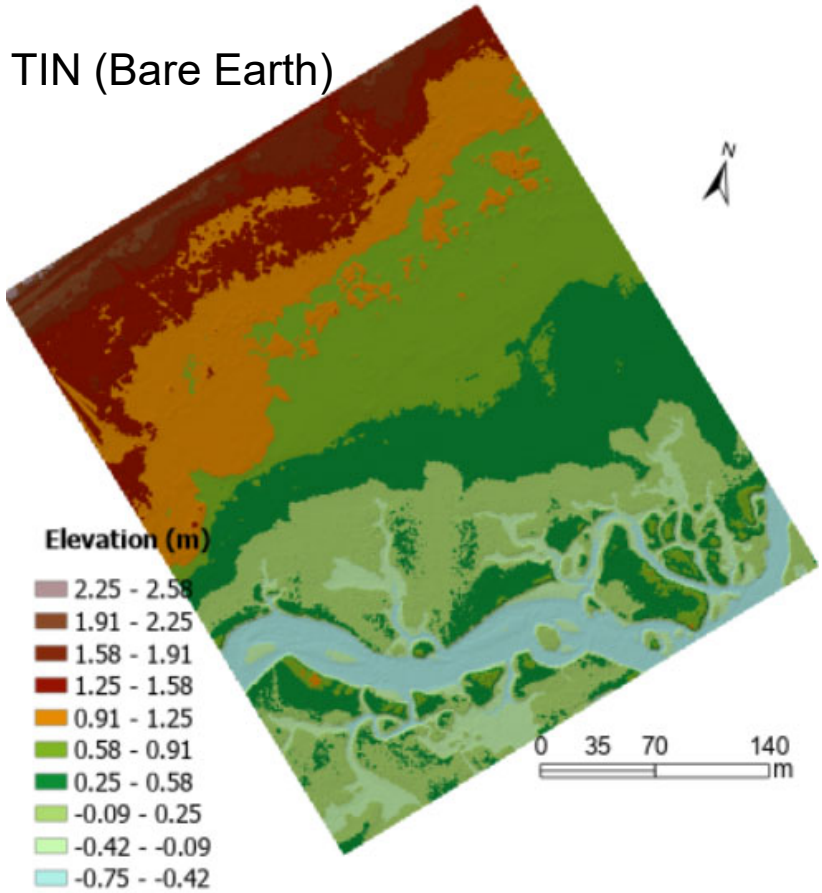


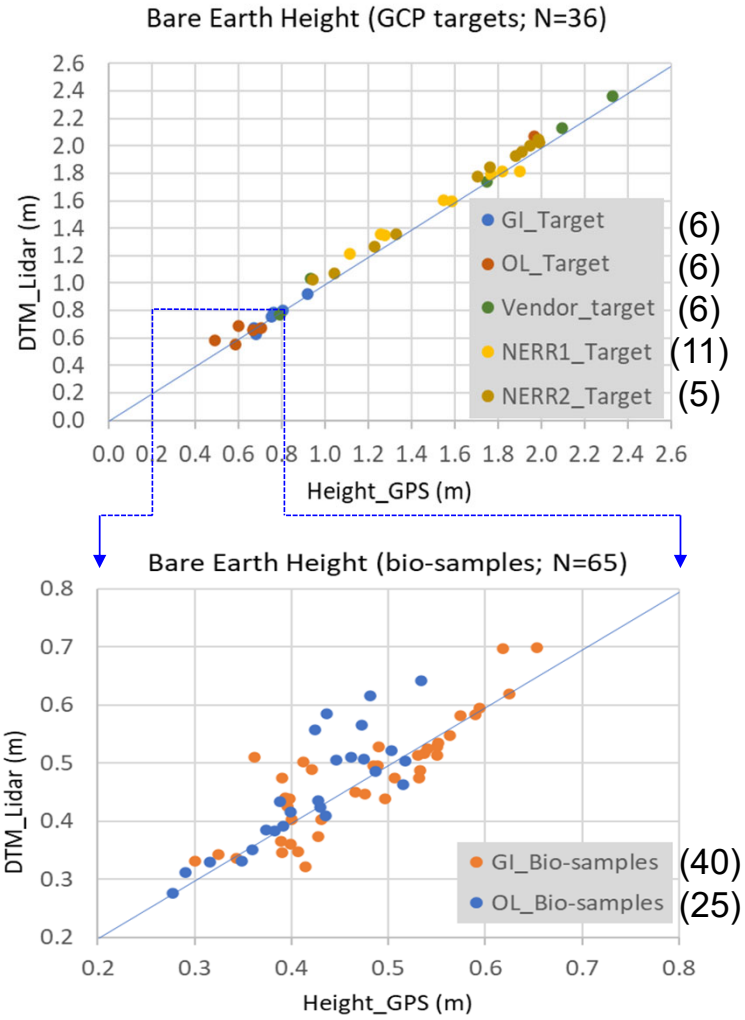
❑ Validation How good is drone Lidar on coastal topography?

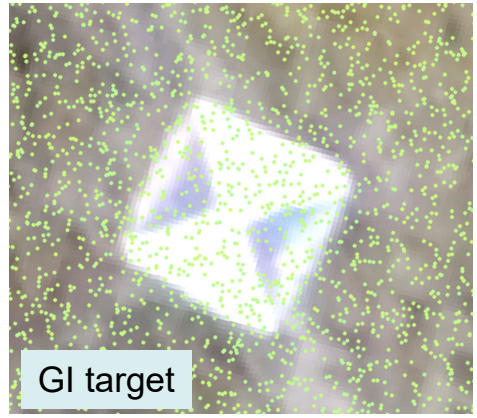
DTM
at Ground Control Targets (36)

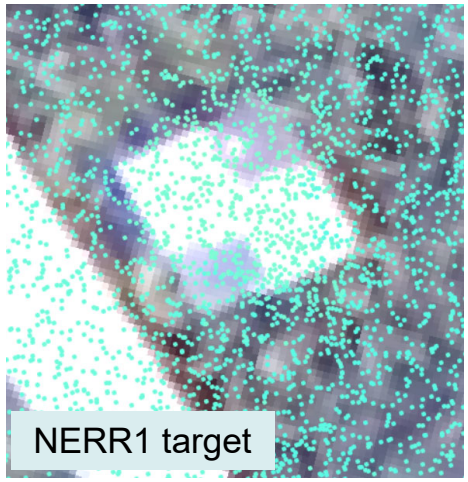
RMSE = 5.55 cm

DTM
at Biomass samples (65)

RMSE = 5.33 cm







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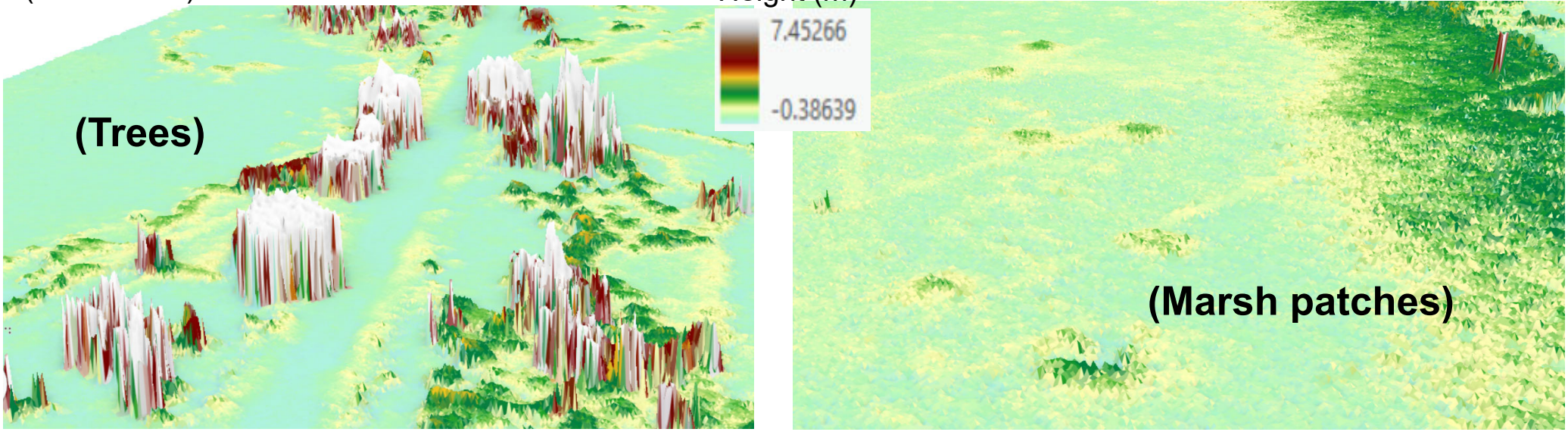
❑ 3D marsh modeling

Marsh height:

H = DSM-DTM

(Goat island)



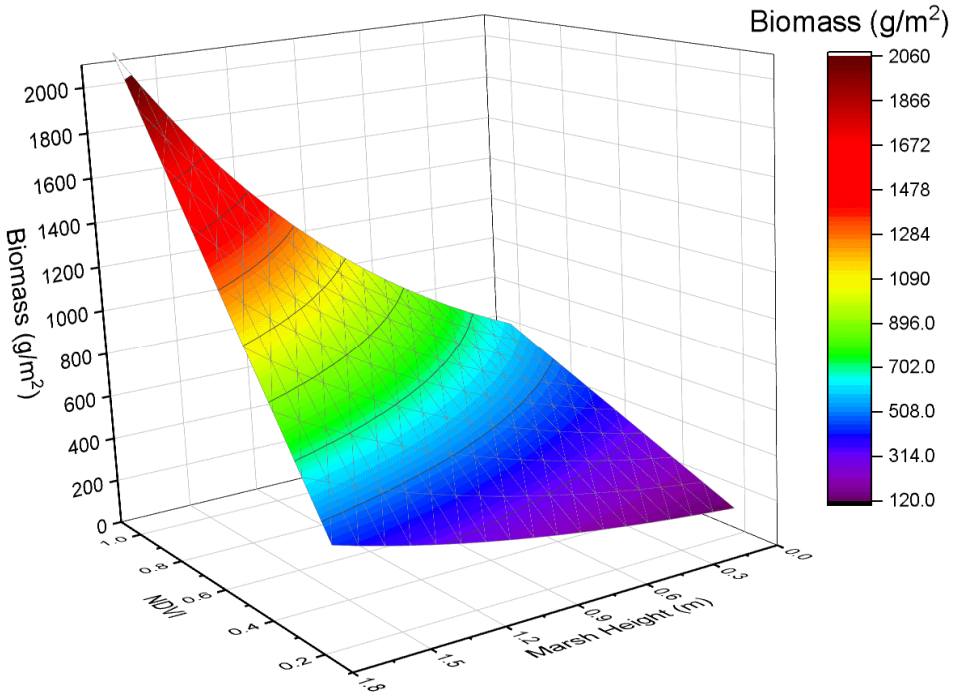
Biomass Model (N=65):

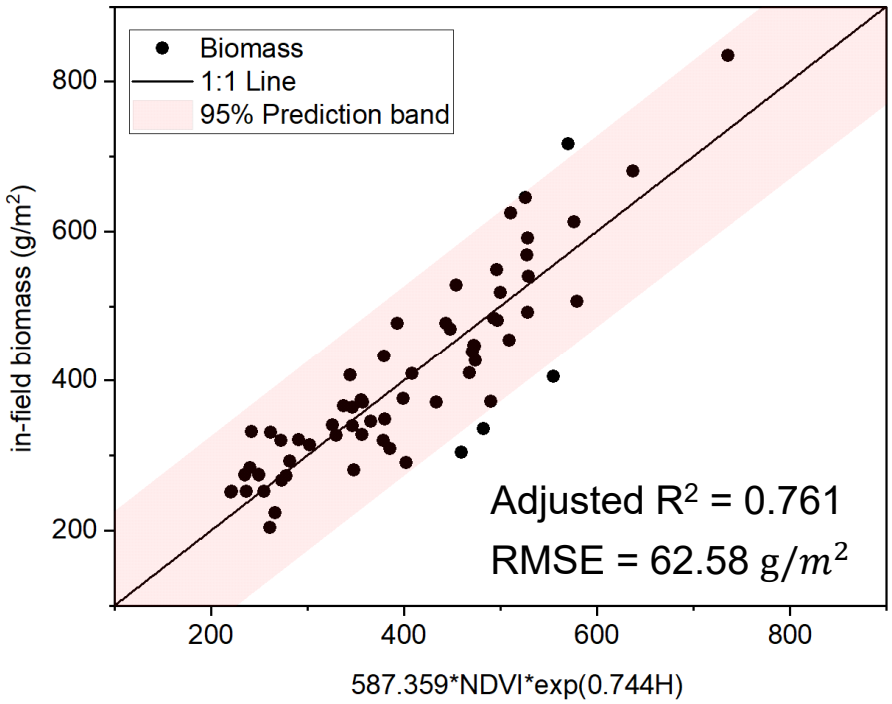
Marsh Biomass (g/m^2)=587.36×*NDVI*×$e^{0.744*H}$

Constraints:

NDVI > 0.2

Biomass > 120 (g/m²)





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❑ Drone Lidar for 3D marsh mapping: Pros & Cons

Pros

- Flexible, large-coverage data acquisition
- **5cm** vertical accuracy on DTM
- Much finer spacing than airborne Lidar
- Deep Learning: automated 3D marsh mapping
- 3D marsh mapping - broader applications along SC Coast

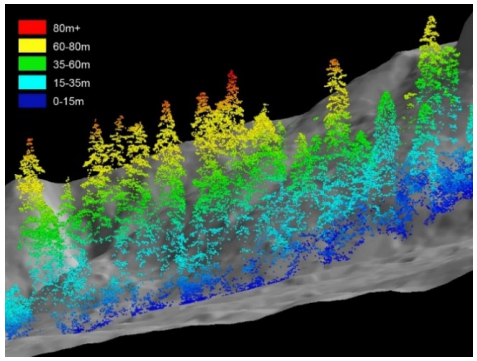
Cons

- Hardware/software maintenance
- Rapidly evolving systems
- Single returns in marshes
- Financial/operational/data analysis challenges
- Time commitment

Drone LiDAR: How do you think?

Dreams not coming true beautifully… But something is there for sure.

Thanks!



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