Testing New Approaches for Multiscale Oyster Mapping and Monitoring

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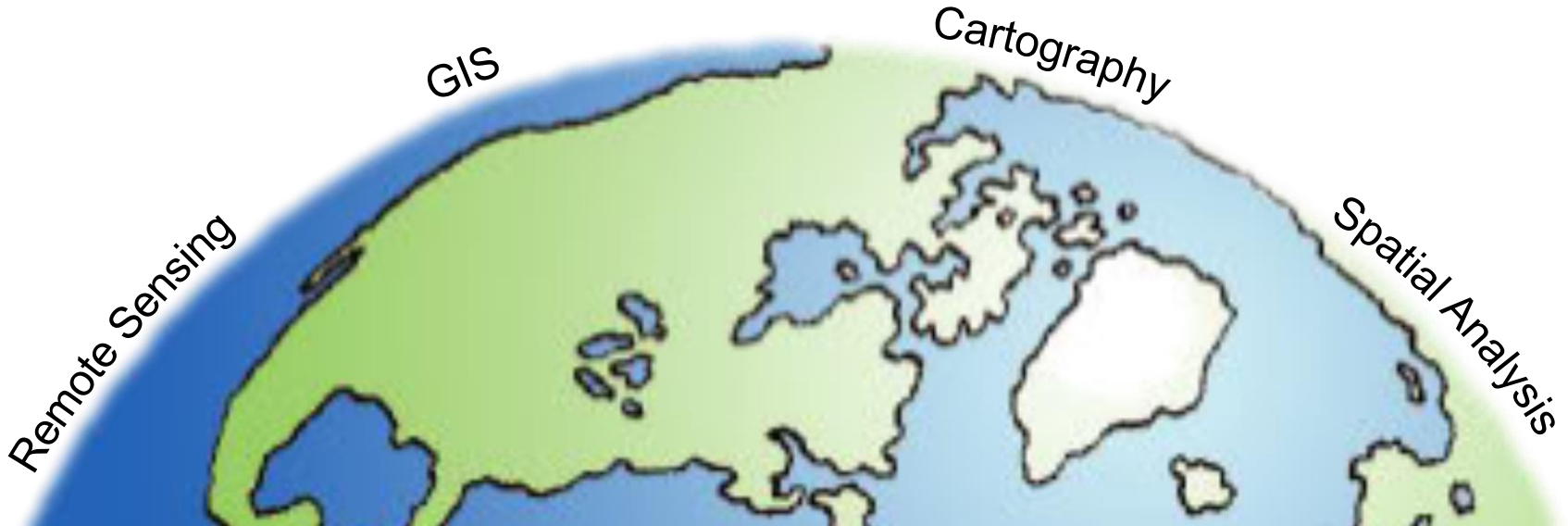
An Interdisciplinary Perspective on Data Collection and Analysis for the Study of Marine Environments

Study of the marine environment



Oyster Mapping

Study of structures is often limited in vertical and horizontal extents

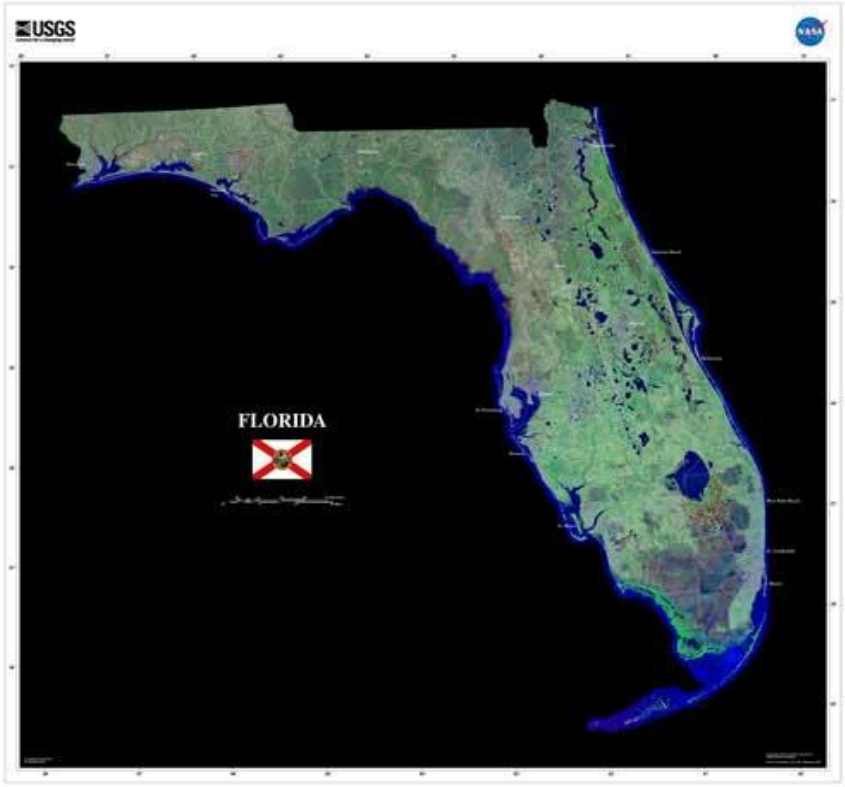
Changes in conditions are dynamic and adequate temporal monitoring is difficult

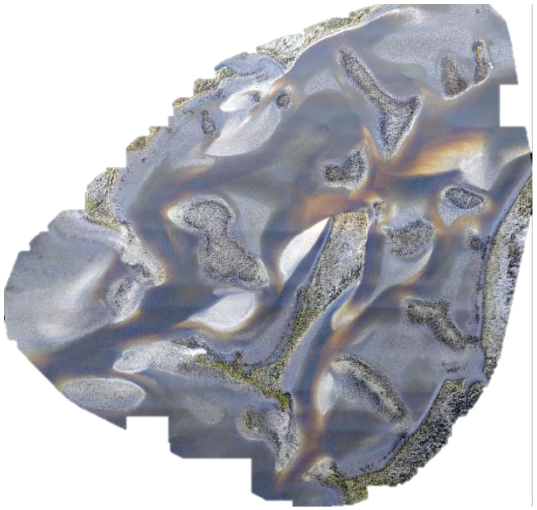
Need for information at multiple scales

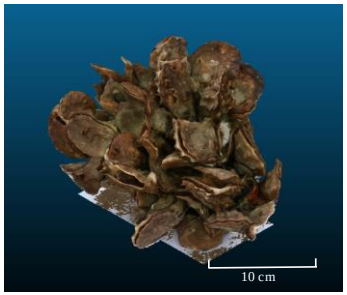
CAN REMOTE SENSING HELP?

Framework

A multiscale framework for oyster mapping and monitoring using remote sensing





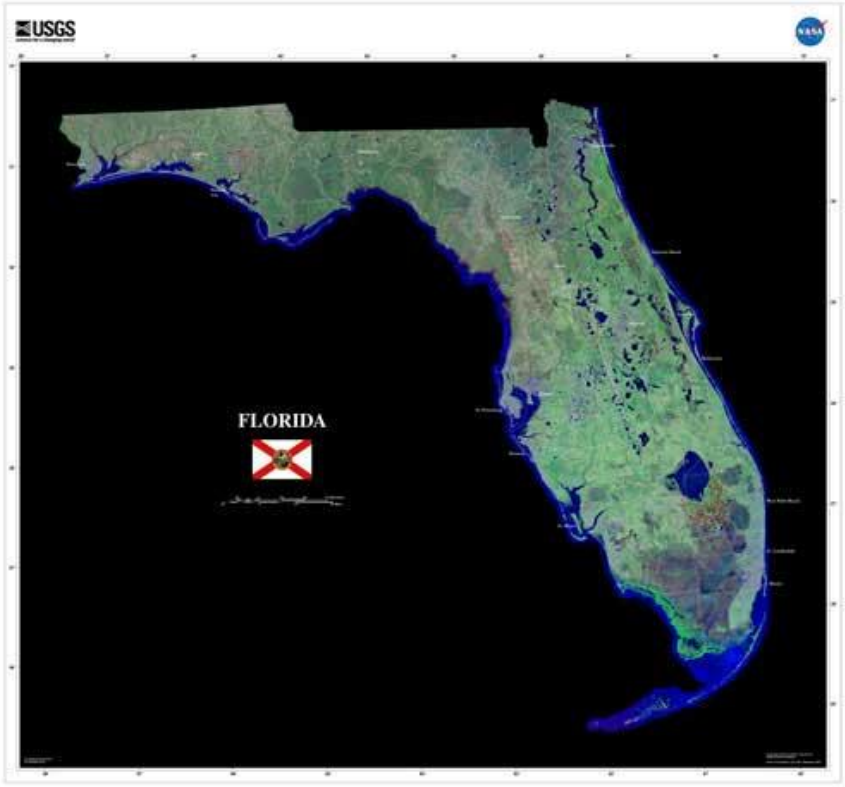


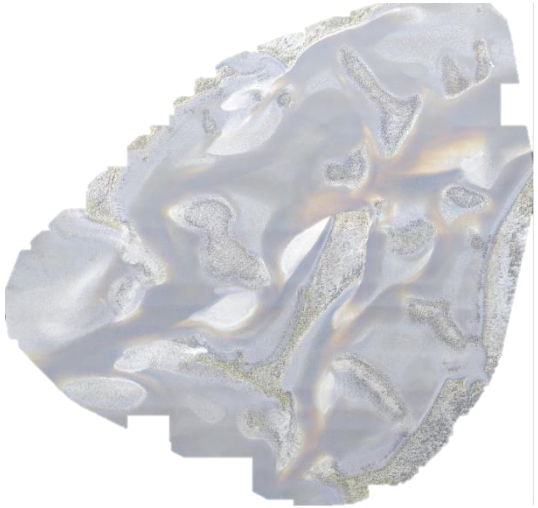
Intertidal & subtidal systems

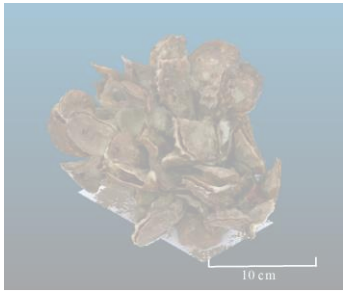
Images courtesy of USGS, Andrew Ortega and Kwanmok Kim

Framework

A multiscale framework for oyster mapping and monitoring using remote sensing

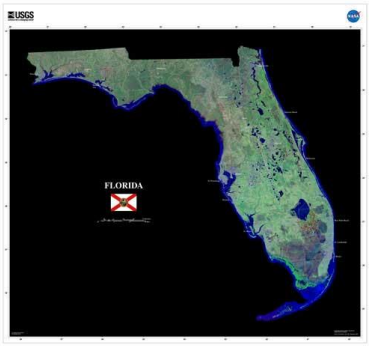




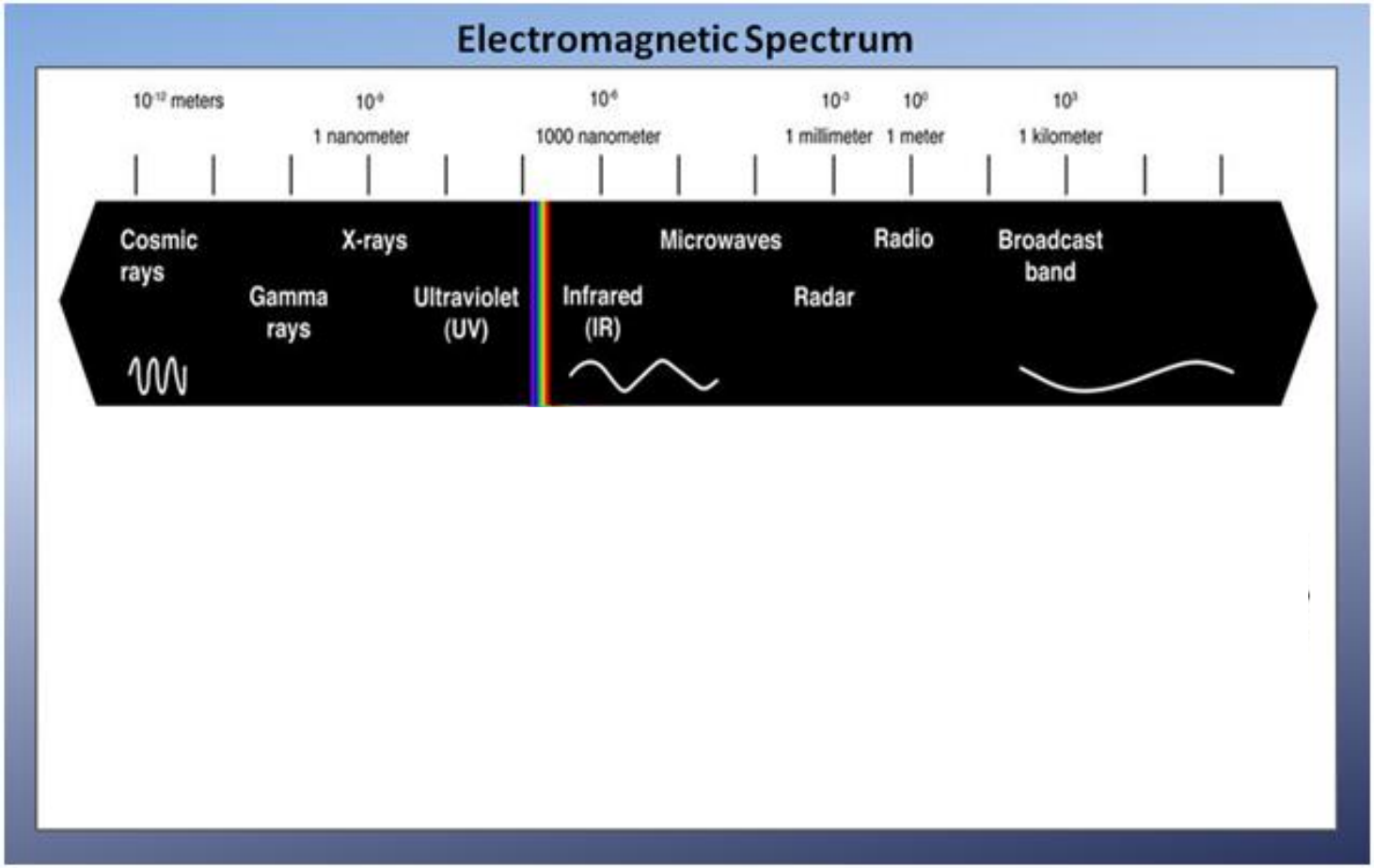


Images courtesy of USGS, Andrew Ortega and Kwanmok Kim

Broad-Scale Mapping



Remote Sensing



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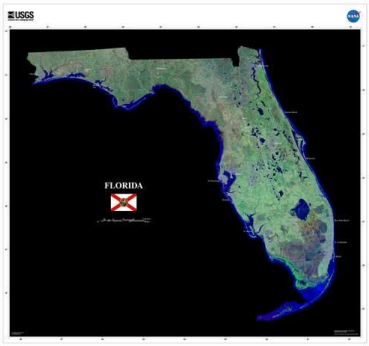
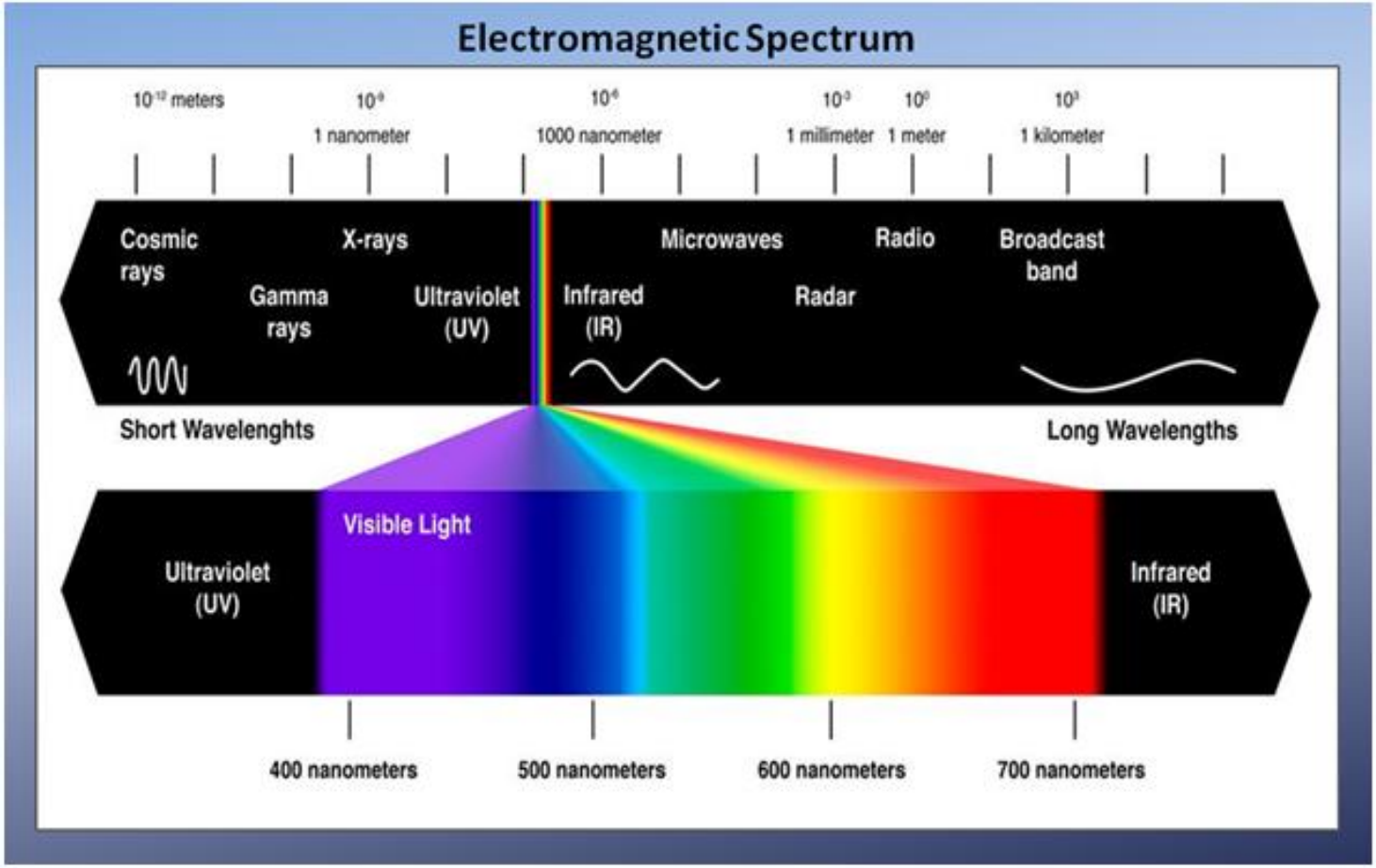


Remote Sensing



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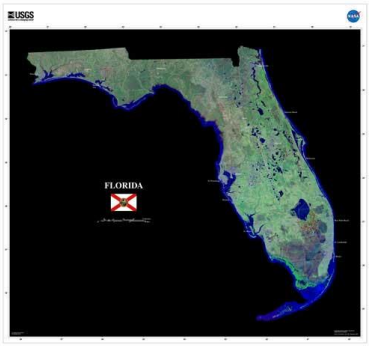
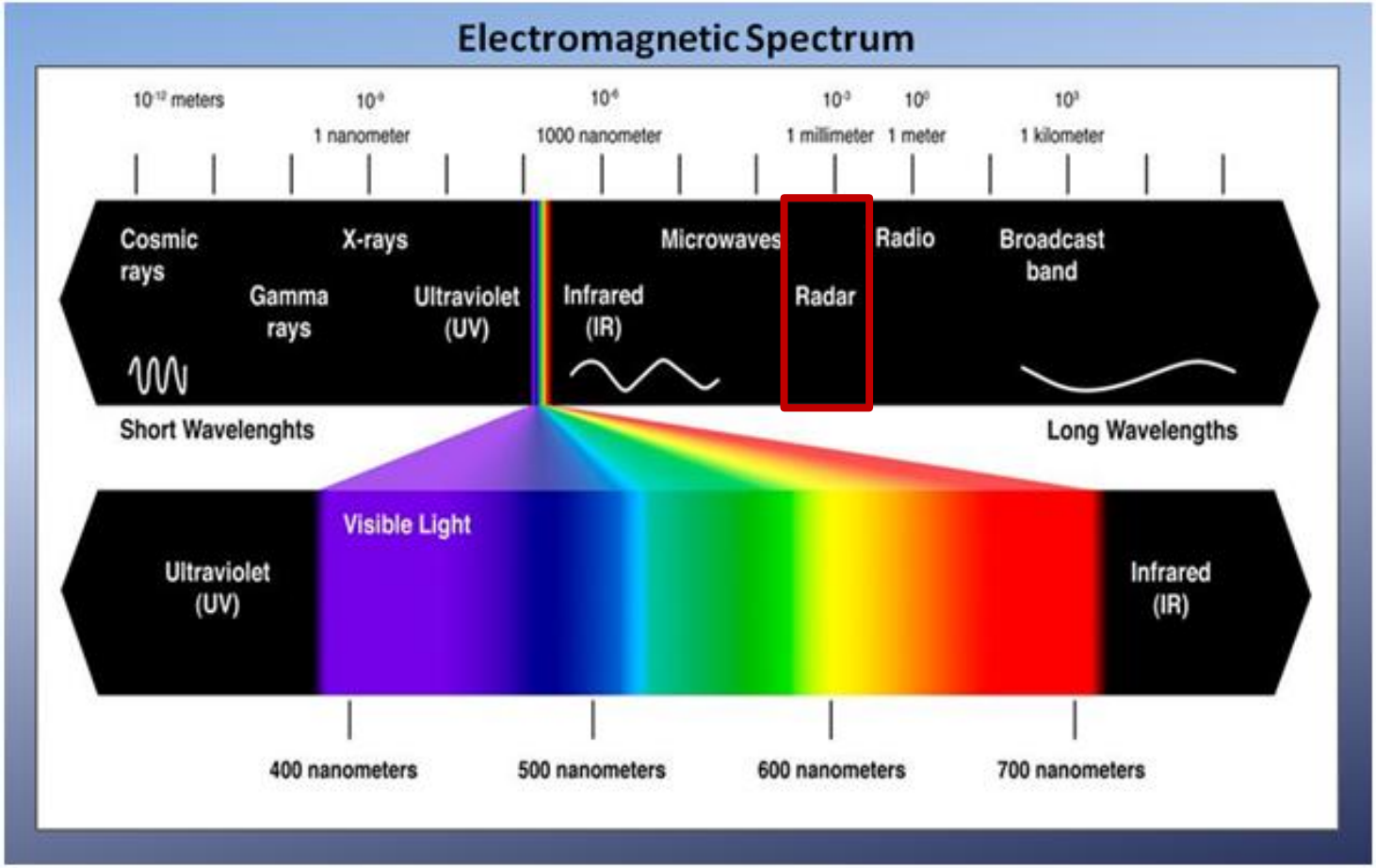
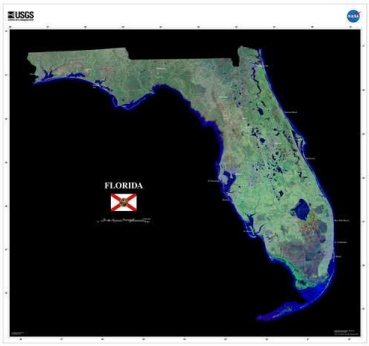


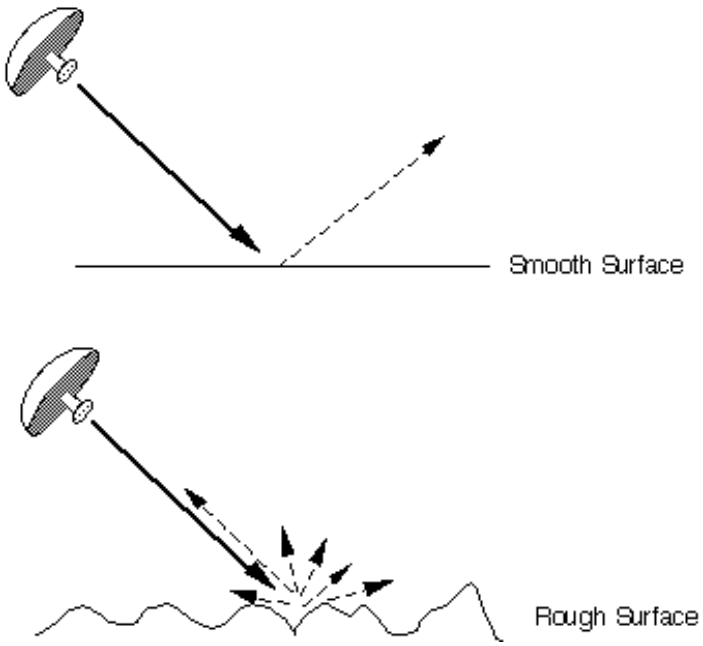
Remote Sensing



Broad-Scale Mapping

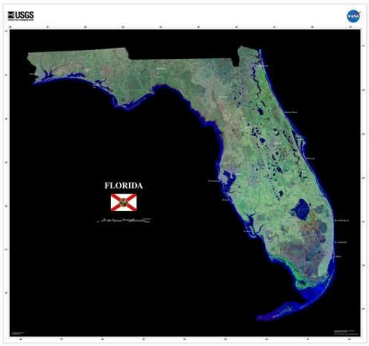


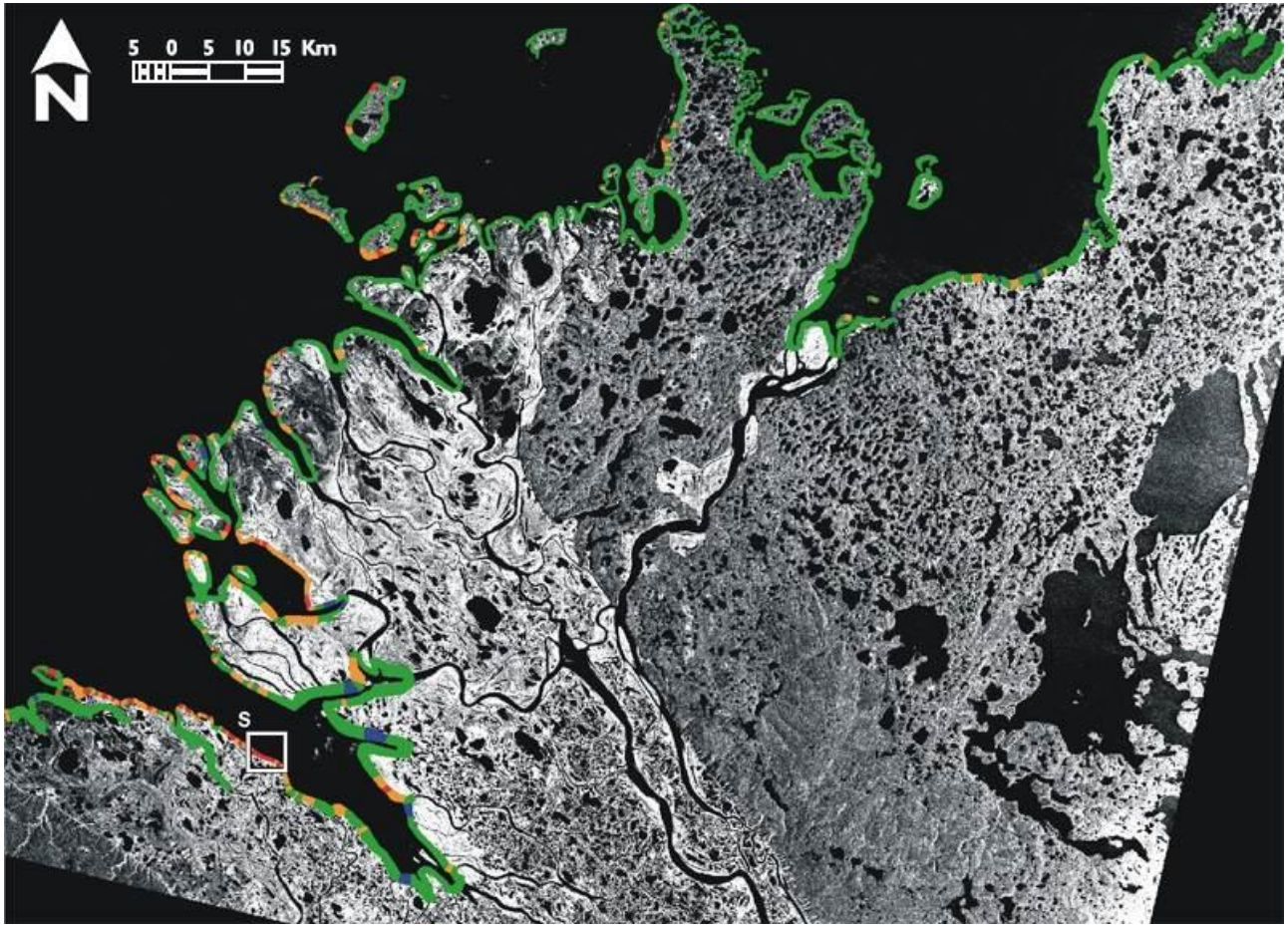
Radar does not provide a reflectance value but an intensity value called “backscatter”, which gives information on surface roughness and geometry



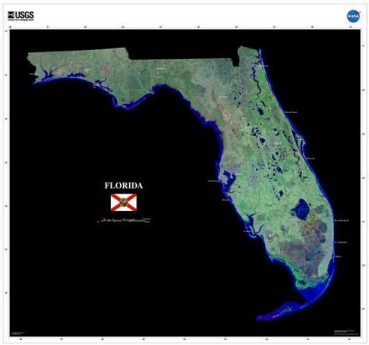
Images courtesy of Canadian Centre for Remote Sensing

Broad-Scale Mapping



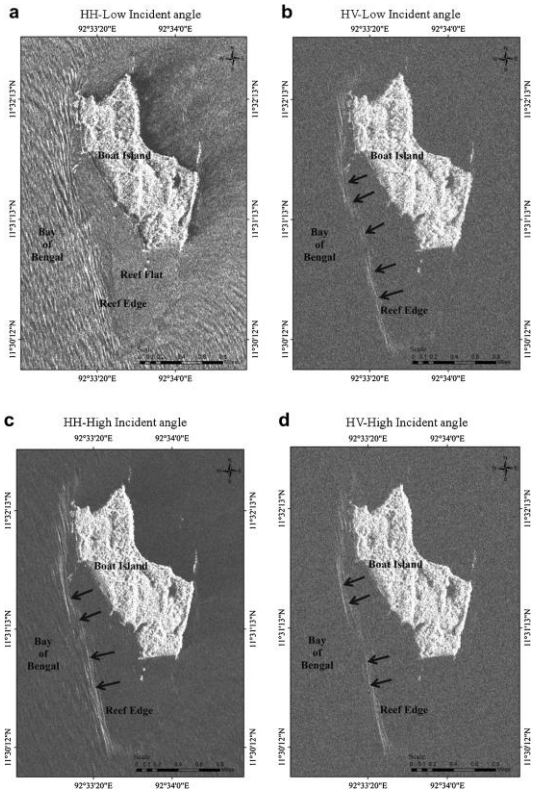


Broad-Scale Mapping



Hypothesis (interdidal):

Intertidal coastal features can be delineated and subsequently identified using a combination of multispectral and radar imagery at a broad scale

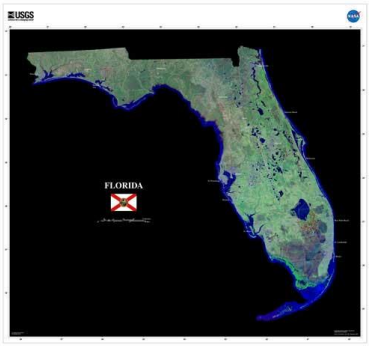


Radar Imagery

False-color Composite

Yuvaraj *et al.* (2015)

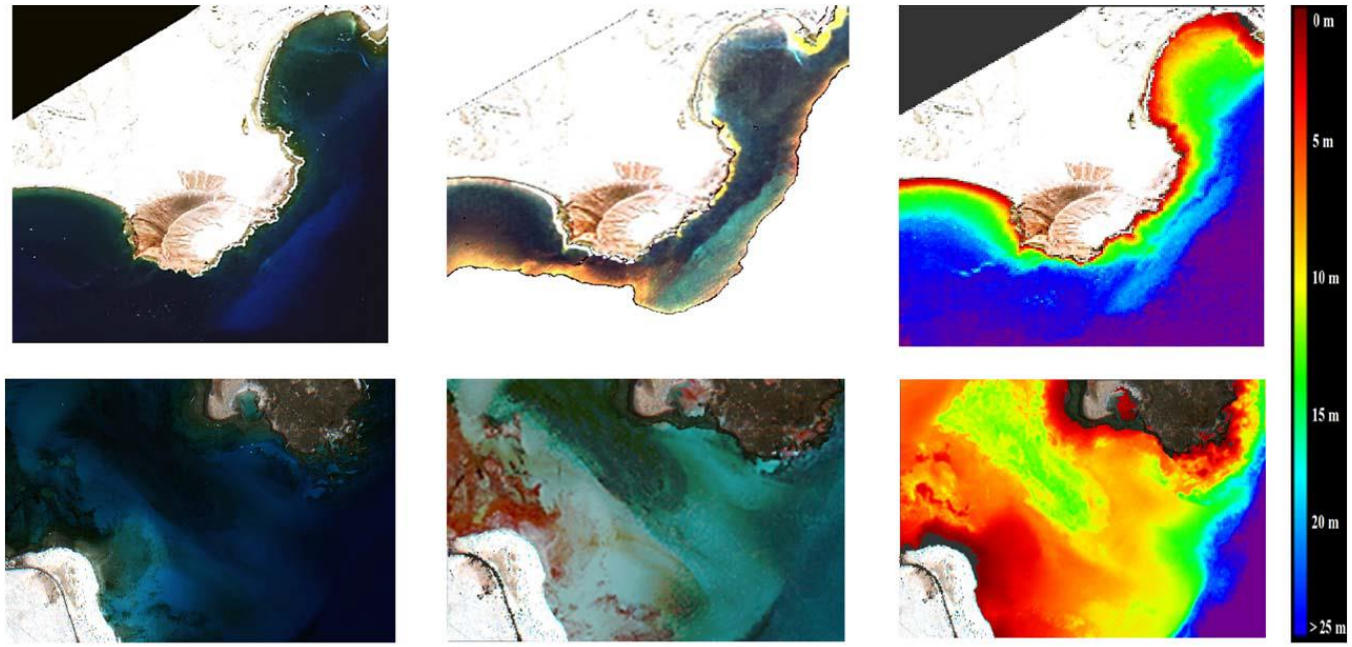
Broad-Scale Mapping



Subtidal

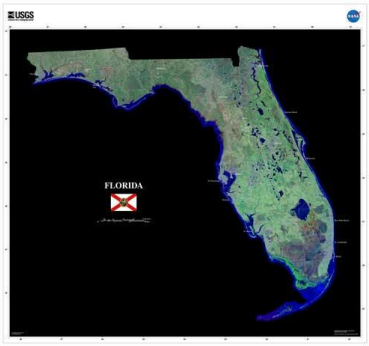
Satellite-derived bathymetry and geomorphometry

Approaches:
-Physical-based
-Empirical-based
-Photogrammetry



Eugenio *et al.* (2015)

Broad-Scale Mapping



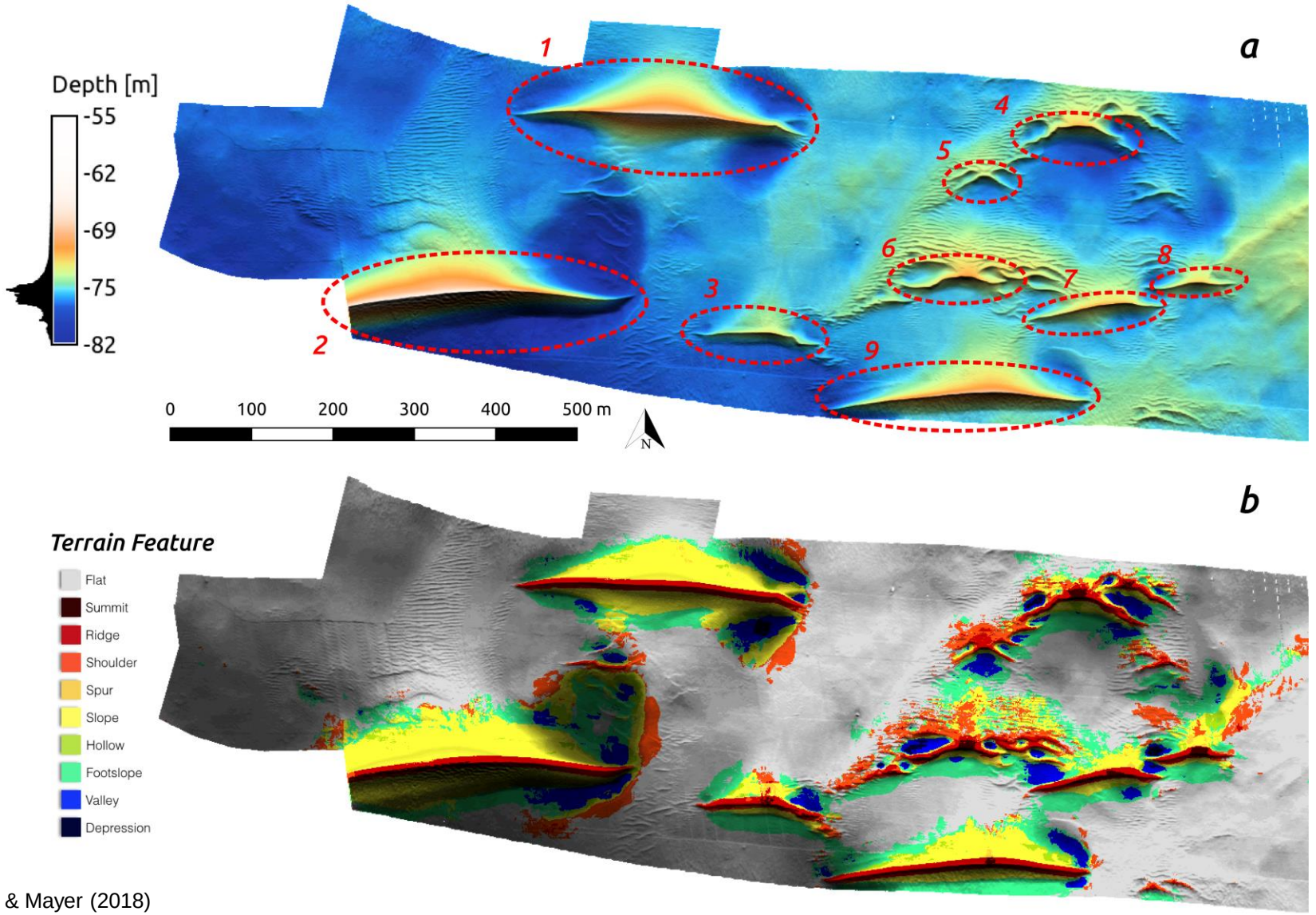
Subtidal

Satellite-derived bathymetry and geomorphometry

Gemorphometry:

The discipline that helps derive quantitative measures of terrain morphology; digital terrain analysis

Broad-Scale Mapping



Di Stefano & Mayer (2018)

Broad-Scale Mapping

geosciences

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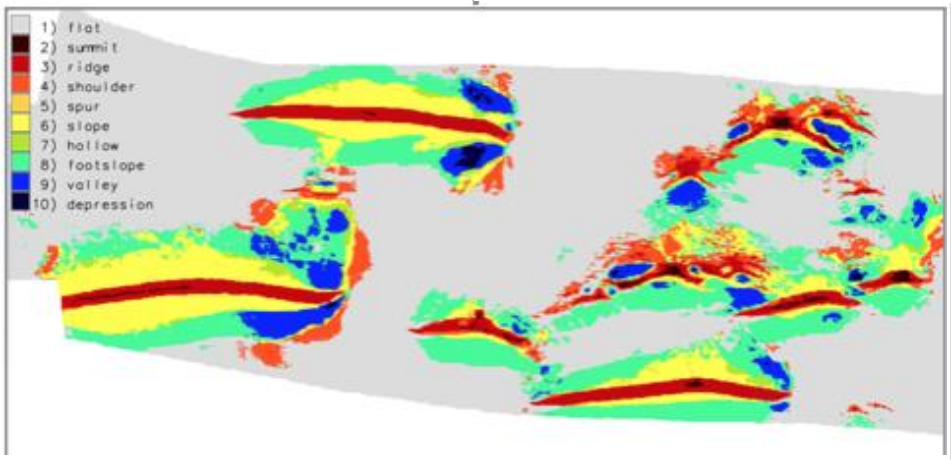
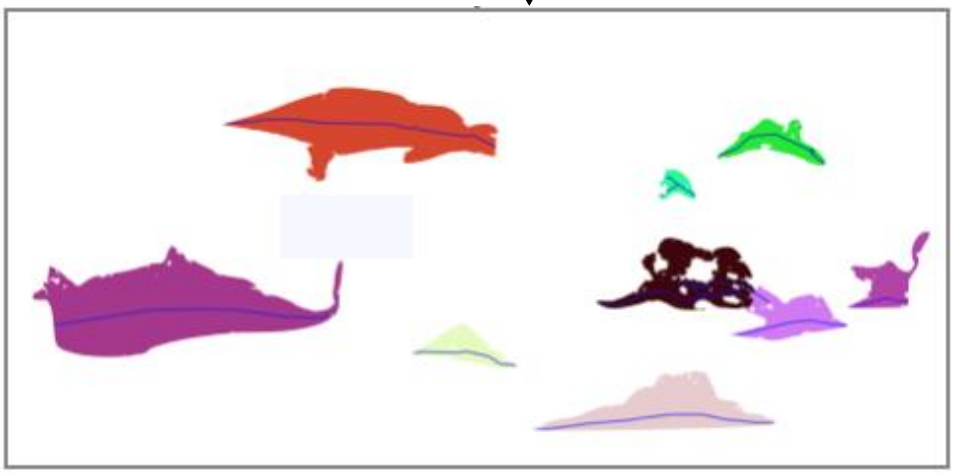
Article

An Automatic Procedure for the Quantitative Characterization of Submarine Bedforms

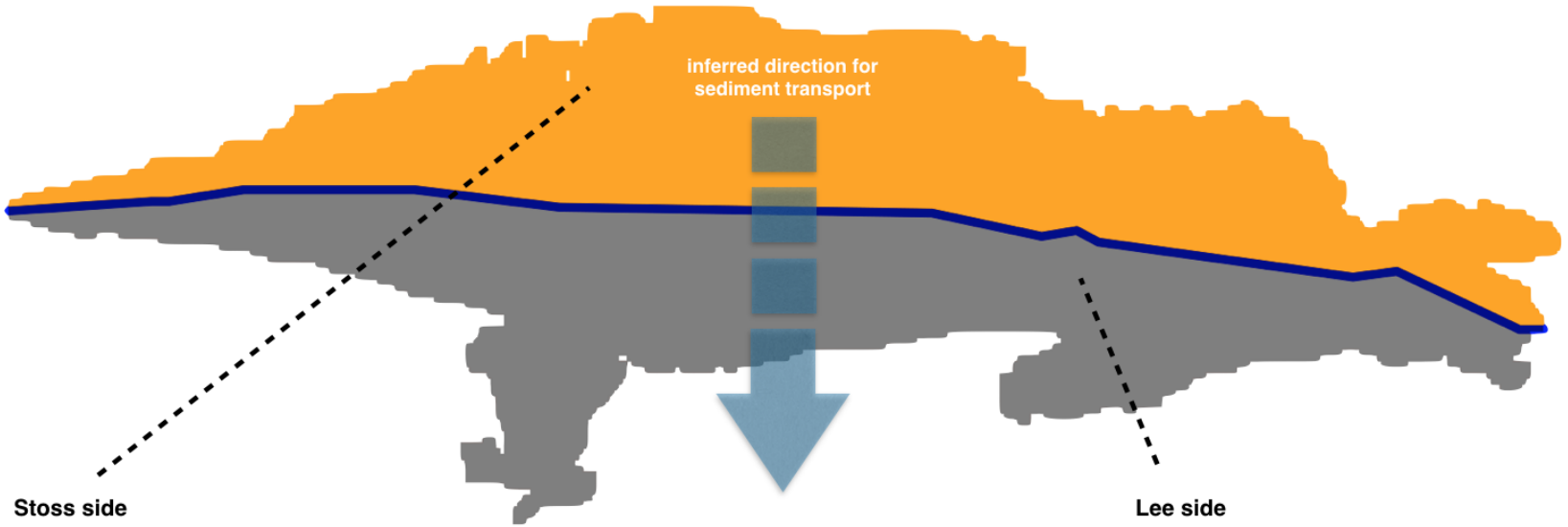
Massimo Di Stefano [1,2,*] and Larry Alan Mayer [1,2]

Terrain Feature Extraction → Geospatial Rule-Based Model





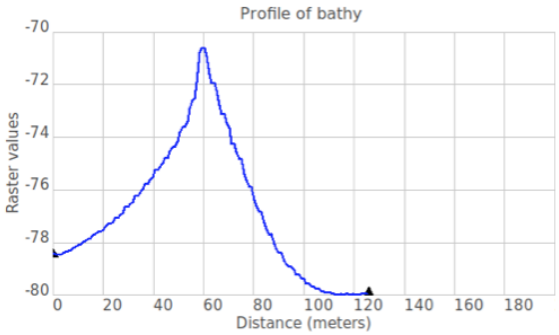
Broad-Scale Mapping



Stoss side

total null and non-null cells: 1873152
total null cells: 1865919

Of the non-null cells:
---
n: 7233
minimum: 0.0187112
maximum: 0.887471
range: 0.86876
mean: 0.365848
mean of absolute values: 0.365848
standard deviation: 0.182464
variance: 0.033293
variation coefficient: 49.8742 %
sum: 2646.17617387161
1st quartile: 0.230407
median (odd number of cells): 0.300023
3rd quartile: 0.480246
90th percentile: 0.678802



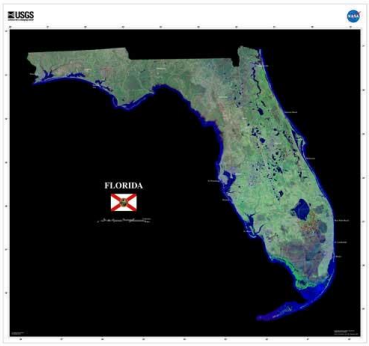
Lee side

total null and non-null cells: 1873152
total null cells: 1866281

Of the non-null cells:
---
n: 6871
minimum: 0.00482273
maximum: 0.660528
range: 0.655705
mean: 0.418378
mean of absolute values: 0.418378
standard deviation: 0.183052
variance: 0.033508
variation coefficient: 43.7528 %
sum: 2874.67575302325
1st quartile: 0.289569
median (odd number of cells): 0.483805
3rd quartile: 0.571185
90th percentile: 0.607989

Di Stefano & Mayer (2018)

Broad-Scale Mapping



Subtidal

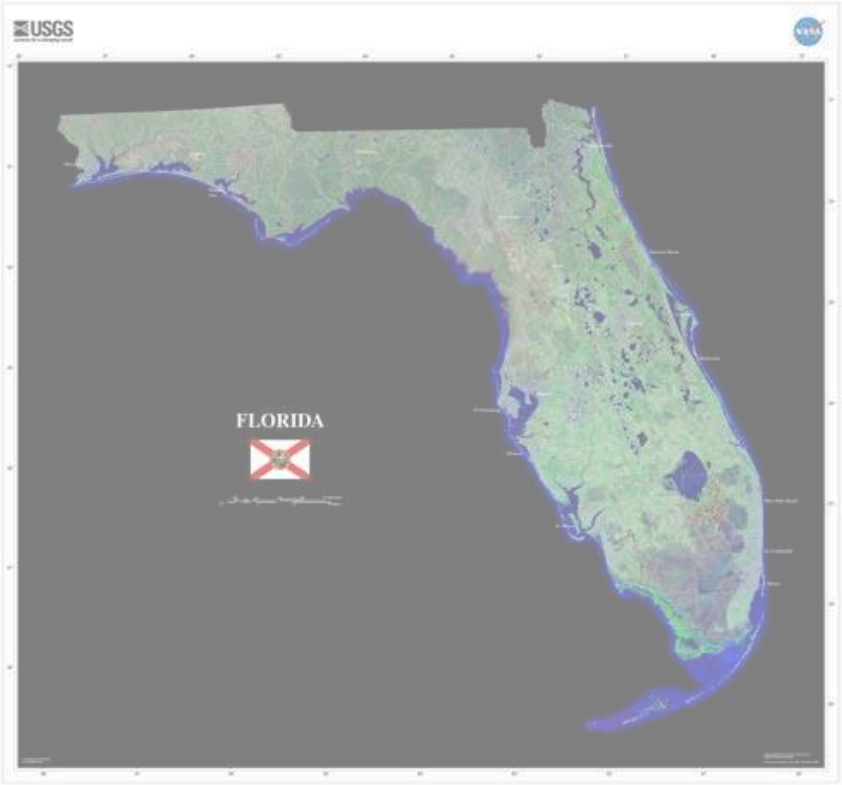
Satellite-derived bathymetry and geomorphometry

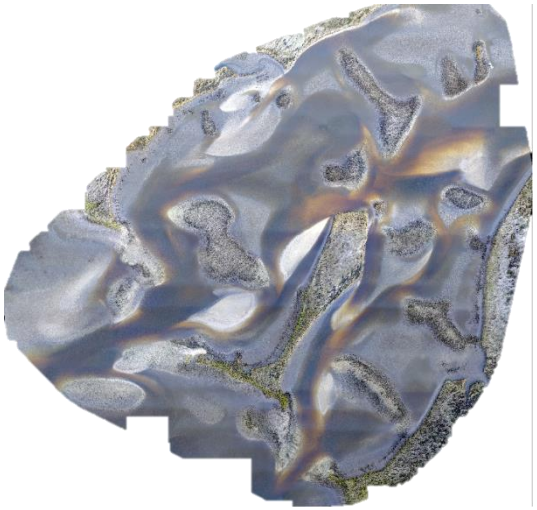
Hypothesis:

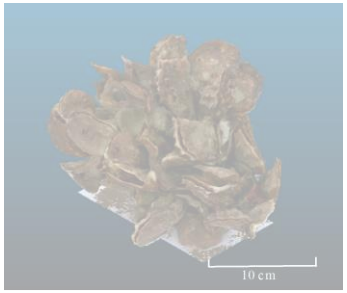
The combination of geomorphometry with satellite-derived bathymetry can help target areas that are susceptible to be subtidal oyster reefs. However, validation will be necessary.

Framework

A multiscale framework for oyster mapping and monitoring using remote sensing





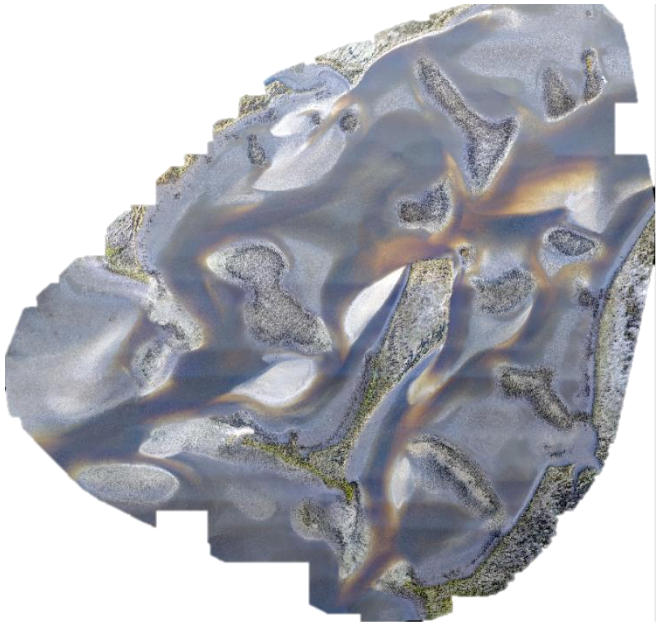


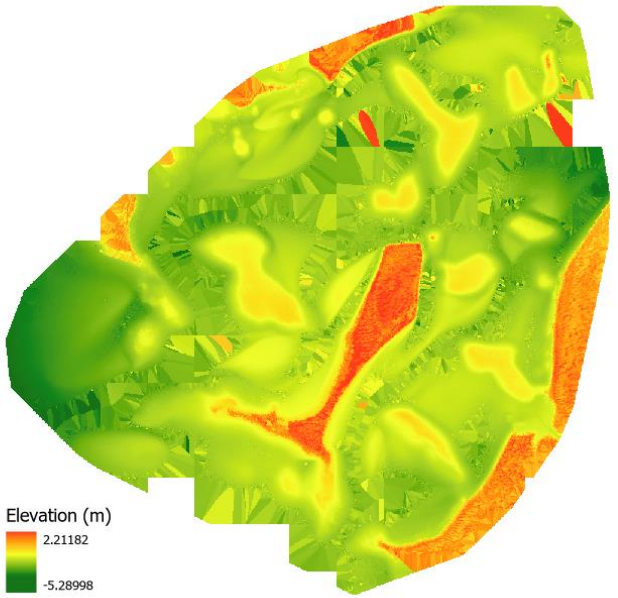
Images courtesy of USGS, Andrew Ortega and Kwanmok Kim

Intermediate-Scale Mapping

Intertidal:

UAS imagery with geomorphometry and object-based image analysis (OBIA)





+ slope, rugosity, relative position index, orientation of the slope, etc.

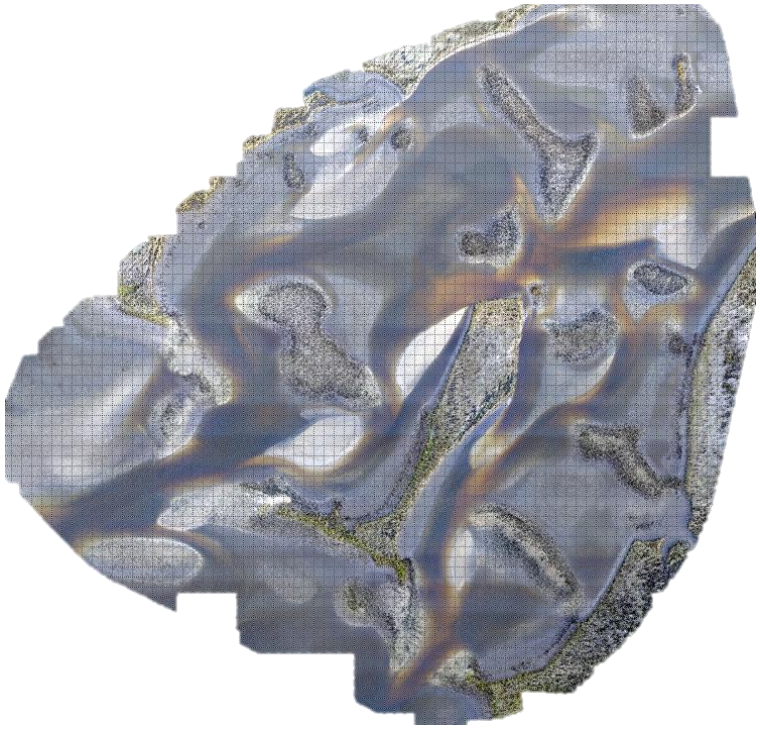
Images courtesy of Andrew Ortega and Michael Espriella

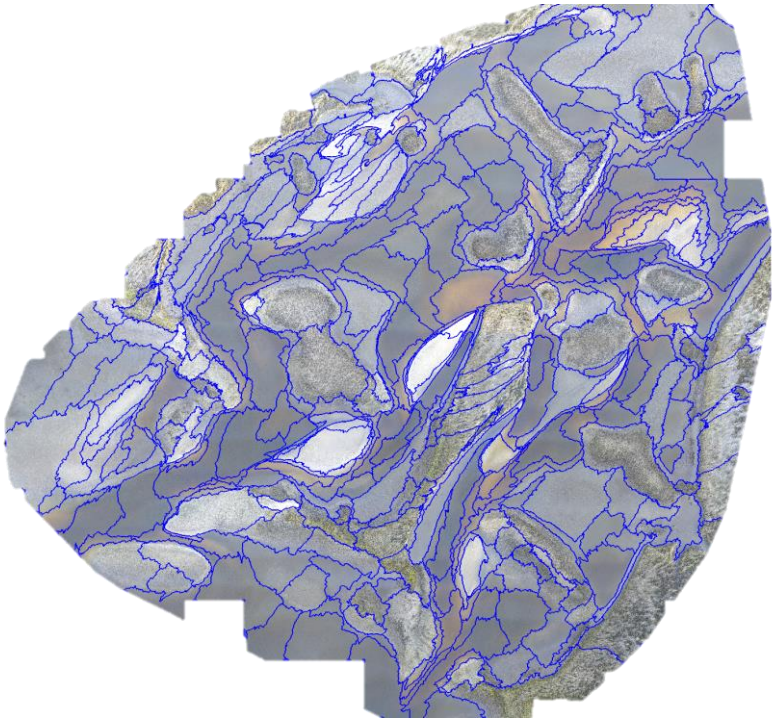
Intermediate-Scale Mapping

Object-based image analysis

Instead of grouping similar individual pixels together, it first segments the imagery into objects based on spectral, topographic, and structural characteristics (segmentation)

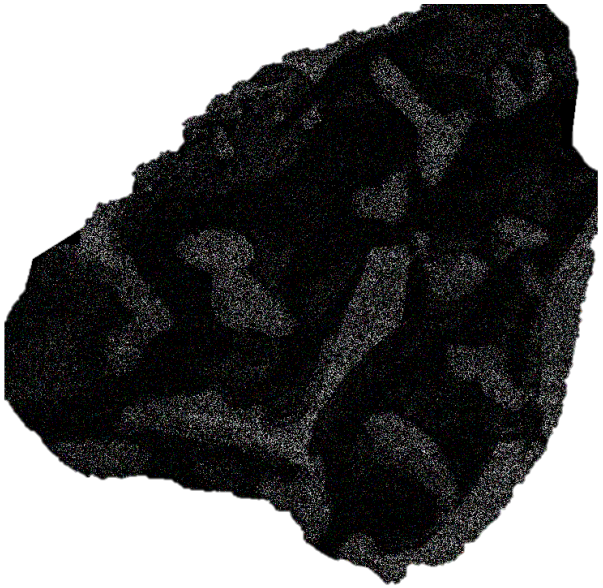
Those objects are then classified (classification)



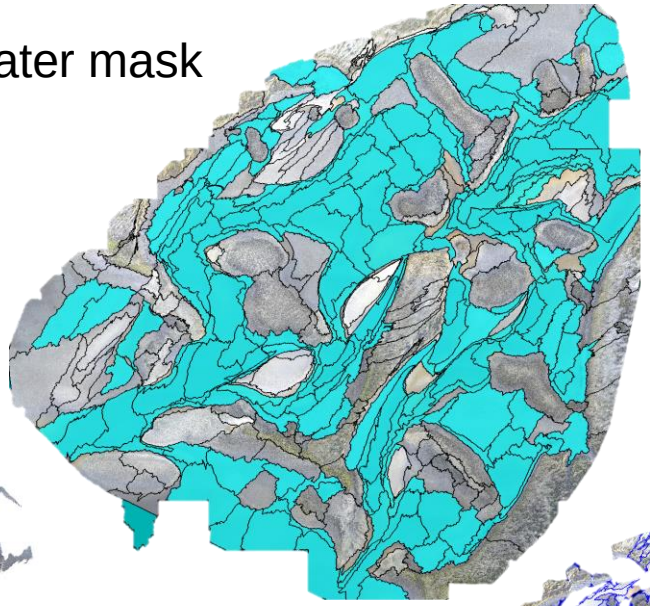


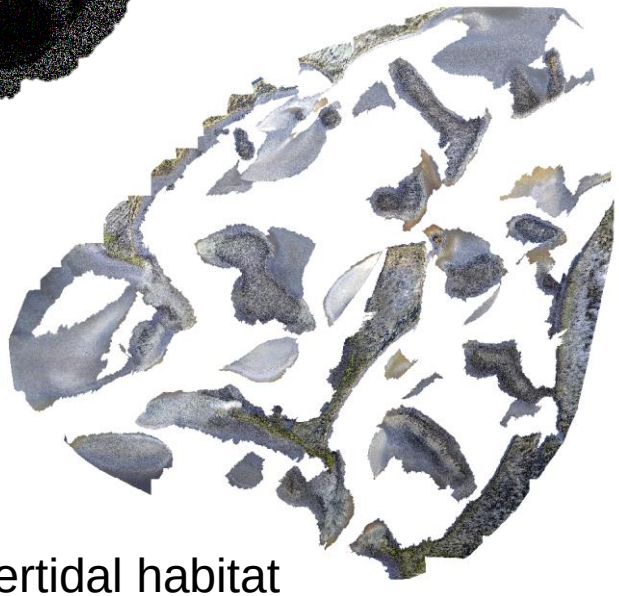
Intermediate-Scale Mapping

1. Laplacian filter (edge detection)

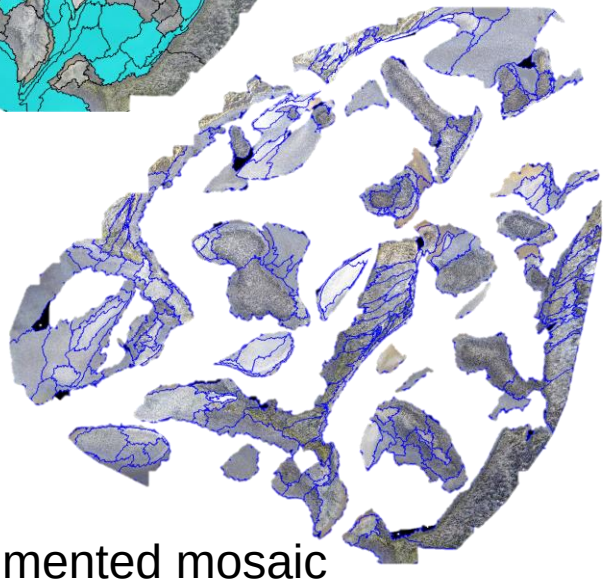


2. Water mask





3. Mosaic with intertidal habitat



4. Segmented mosaic

Intermediate-Scale Mapping

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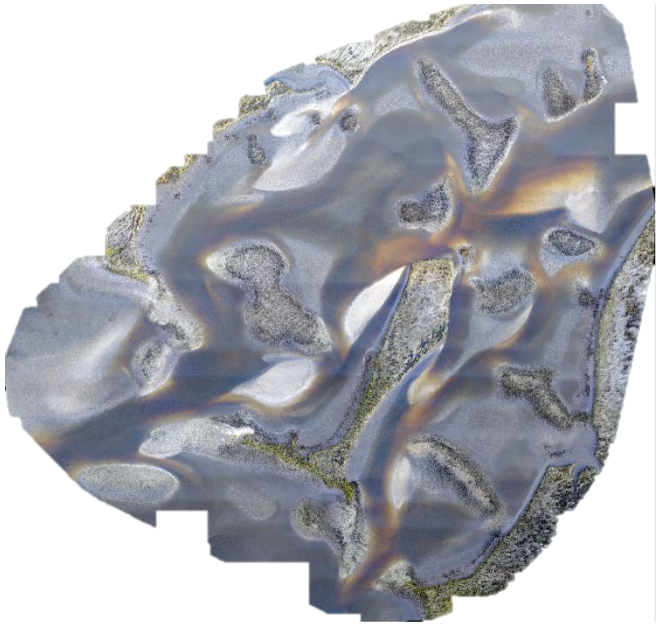
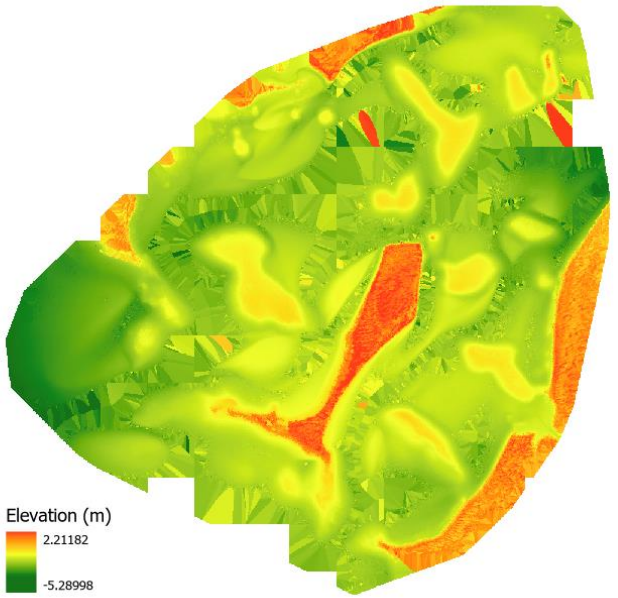
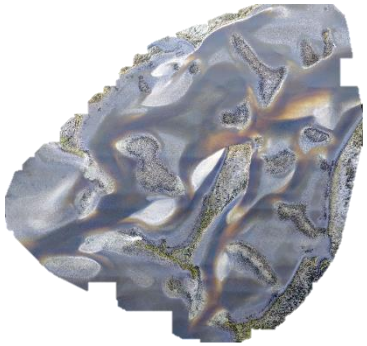




Provides information about horizontal and vertical extent, and 3D structural complexity

Intermediate-Scale Mapping



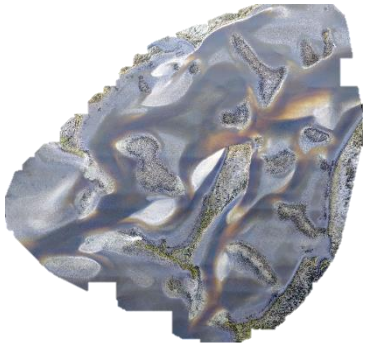
Subtidal:

-UAS-derived bathymetry

-Acoustic mapping using autonomous surface vehicle

Bathymetry & Backscatter data

Intermediate-Scale Mapping



geosciences

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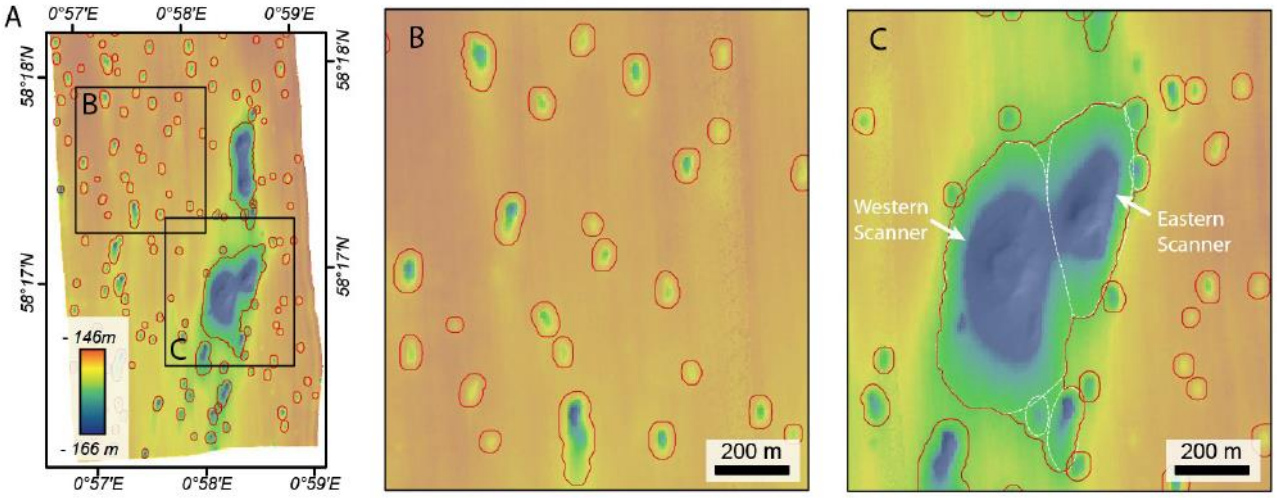
Article

Geomorphometric Characterization of Pockmarks by Using a GIS-Based Semi-Automated Toolbox

Joana Gafeira [1,*], Margaret F. J. Dolan [2] and Xavier Monteys [3]



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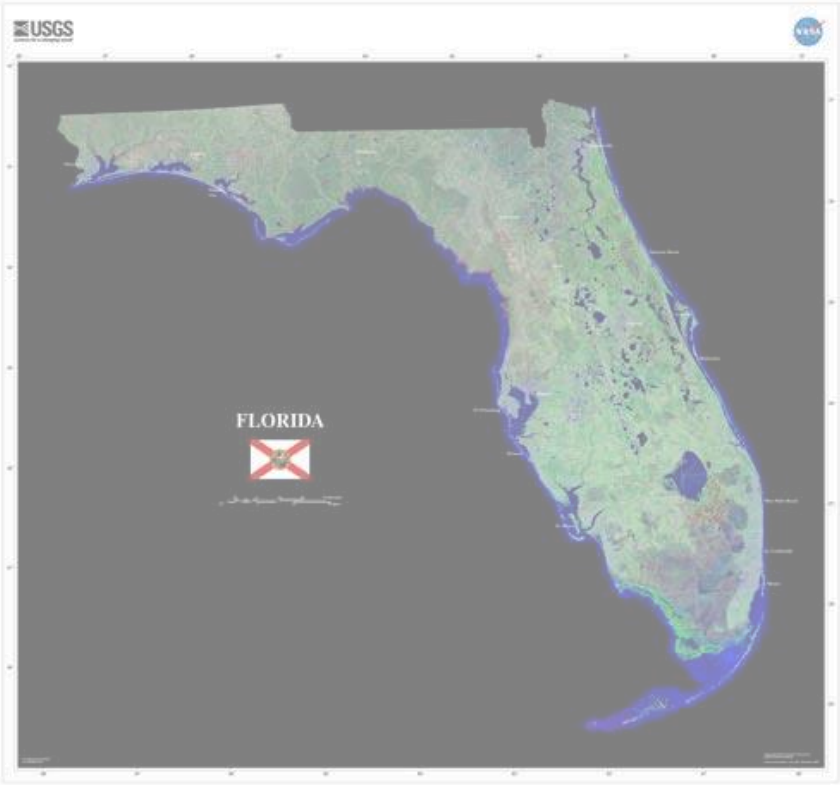
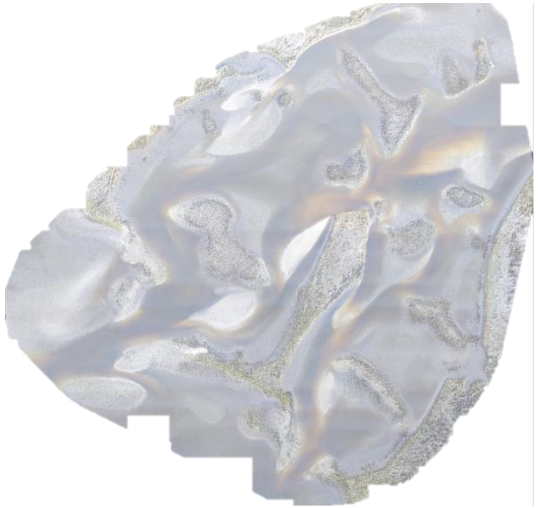
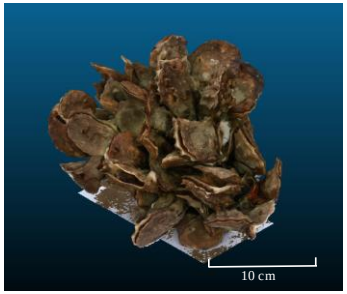
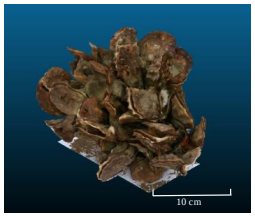






Images courtesy of USGS, Andrew Ortega and Kwanmok Kim

Fine-Scale Mapping

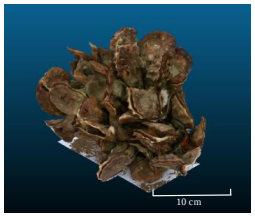


Intertidal:

UAS imagery at low altitude

Images courtesy of Kwan Kim and Michael Espriella

Fine-Scale Mapping

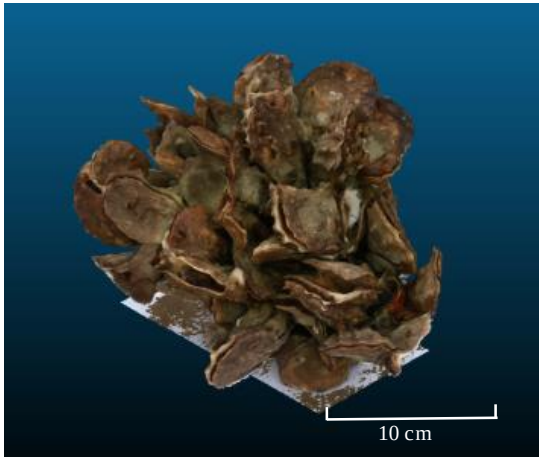


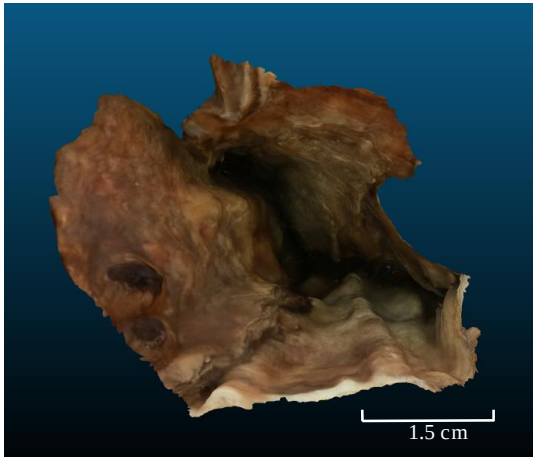
Intertidal:

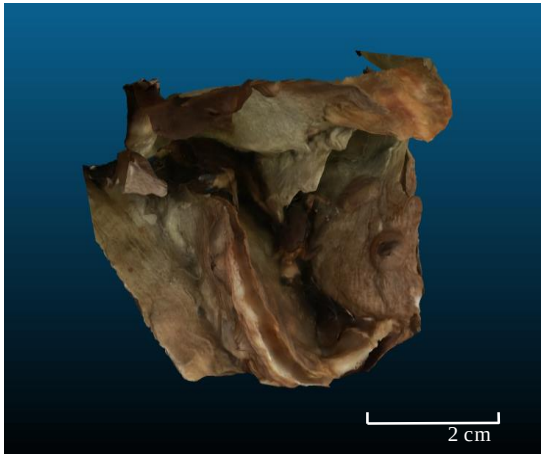
UAS imagery at low altitude

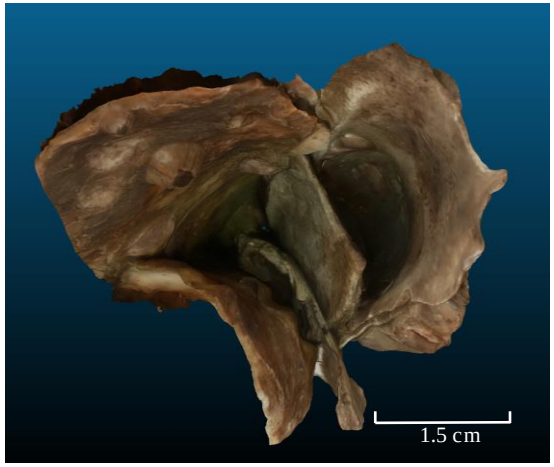
Video courtesy of Kwanmok Kim

Fine-Scale Mapping



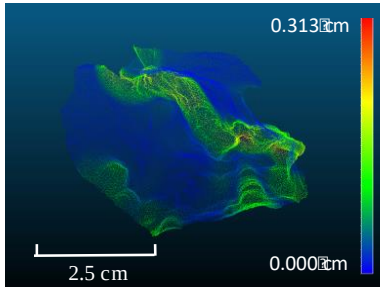
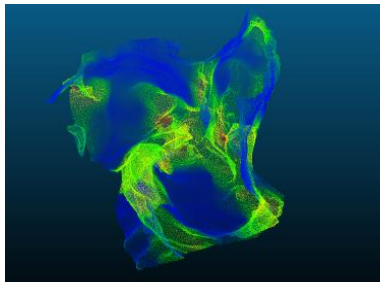
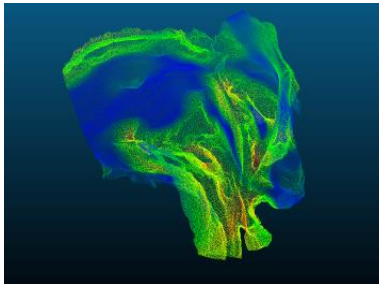
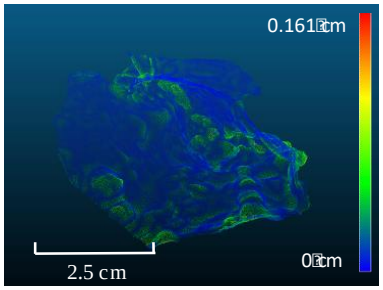
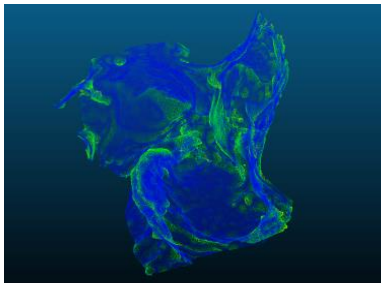
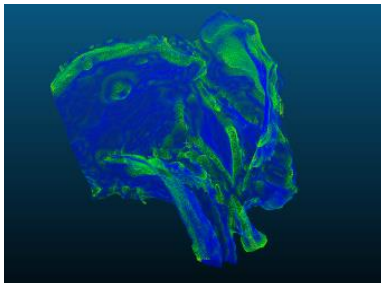
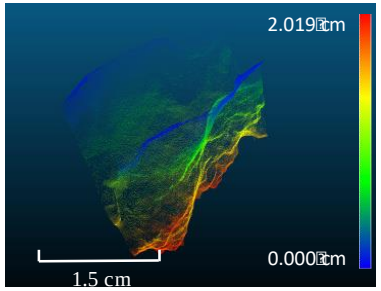
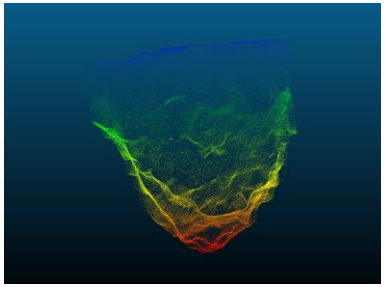
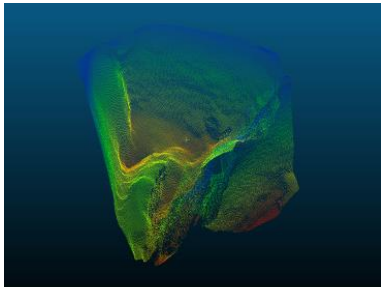






Kim *et al.* (2018)

Fine-Scale Mapping

	Oyster 1	Oyster 2	Oyster 3
Curvature			
Roughness			
Area to Volume Ratio			

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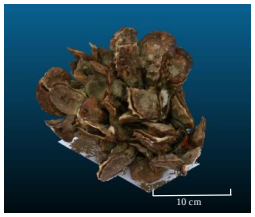
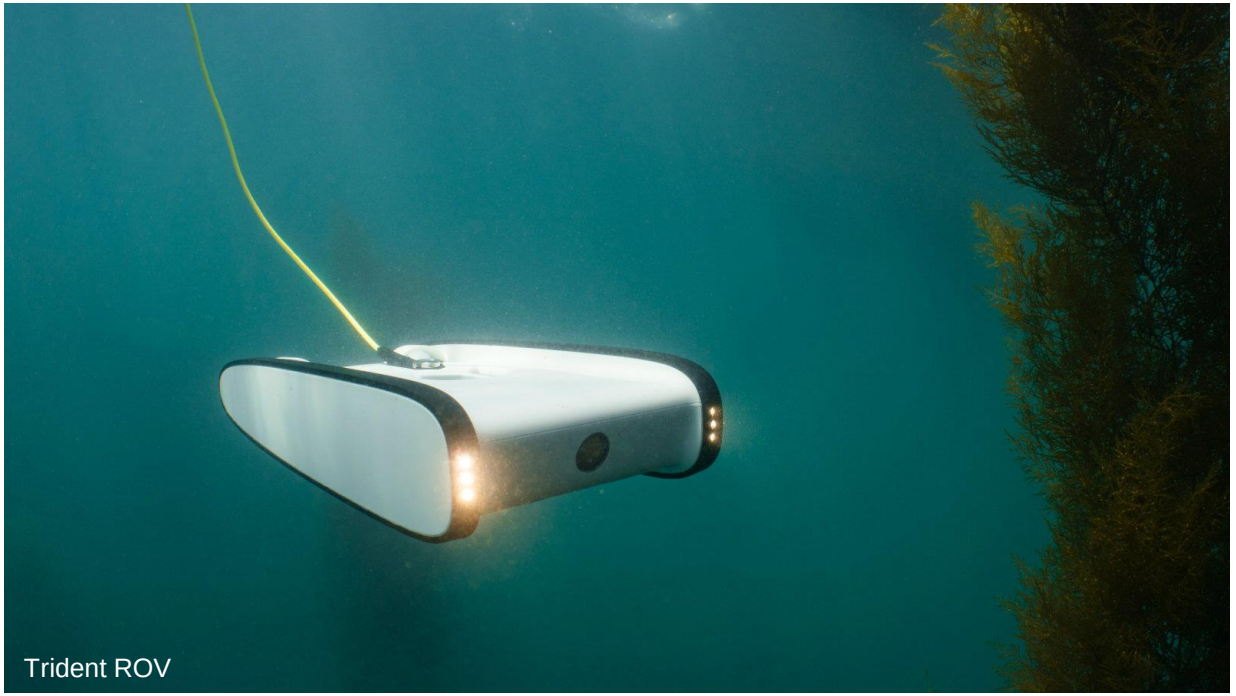


Subtidal:

High-resolution acoustic data

Underwater photogrammetry



Trident ROV

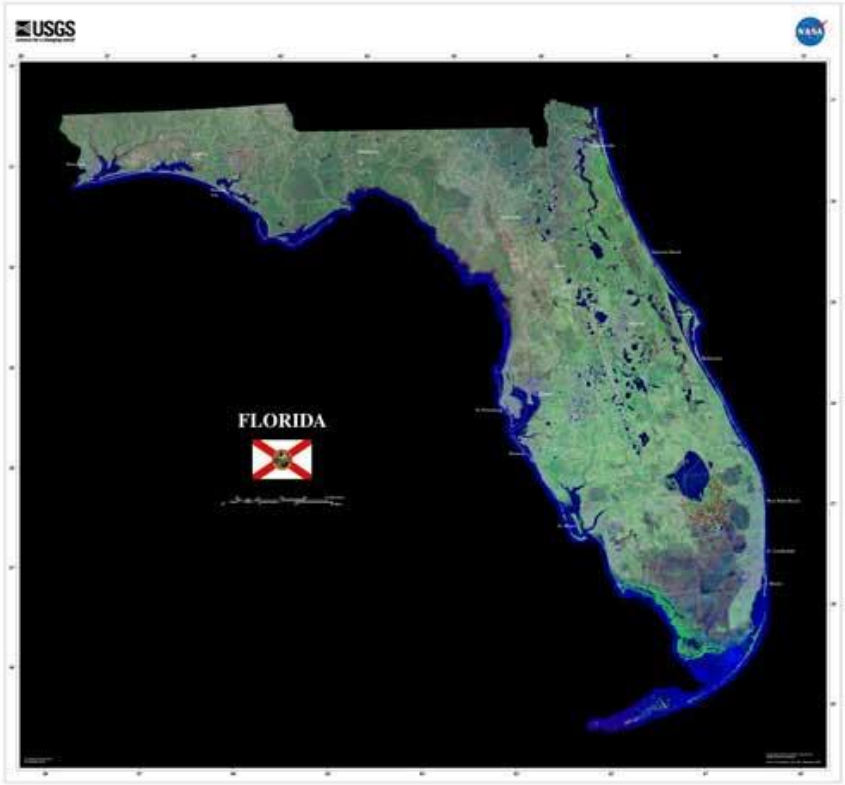
Fine-Scale Mapping

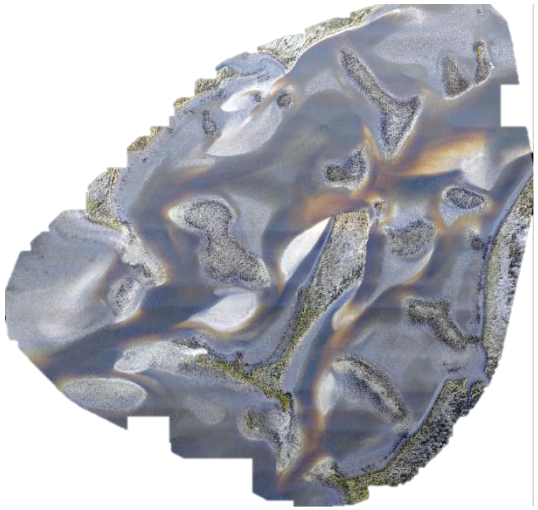
Underwater photogrammetry

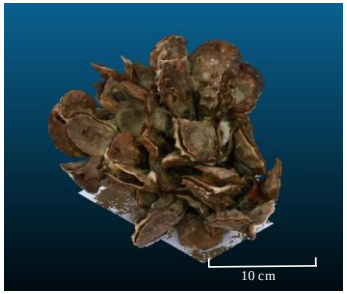
https://vimeo.com/user63129861

Summary

A multiscale framework for oyster mapping and monitoring using remote sensing







-Radar and multispectral imagery
-Satellite-derived bathymetry (Wenhao Liu)
-Geomorphometry
-Object-based image analysis

Images courtesy of USGS, Andrew Ortega and Kwanmok Kim

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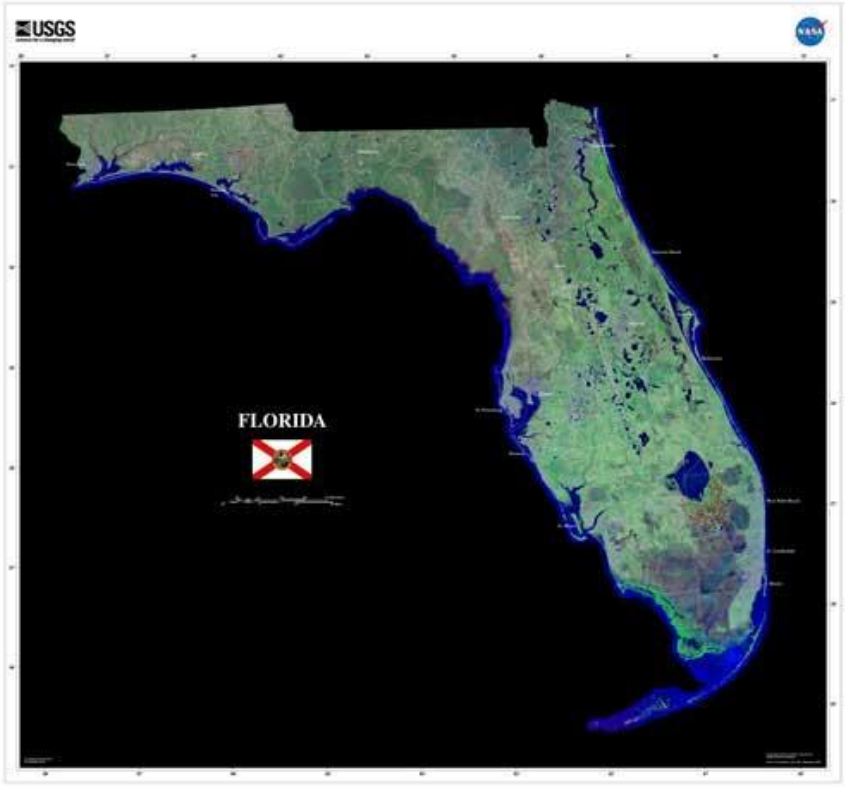

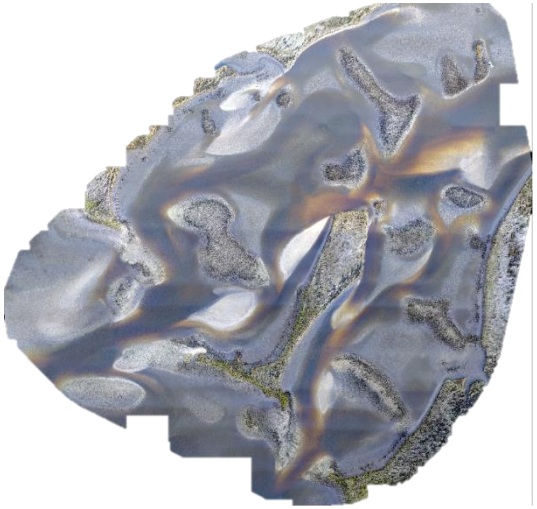

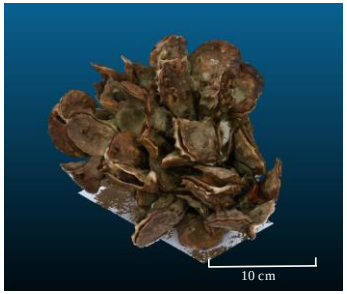

-Unmanned aerial systems (M. Espriella, W. Liu)
-Autonomous surface vehicles
-Geomorphometry (Vincent Lecours)
-Object-based image analysis (Michael Espriella)

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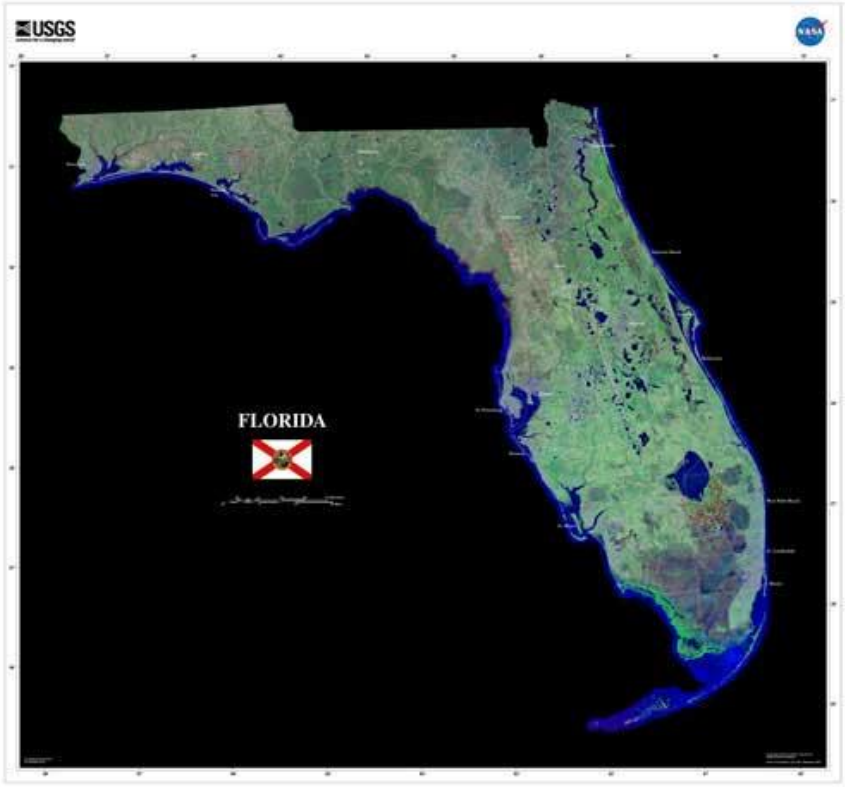

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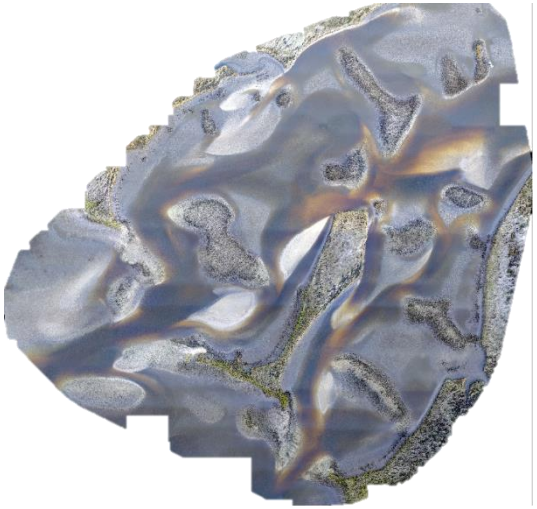

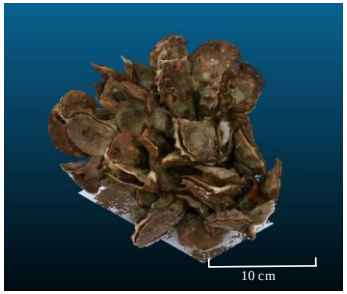

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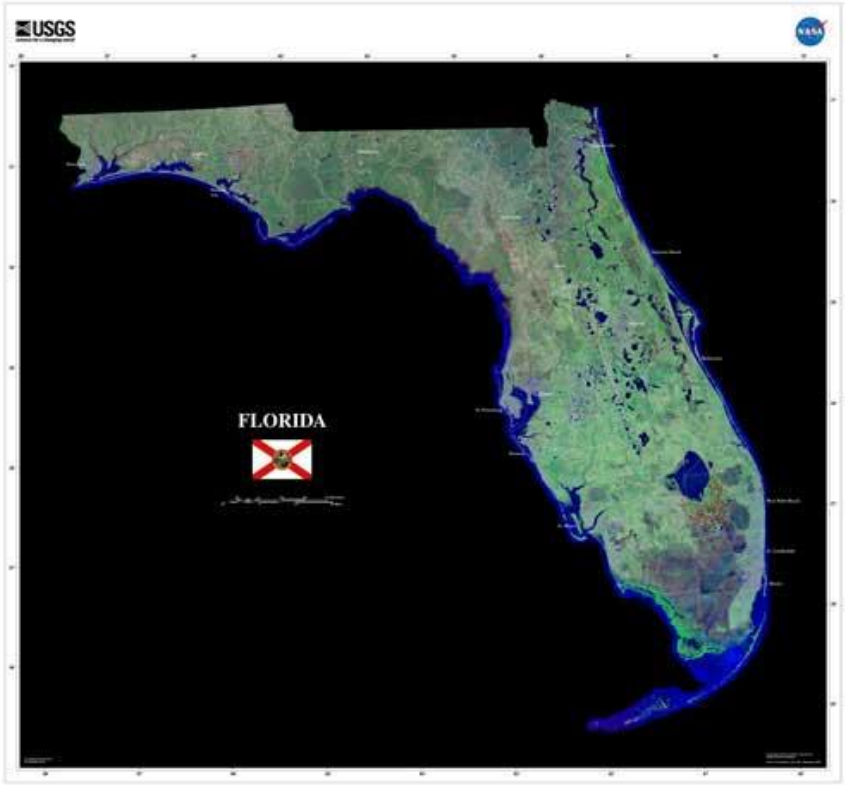

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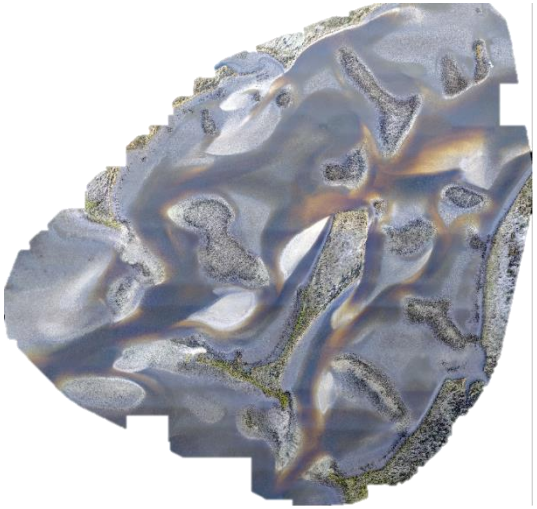

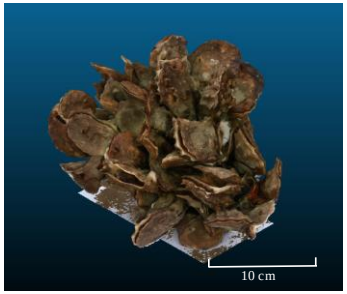

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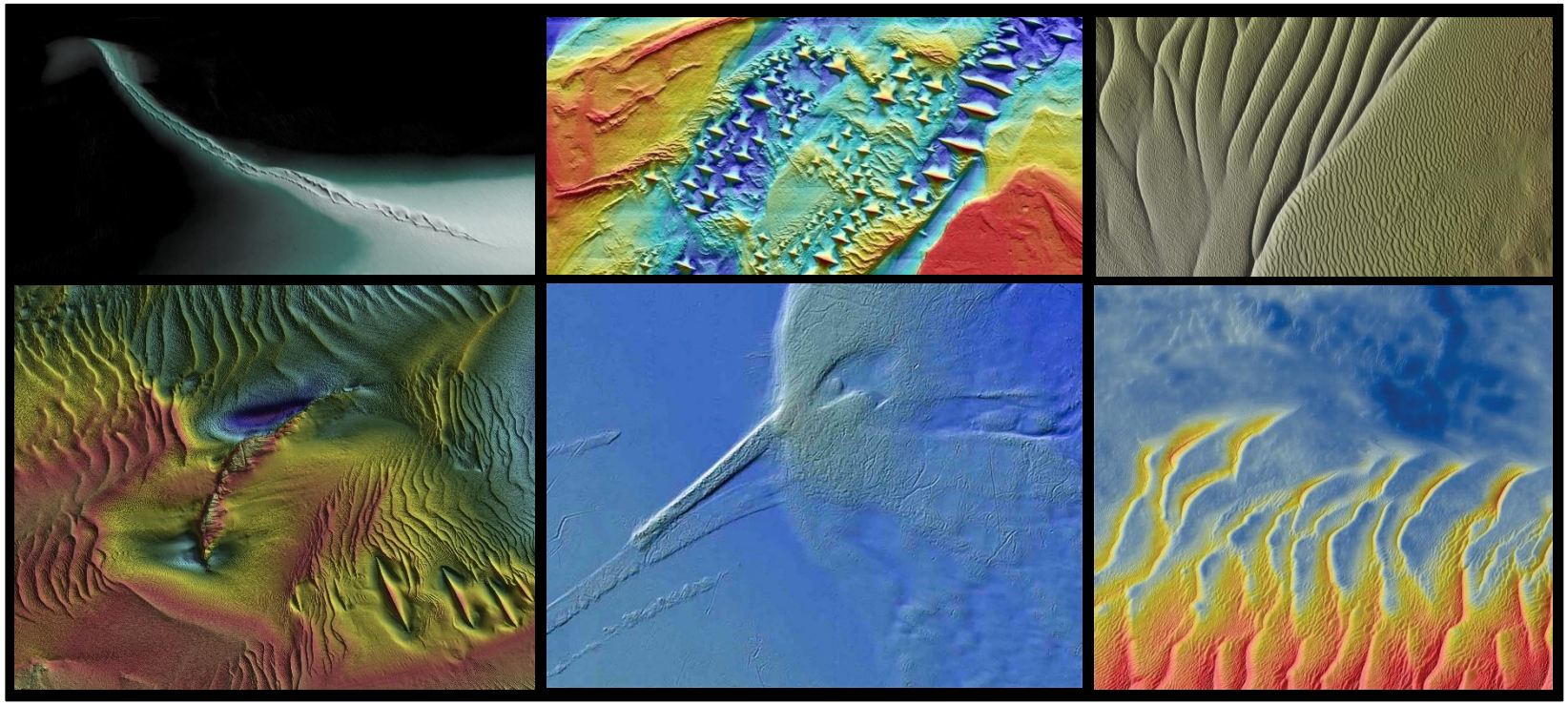
Conclusions

Remote sensing is not a panacea;
all approaches have their limitations

If we don't try to apply these different approaches to our context,
then we'll never know if they work or which kind of information they can provide

With the proper funding, we can possibly have answers in a few years

Thank you!



Images from http://visualsoundings.org/

www.TheLecoursLab.org

vlecours@ufl.edu