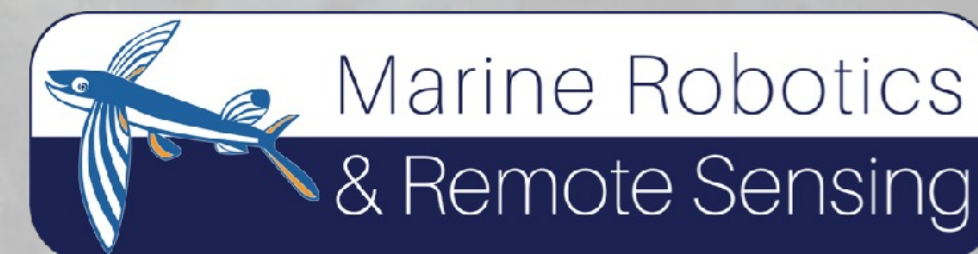




# Unoccupied aircraft systems are transforming marine science and conservation

Patrick Gray for David Johnston  
Duke Marine Robotics and Remote Sensing Lab





# Outline

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- 5 research themes:

1. Population distribution and abundance
2. Organismal behavior and body condition/health
3. Habitat assessment and validation
4. Biological oceanography
5. Natural resource management

**4013**

FLIGHTS

**55**

DRONES

**856:40:14**

FLYING TIME

**307**

BATTERIES

**40617.91** km

TRAVELLED

**182**

LOCATIONS

Powered by



DroneLogbook





Population  
Abundance and  
Distribution

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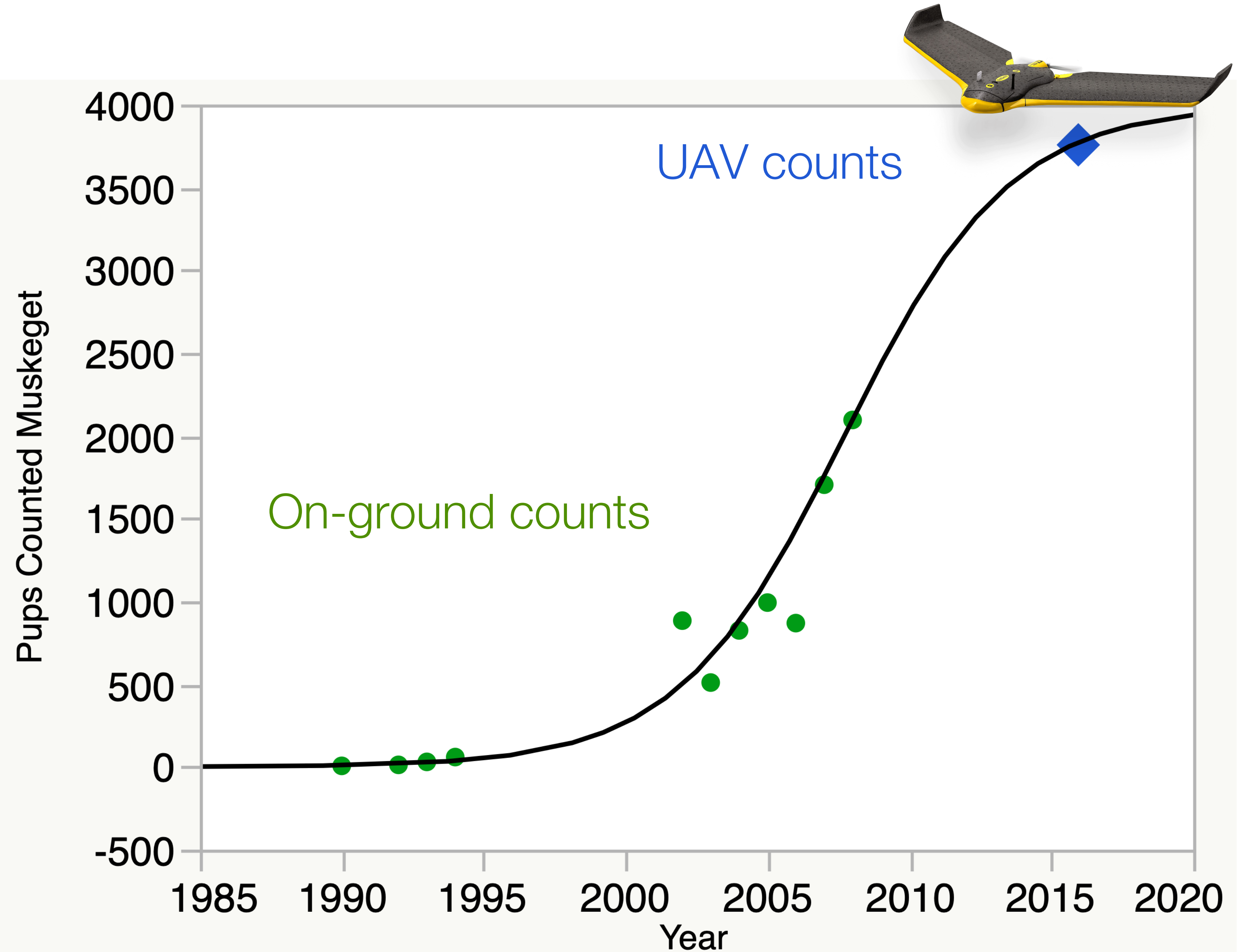






# Muskeget Pup Counts

- Colony reaching carrying capacity?
- Other pupping locations are now evident.





Organismal  
behavior and body  
condition/health

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# MorphoMetriX: a photogrammetric measurement GUI for morphometric analysis of megafauna

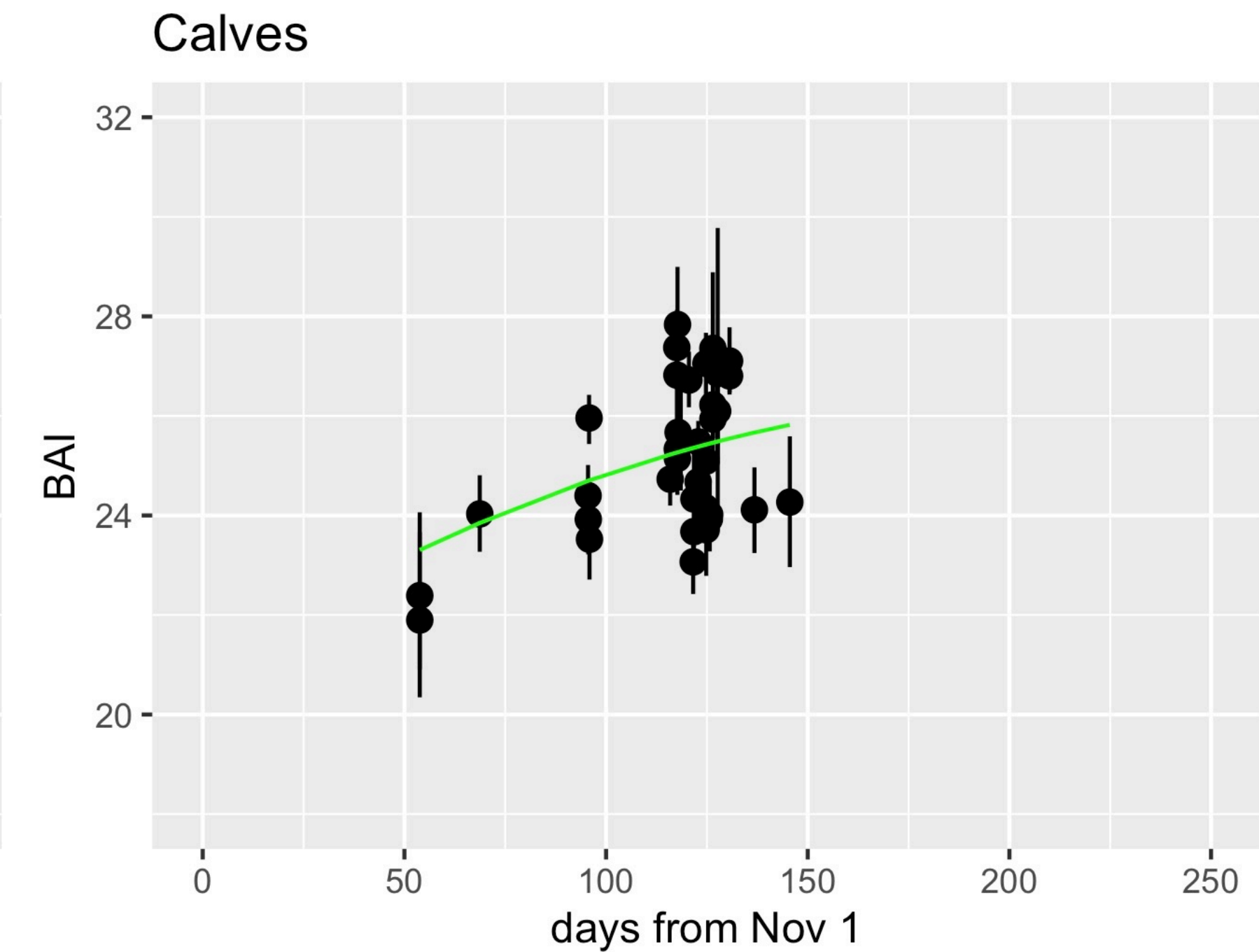
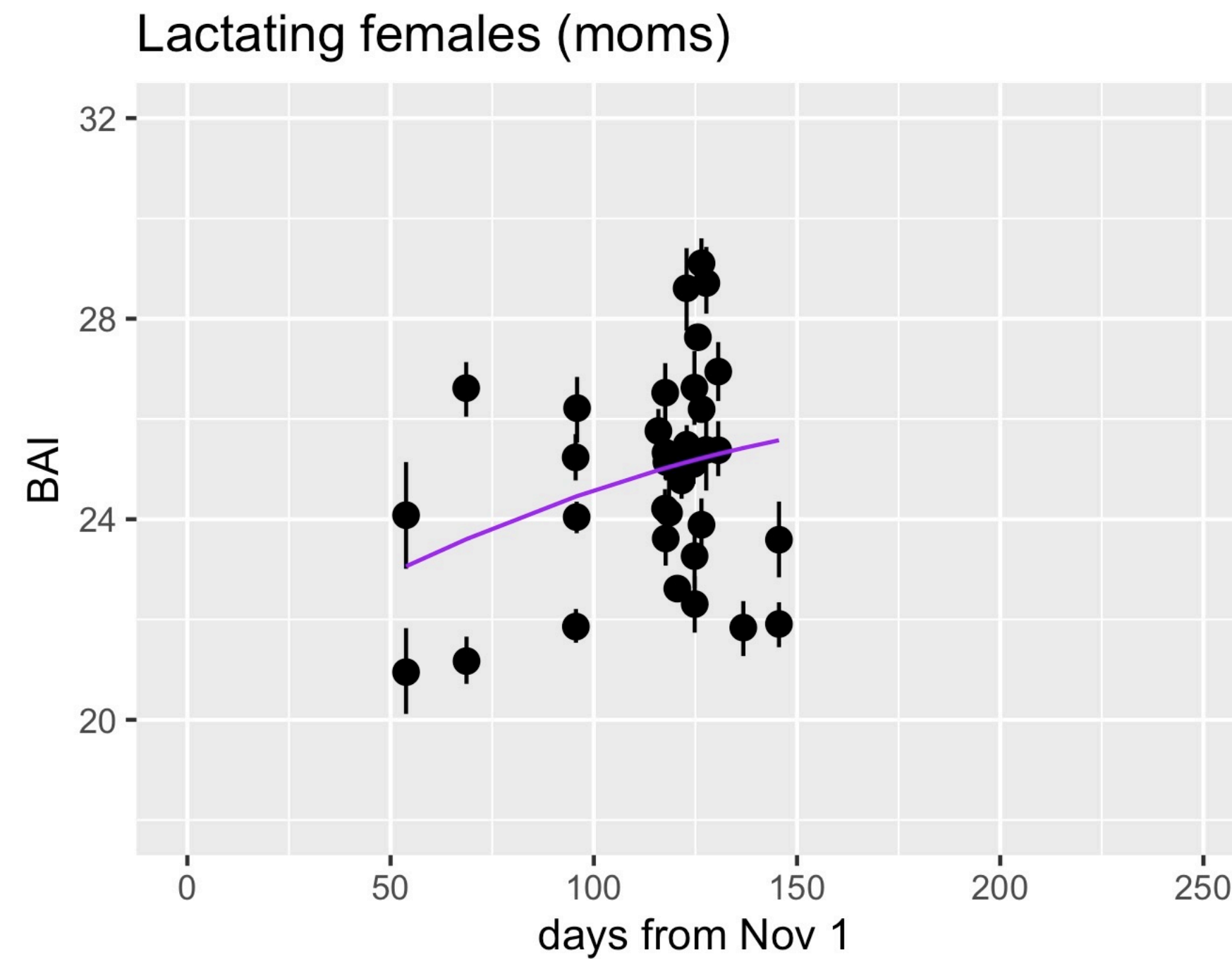
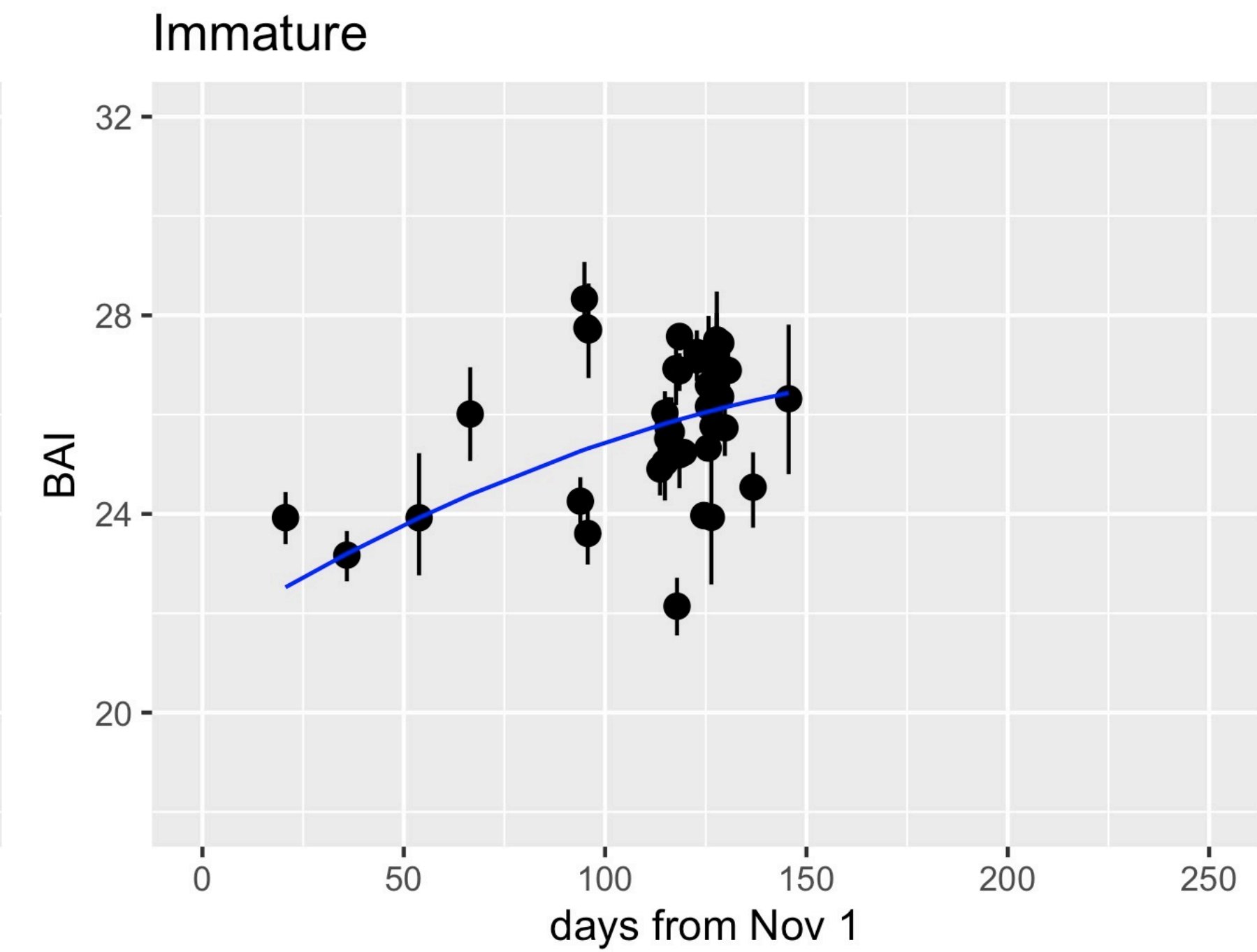
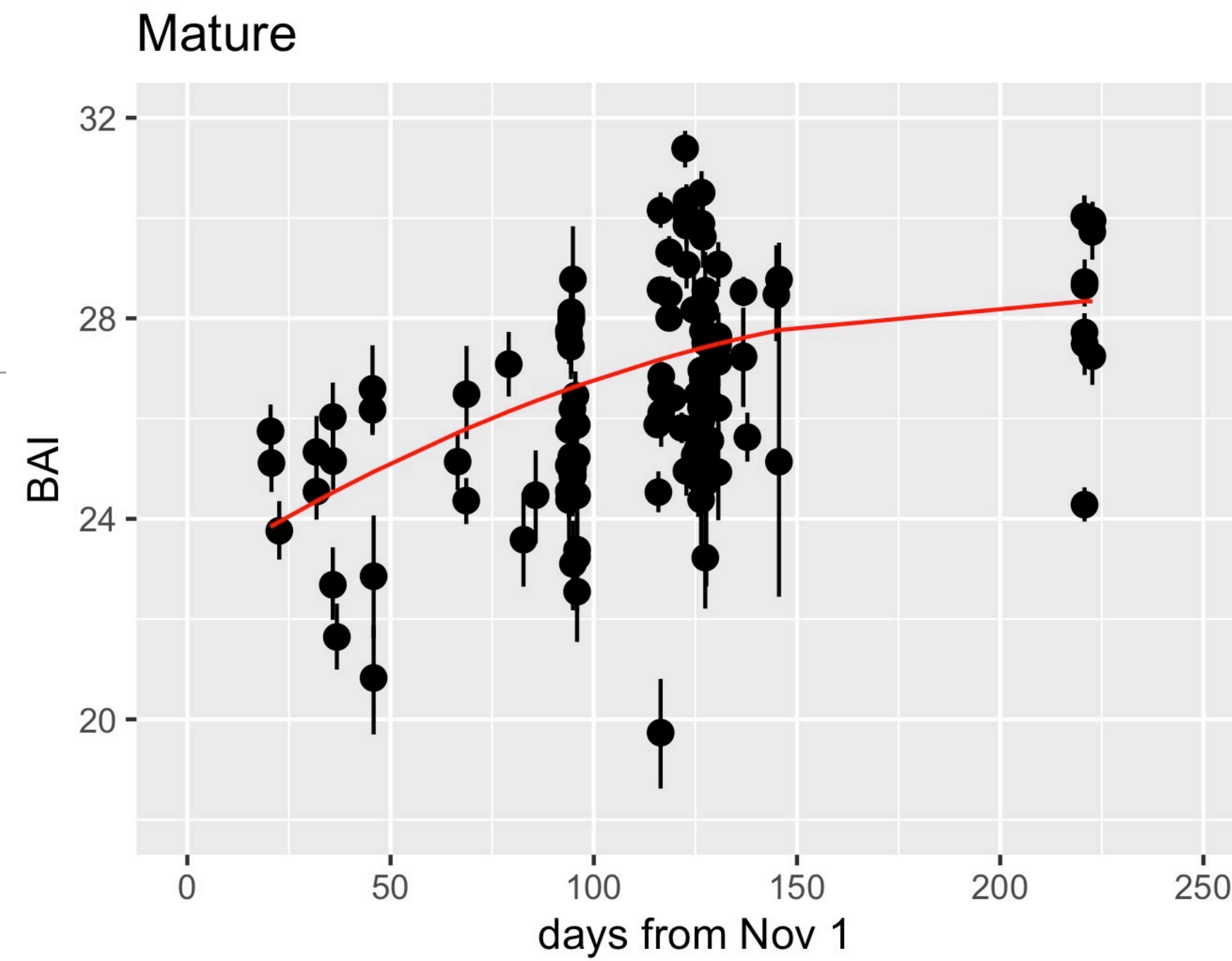


Torres and Bierlich (2020). Journal of Open Source Software



# Humpback Body Condition

- Body Area Index
- 2D estimation of animal condition
- Bayesian error estimation for all measurements
- Animals imaged along the Western Antarctic Peninsula during austral summer feeding period





# Habitat Assessments

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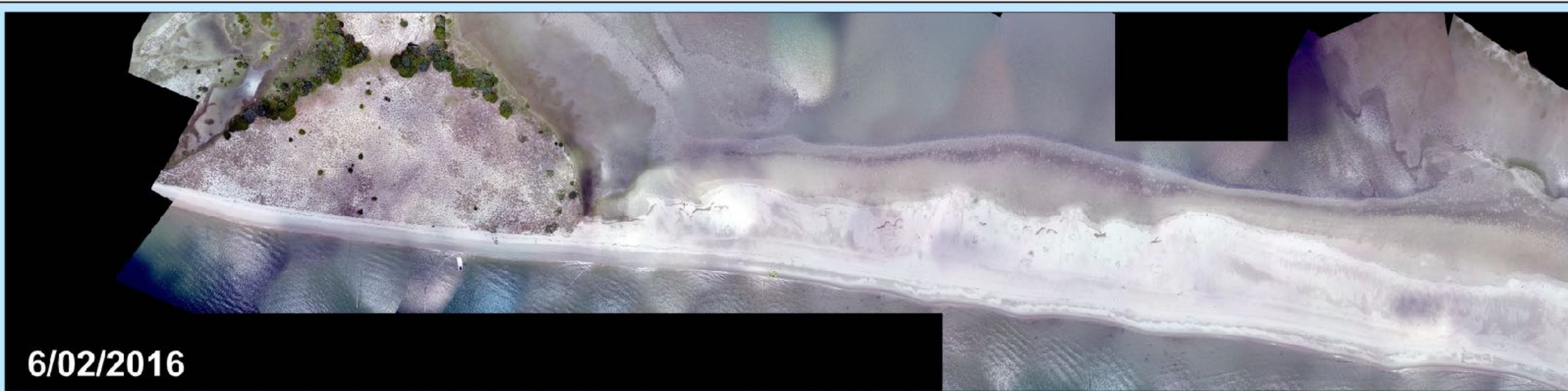




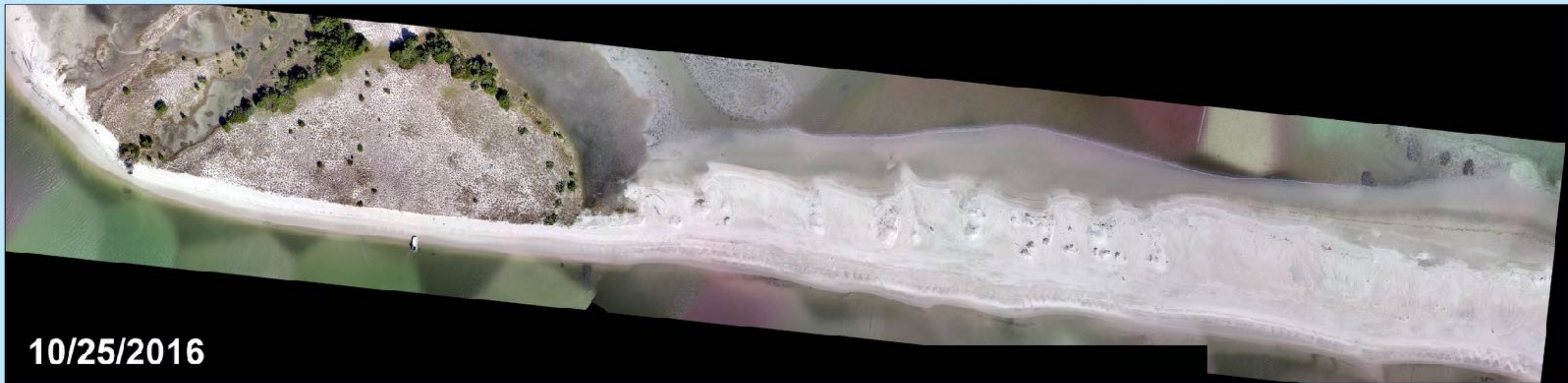




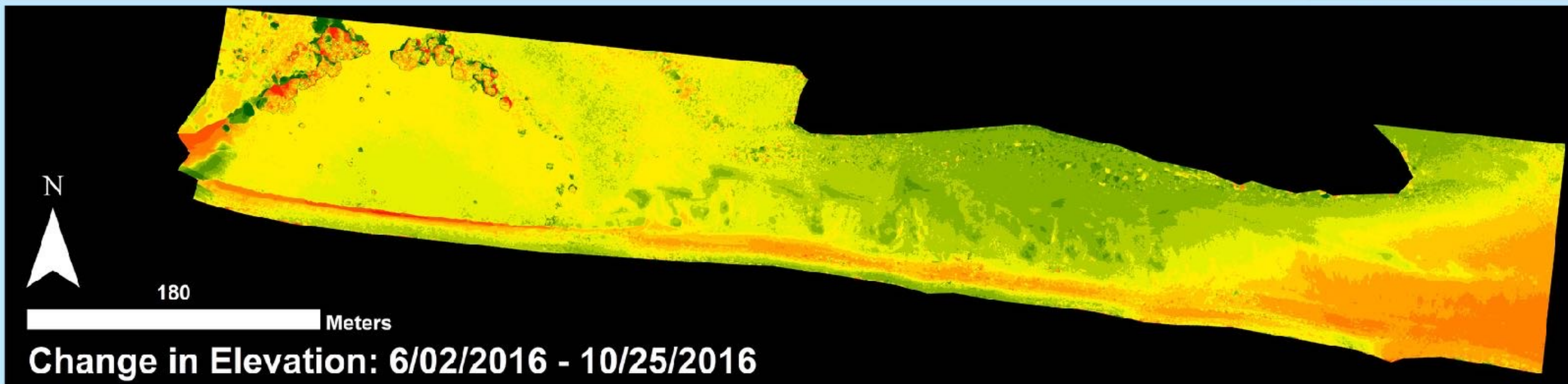
# UAS Shoreline Change Survey Snapshots



Before



After

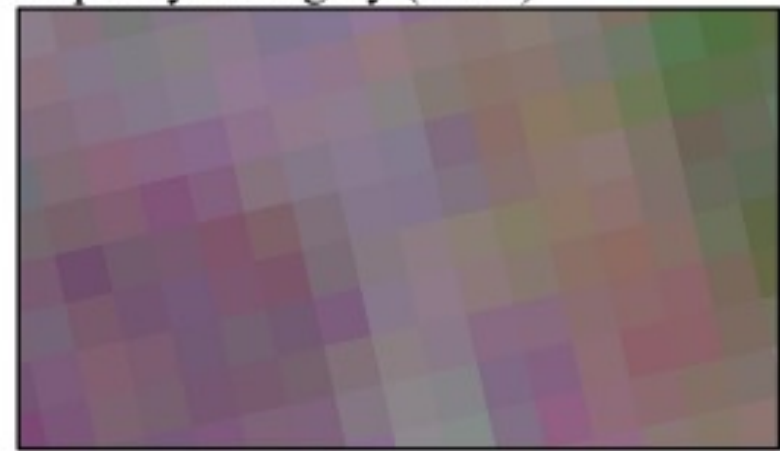


Delta

Seymour et al  
2019



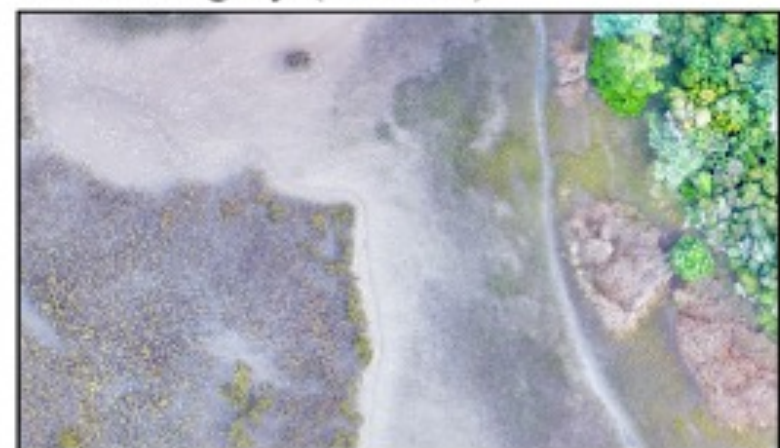
RapidEye Imagery (5.0m)



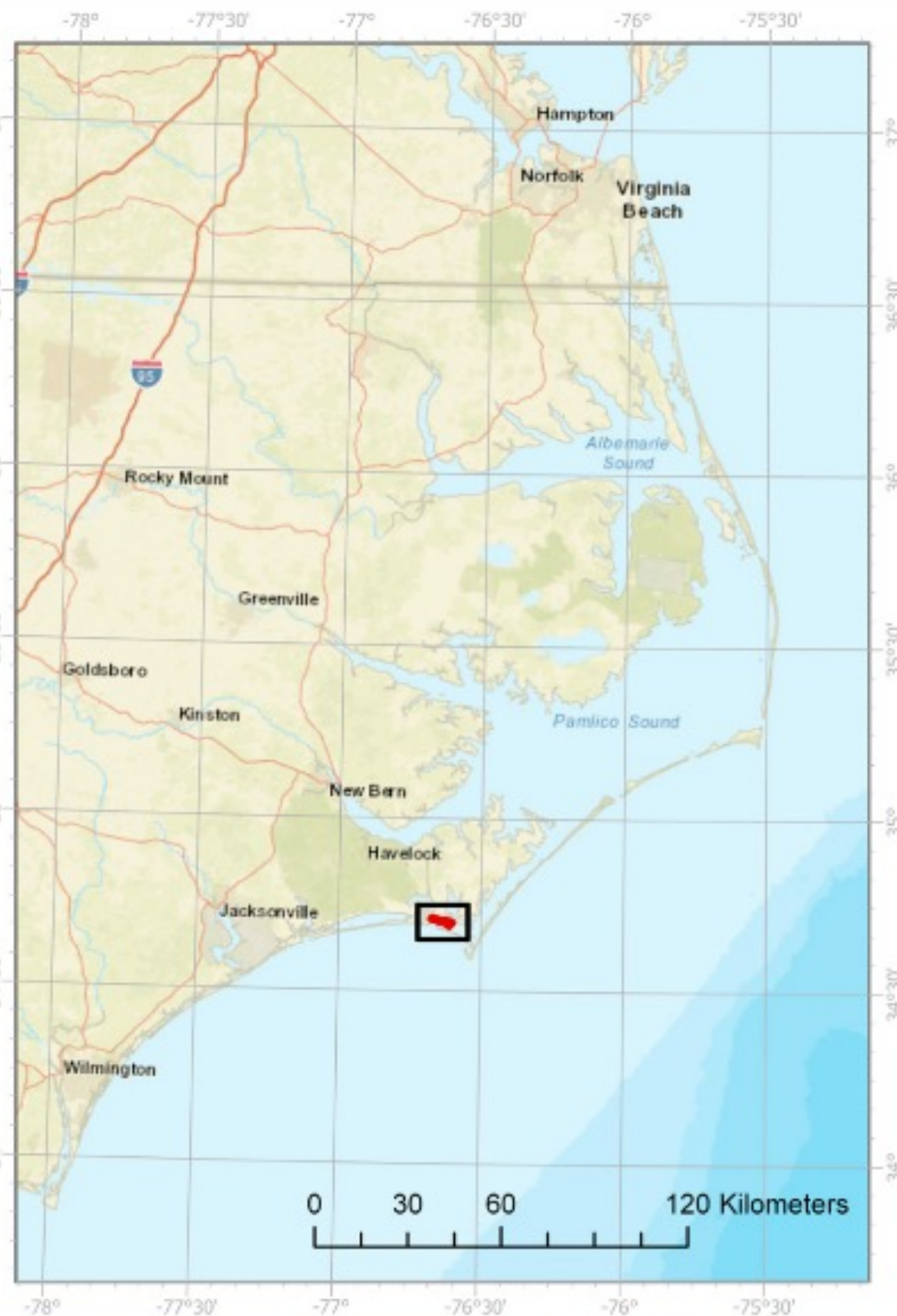
WorldView-3 Imagery (1.24m)



UAS Imagery (0.031m)



0 10 20 40 Meters

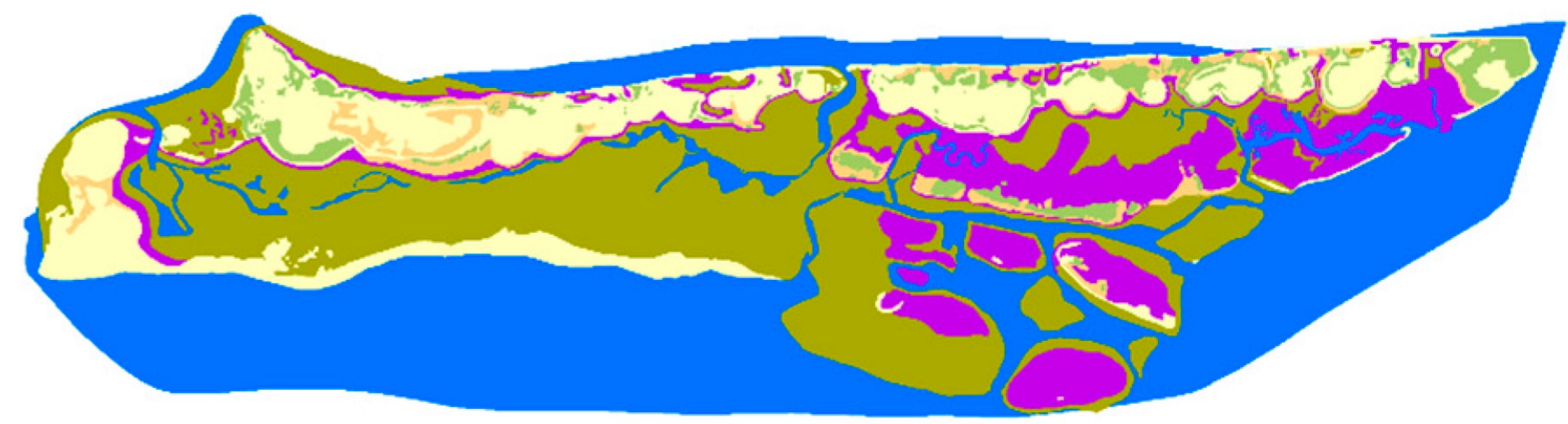


0 30 60 120 Kilometers

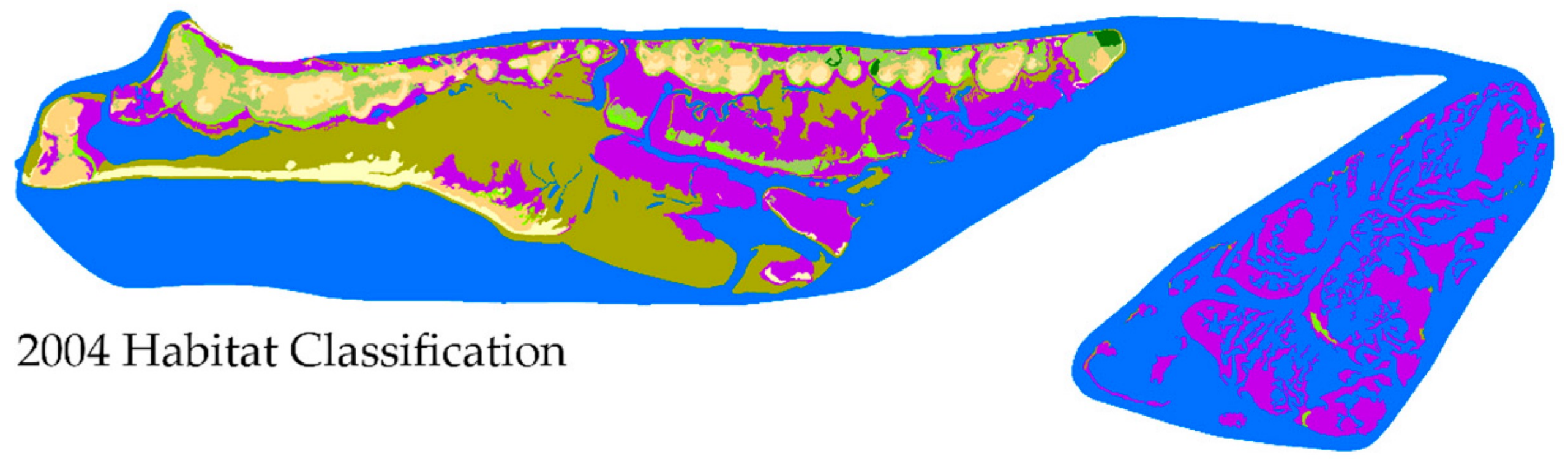


Rachel Carson Reserve  
Ground Truth Transects

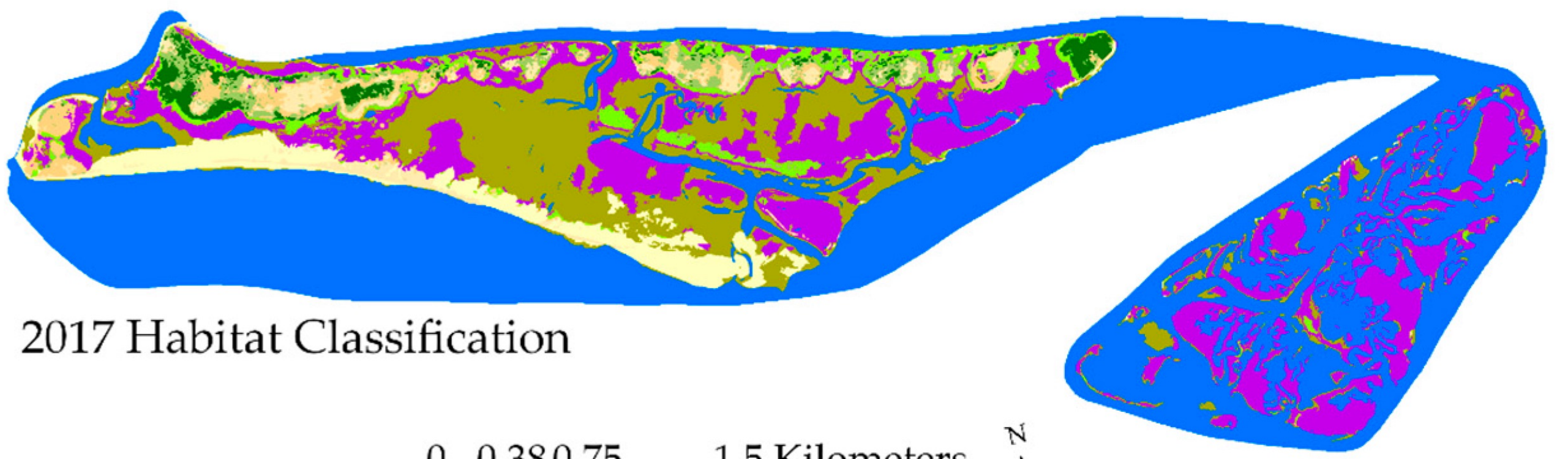
- CLASS
- Emergent Wetland
  - Intertidal Sand
  - Subtidal Haline
  - Scrub-Shrub Wetland
  - Supratidal Sand
  - Forested Upland
  - Herbaceous Upland
  - Scrub-Shrub Upland
  - Upland Sand



1986 Habitat Classification



2004 Habitat Classification



2017 Habitat Classification

0 0.380.75 1.5 Kilometers



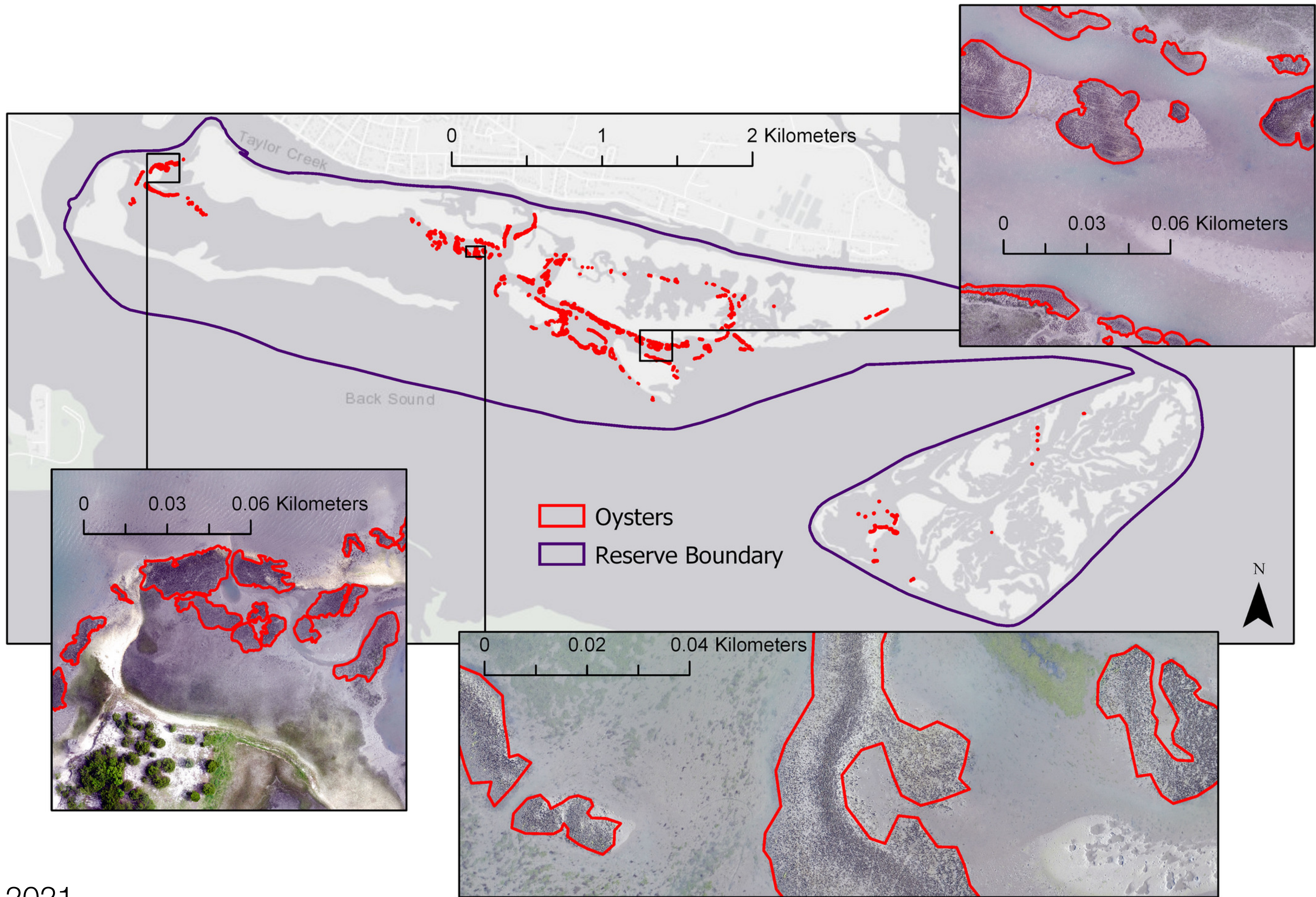


# Computer Vision and Artificial Intelligence

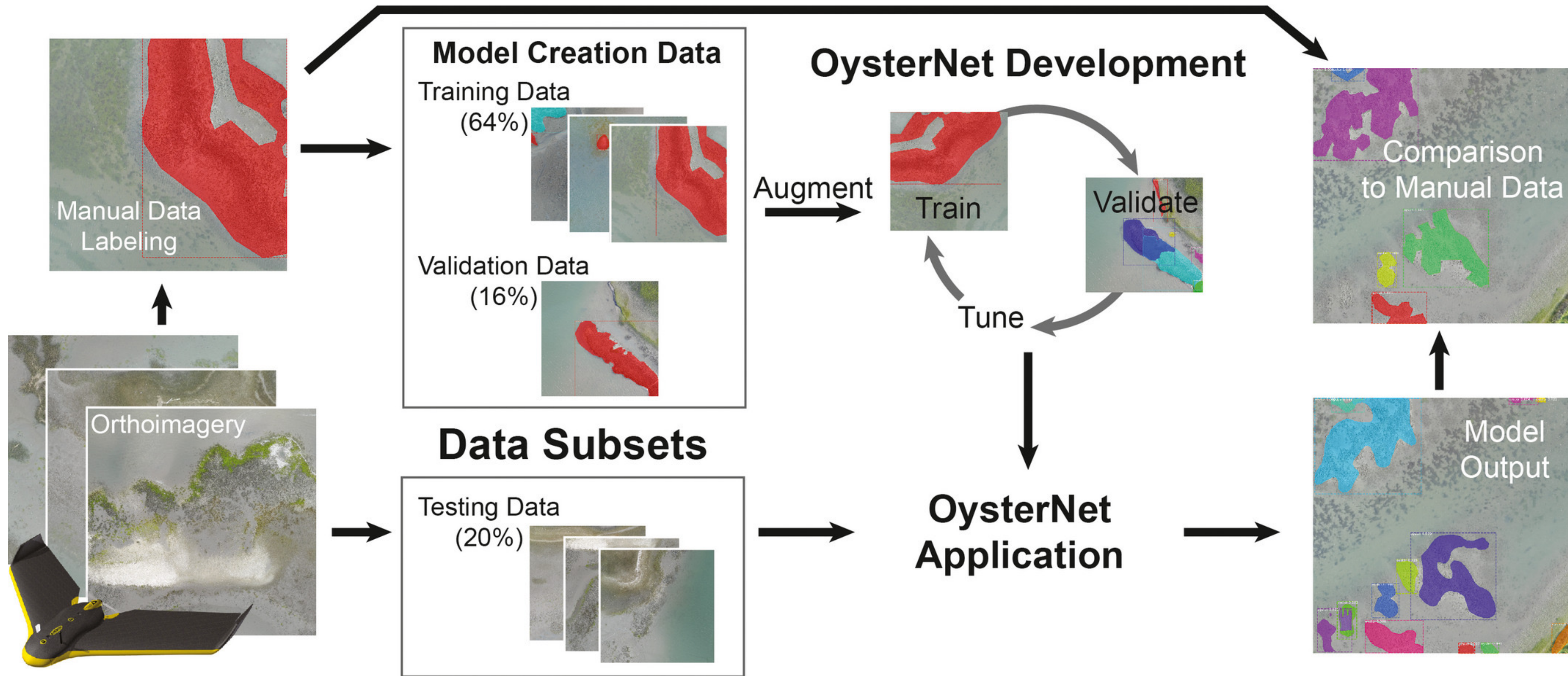
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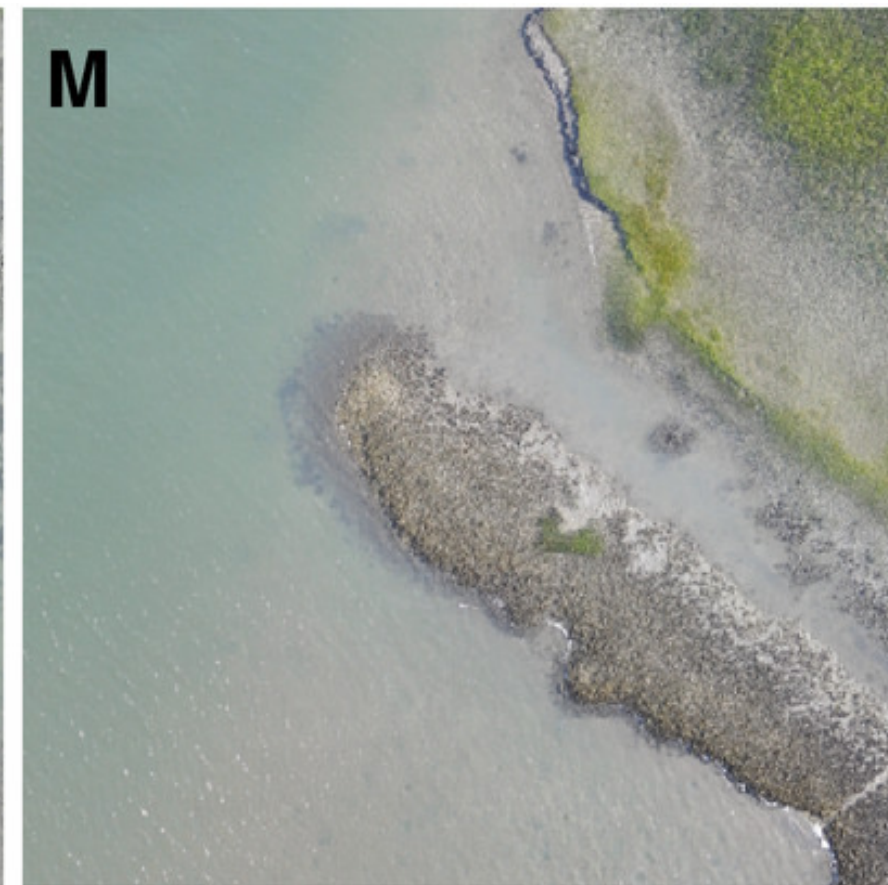
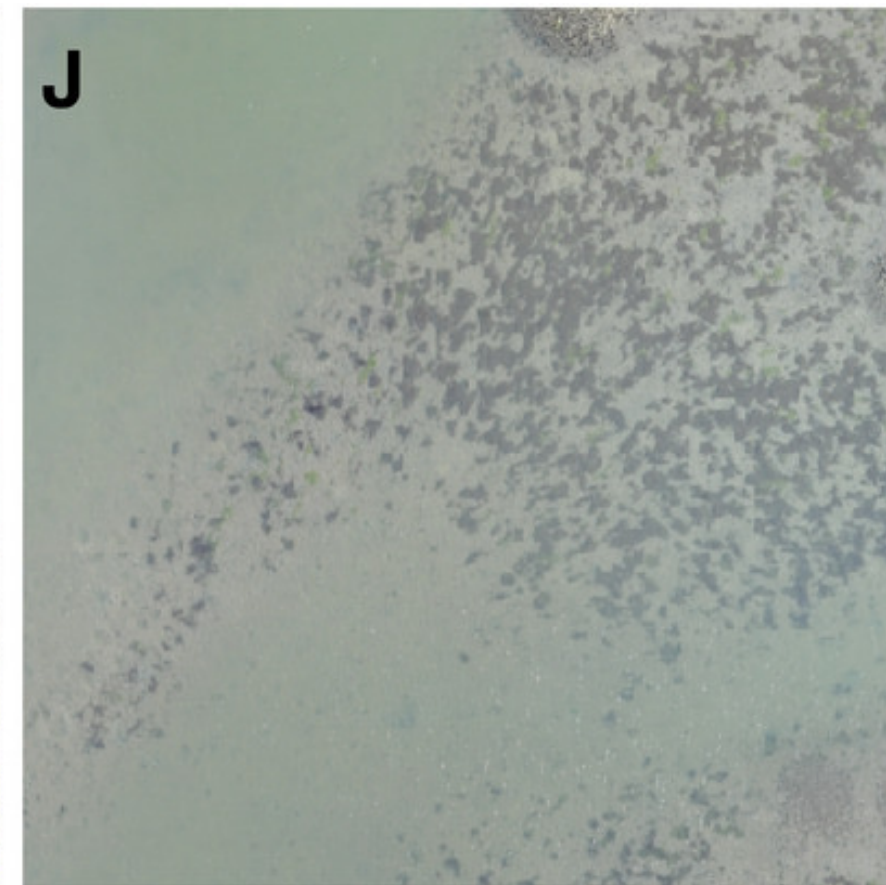
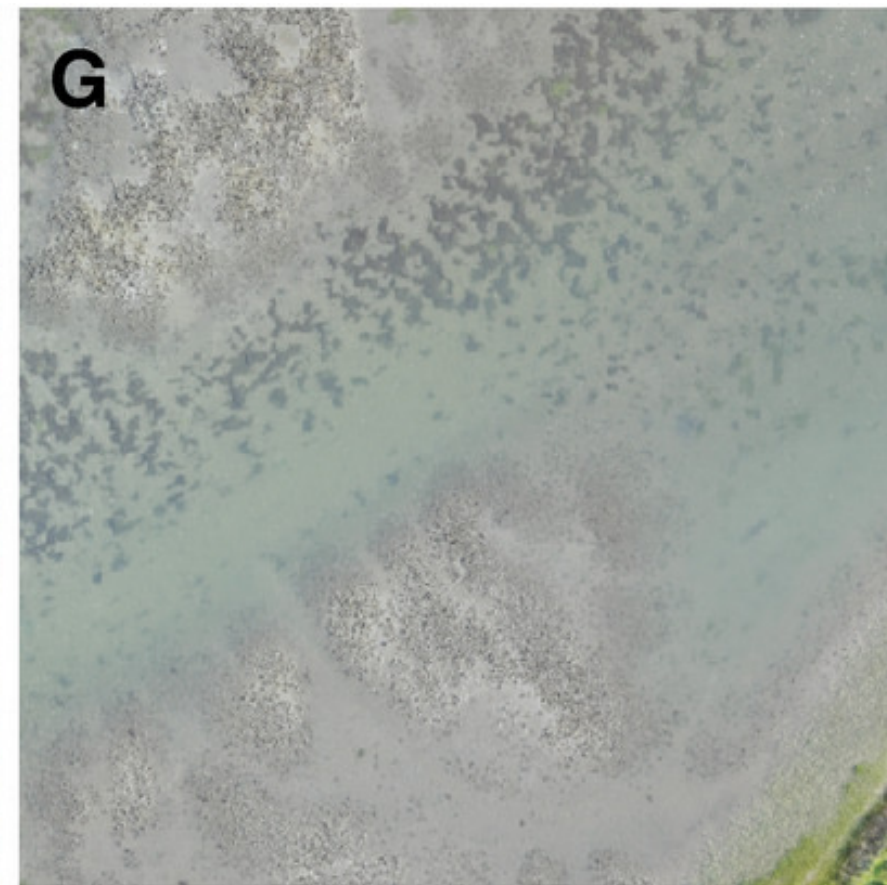
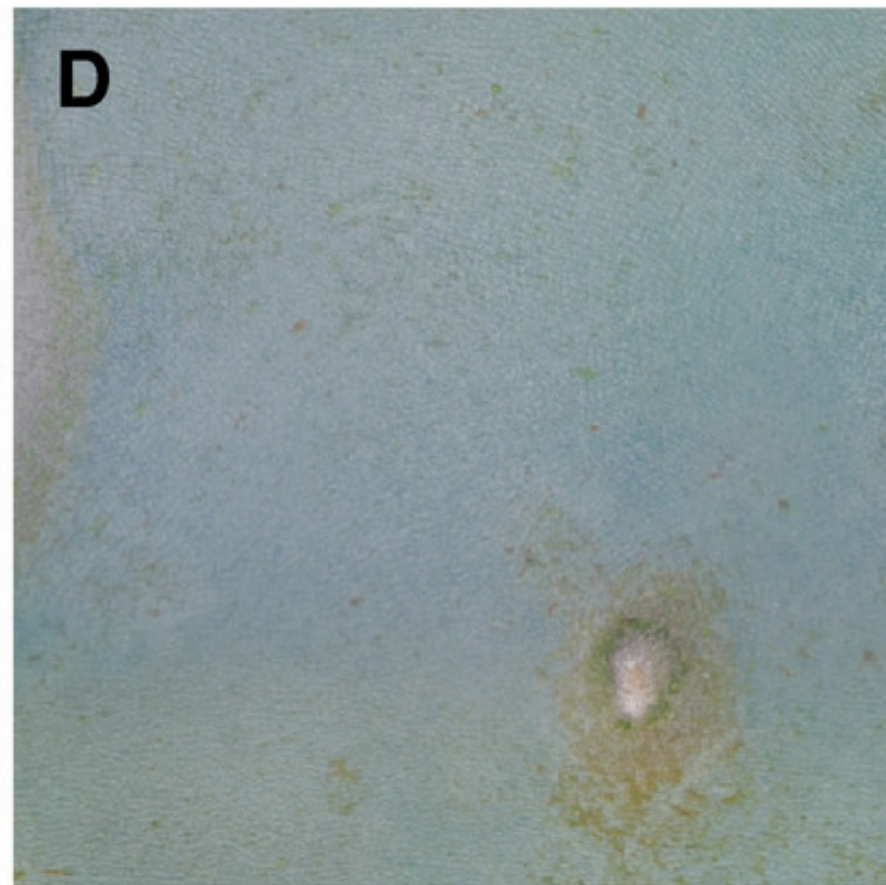
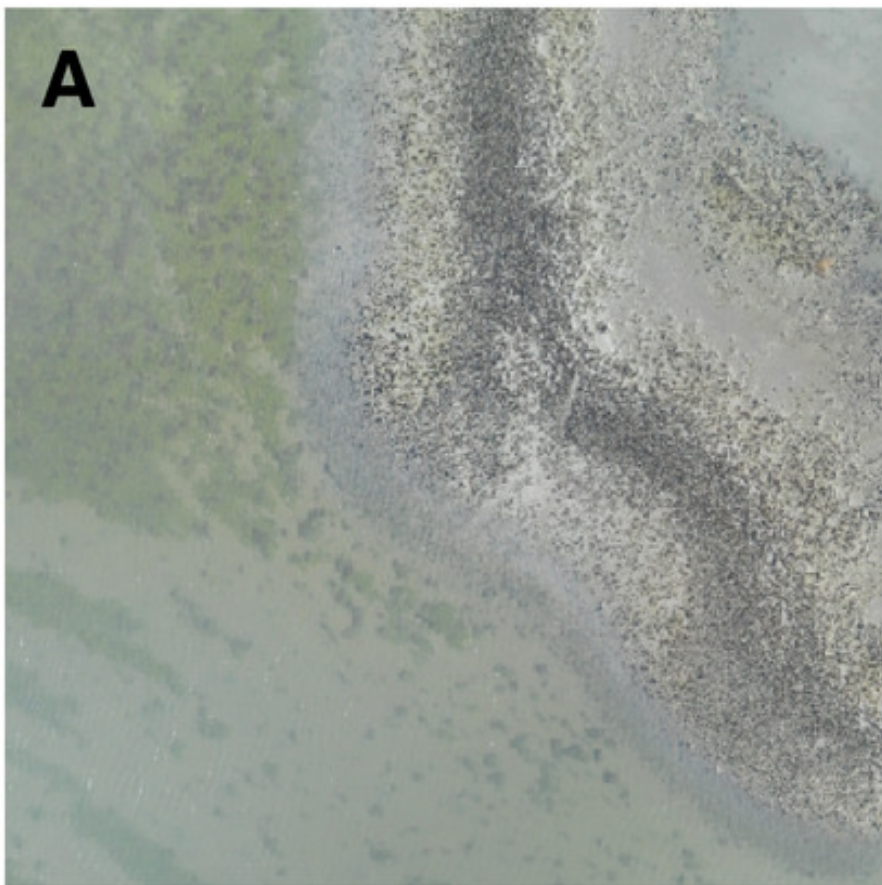




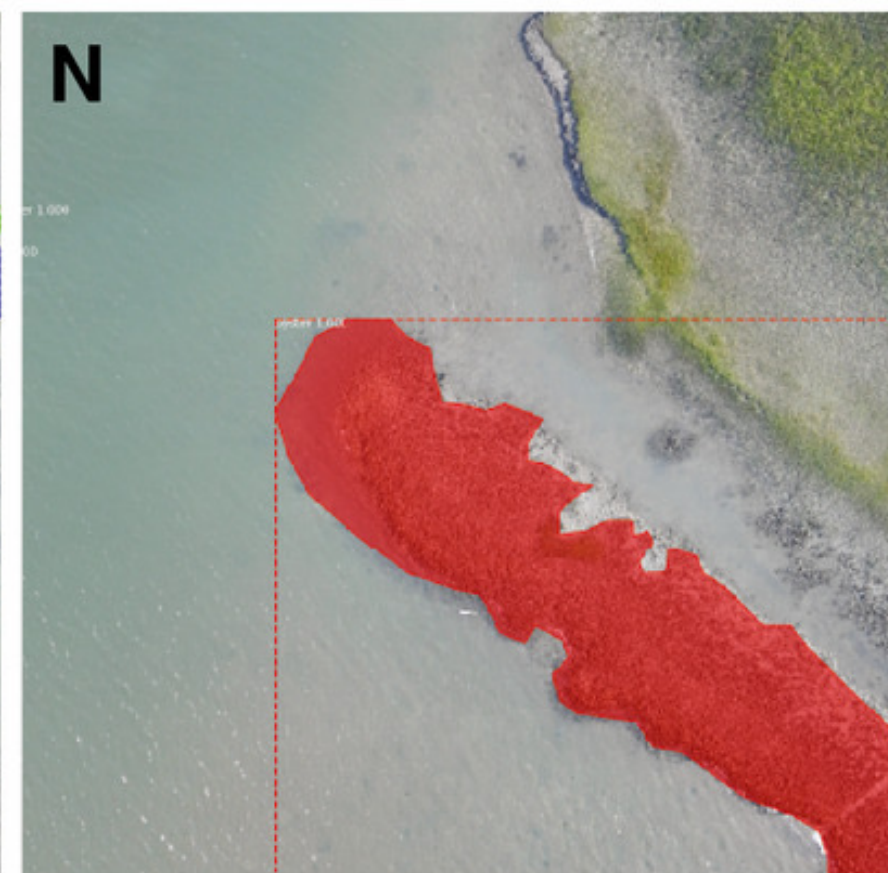
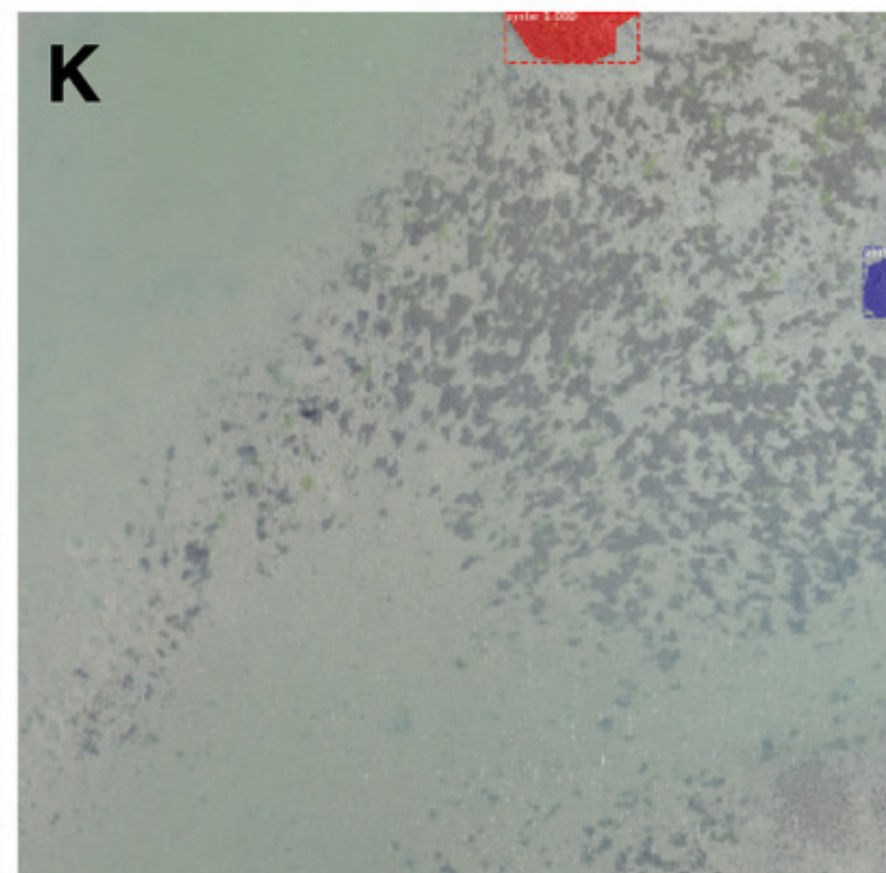
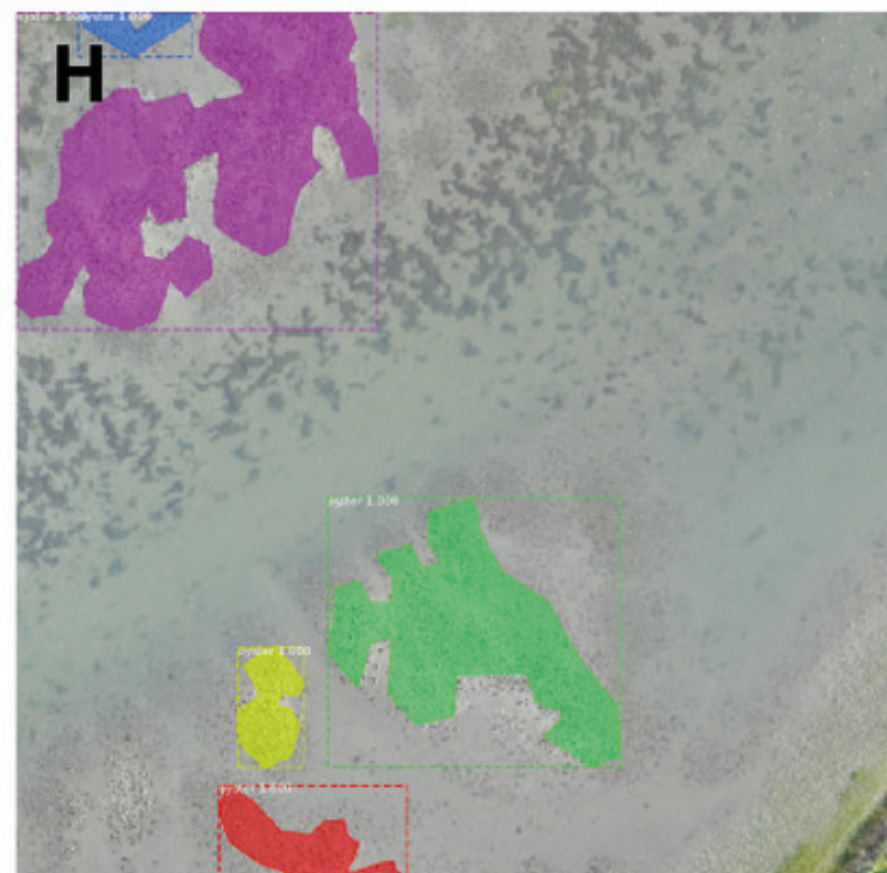
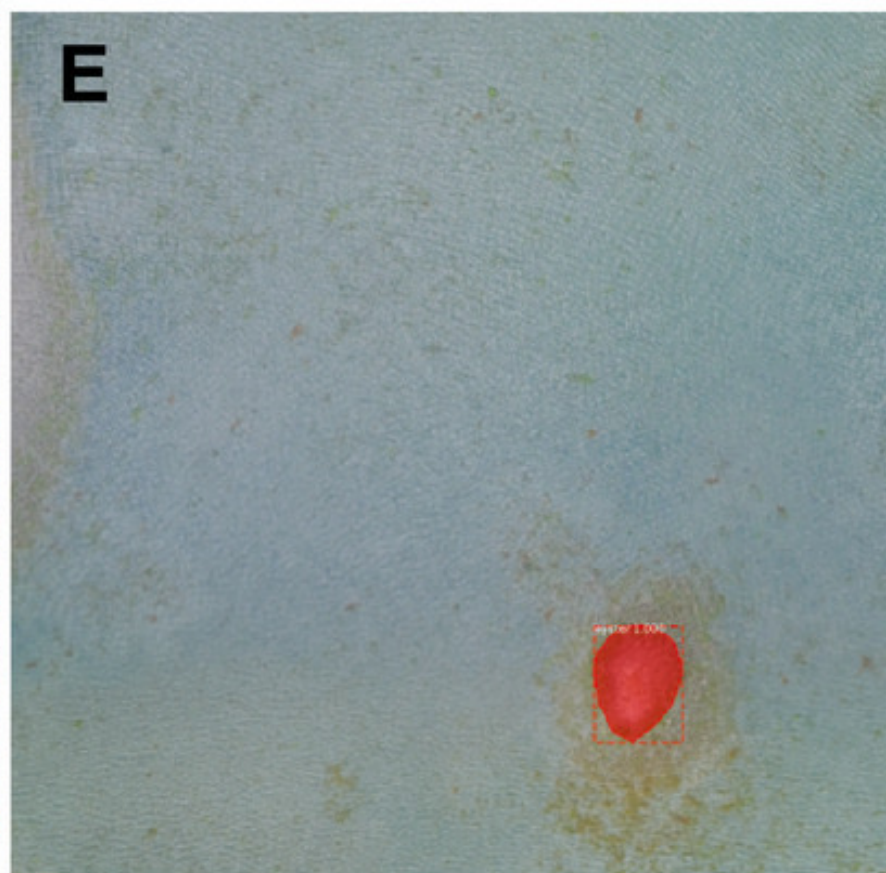
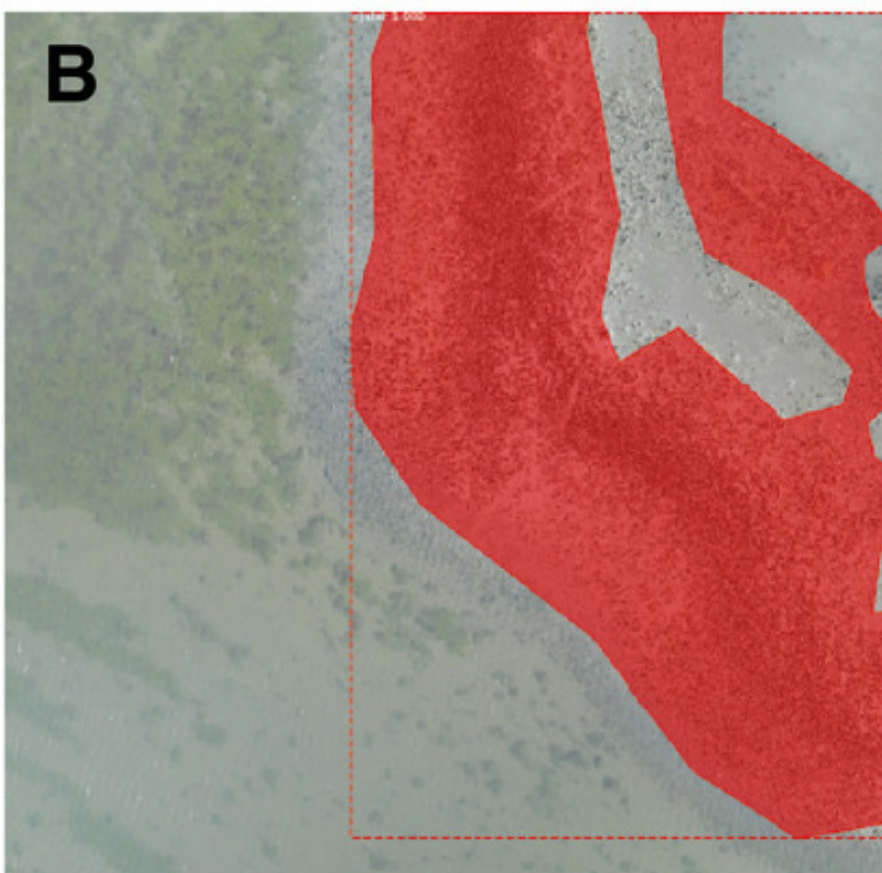




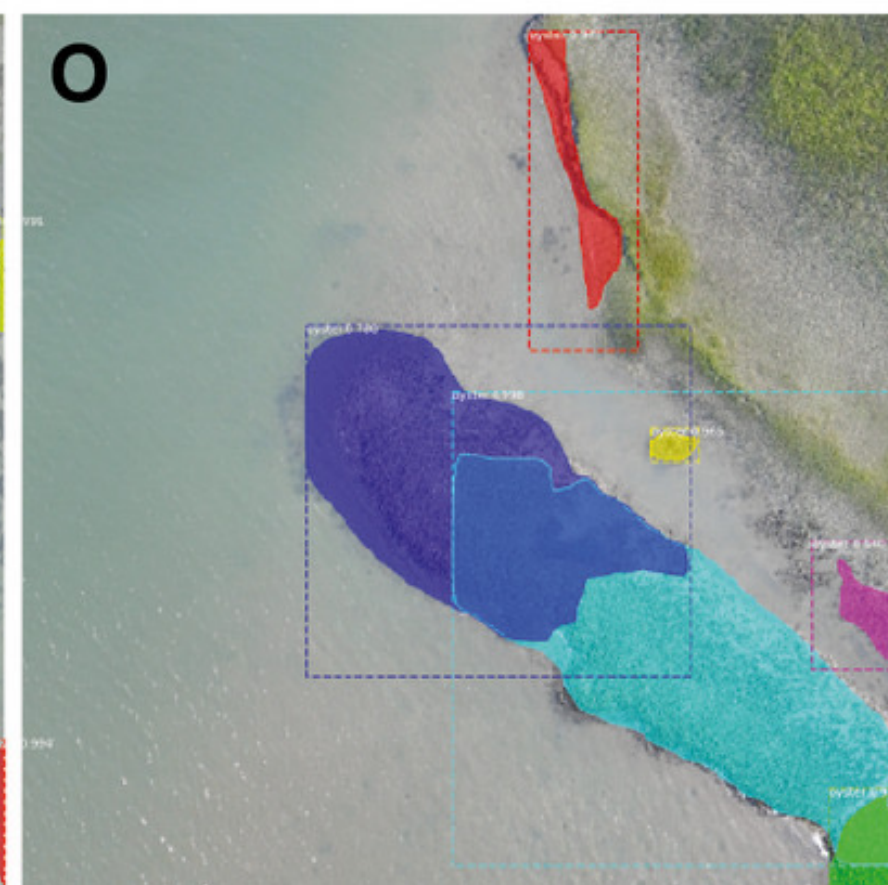
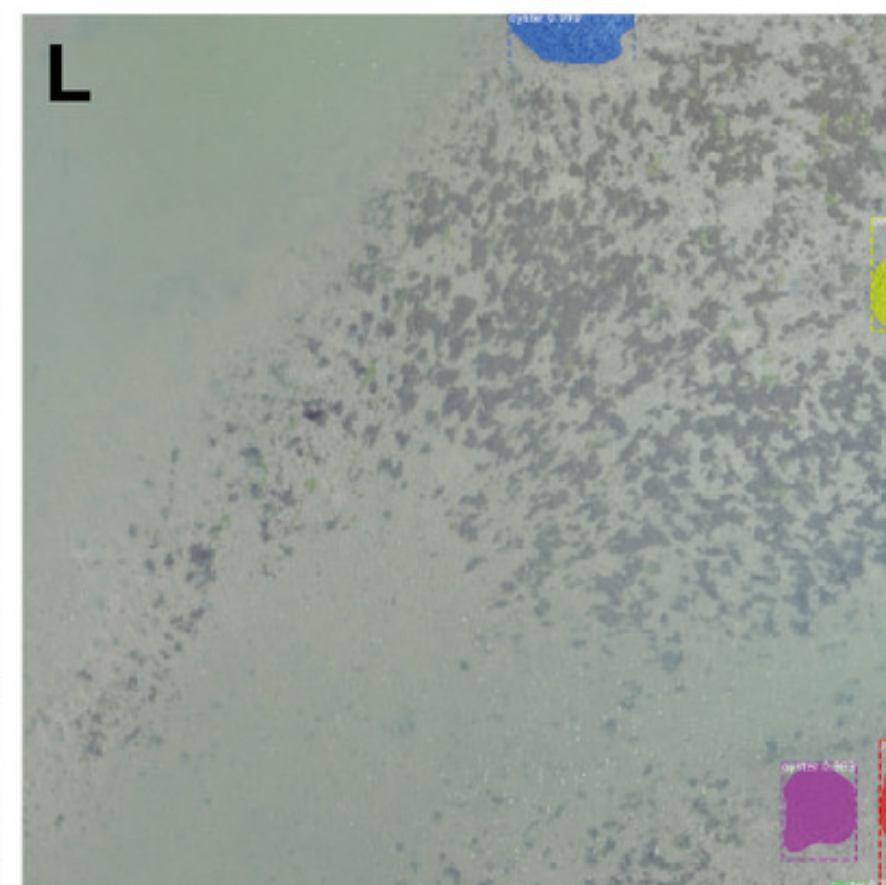
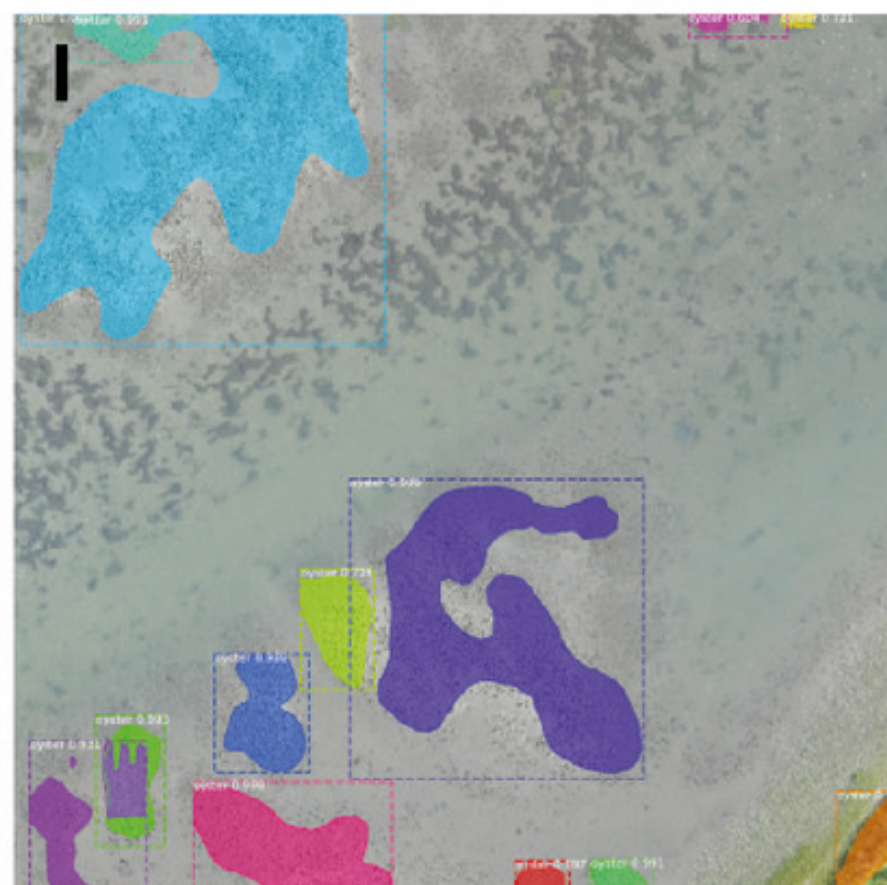
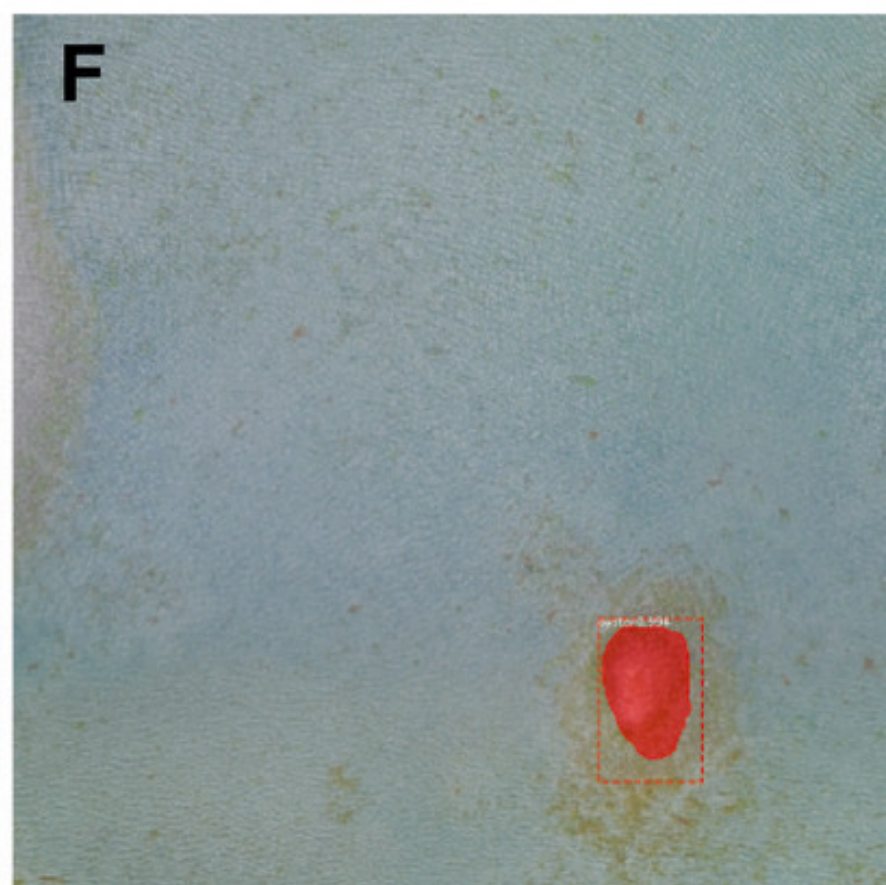
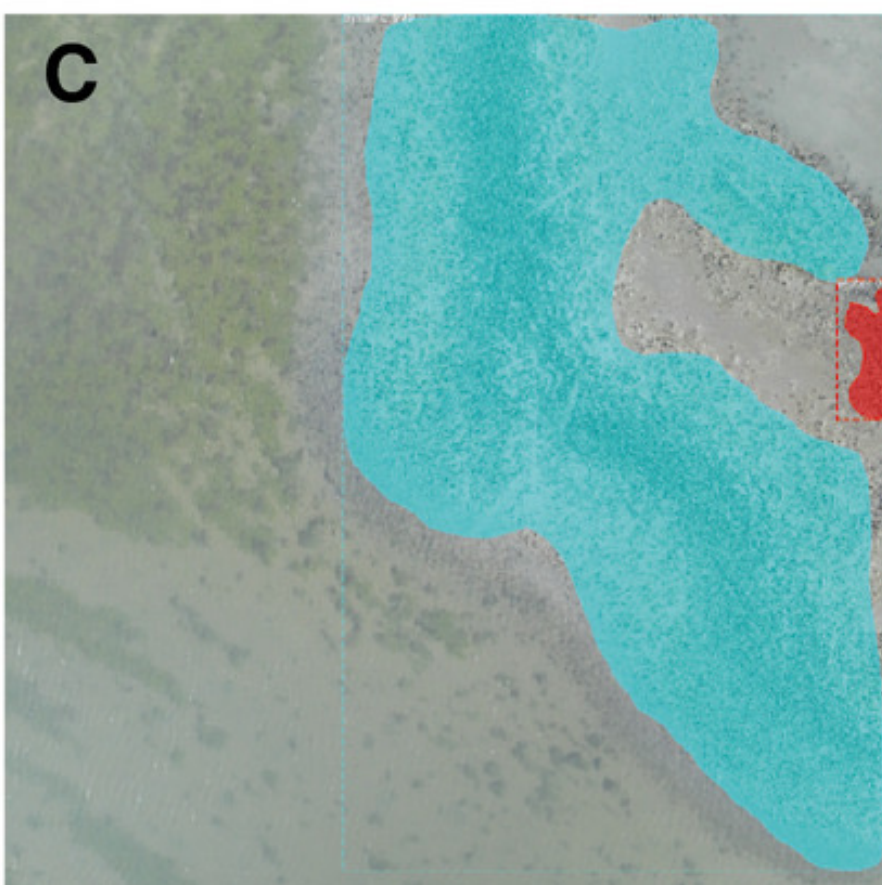
Orthoimagery



Manual Polygons

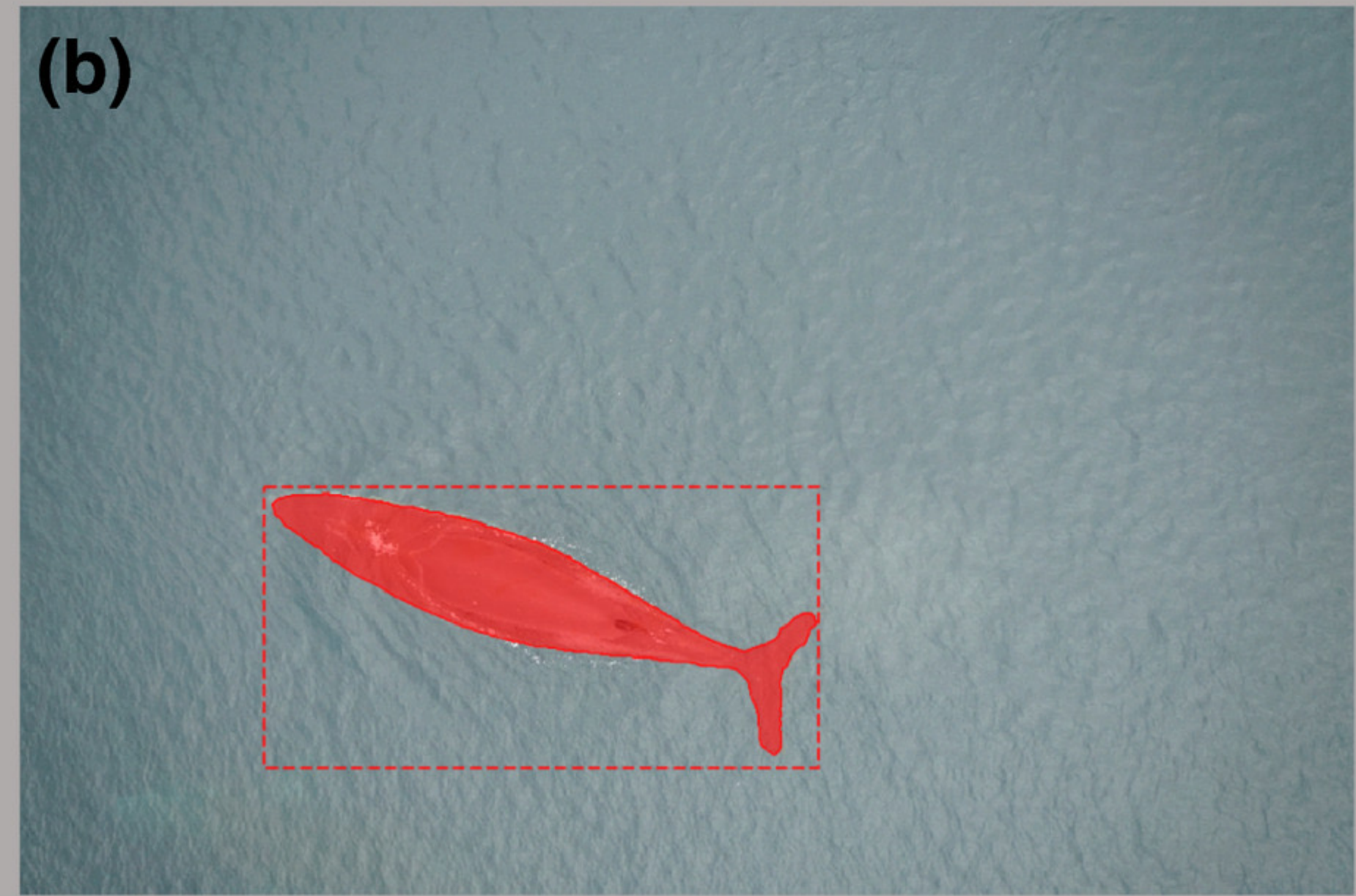


Predicted Polygons

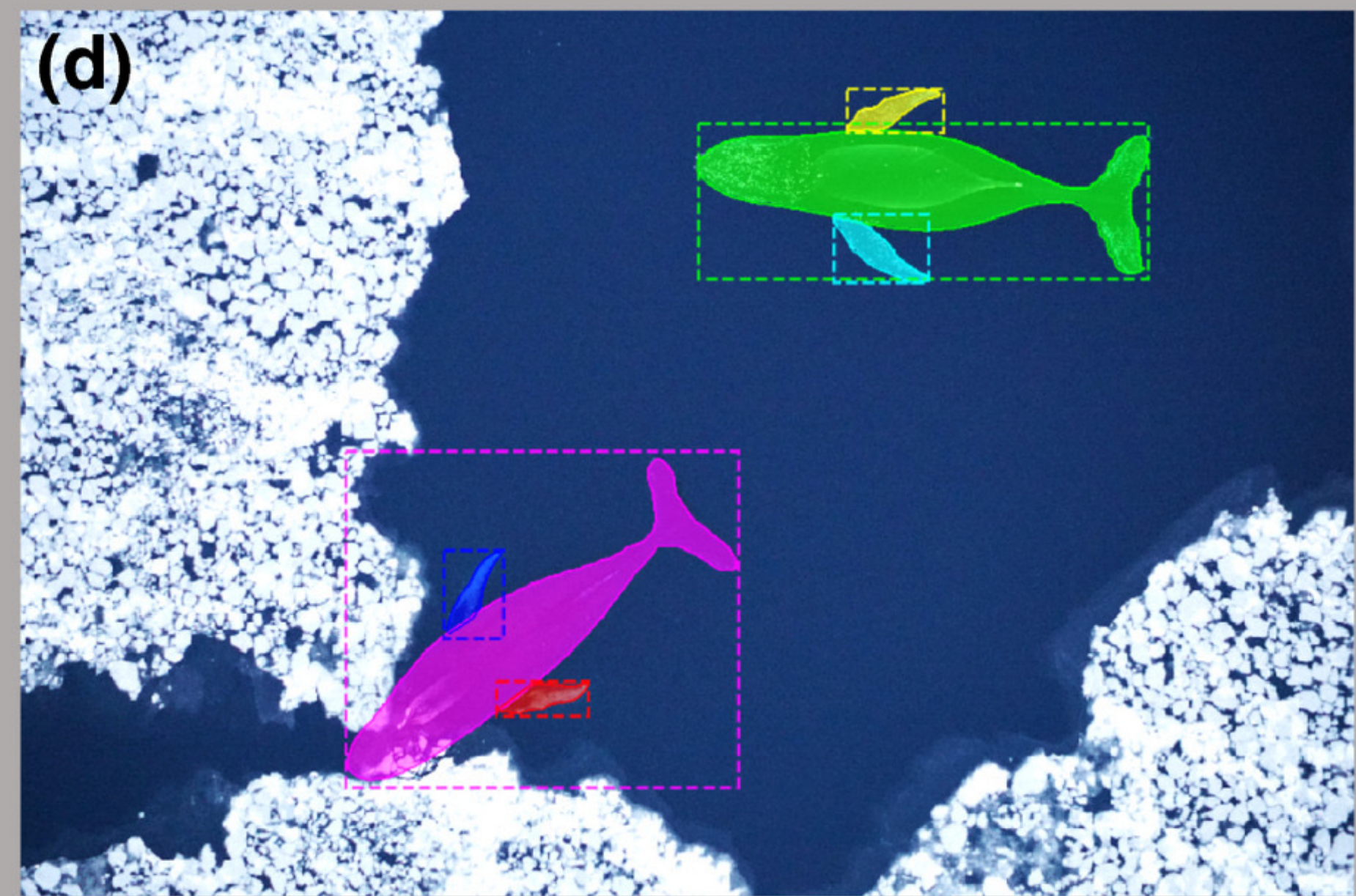




Single mask



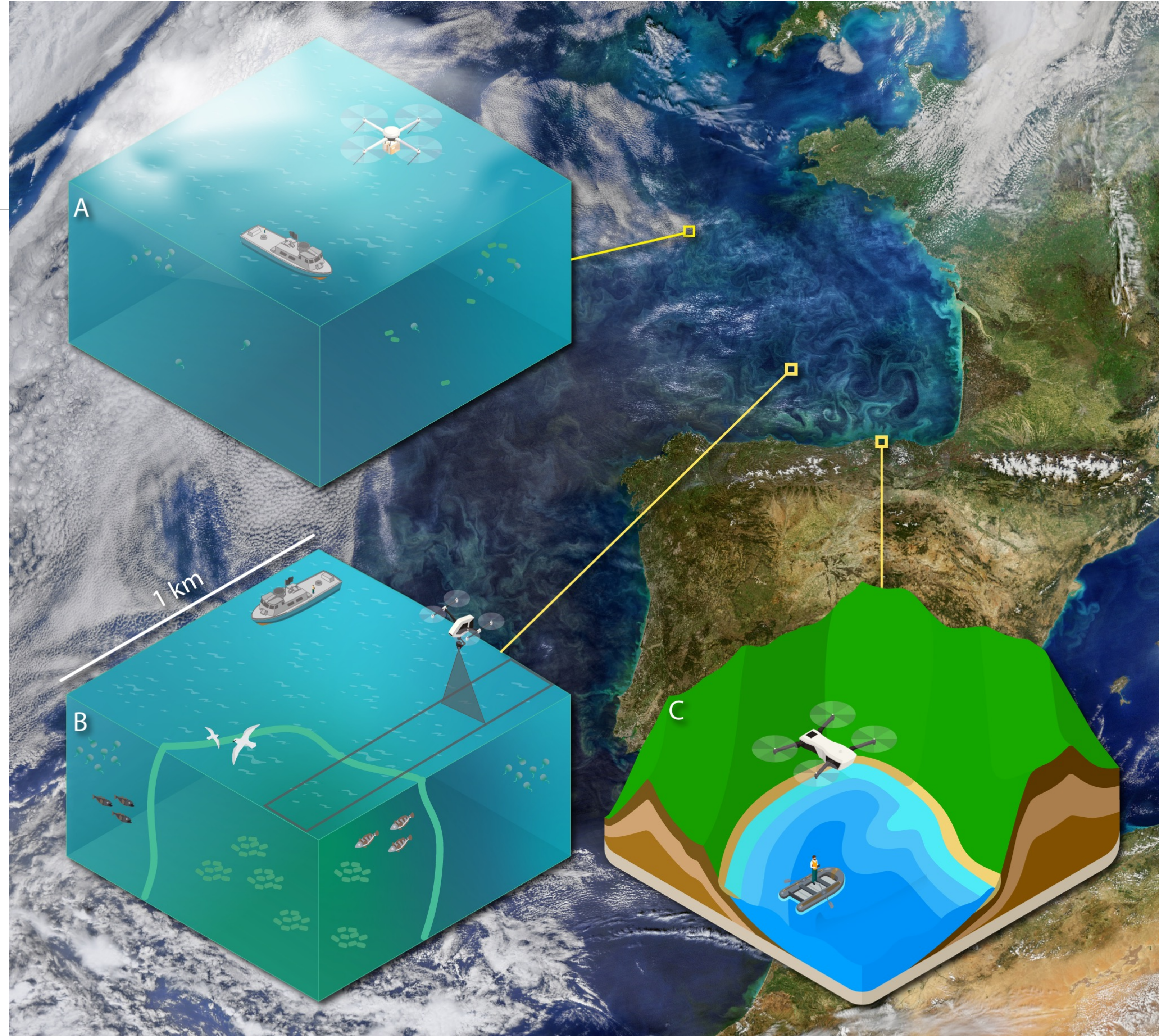
Multiple masks





# Biological Oceanography

- On-demand remote sensing
  - Below clouds
  - Submesoscale features
  - Close to land
- Shed light on satellite remote sensing blindspot



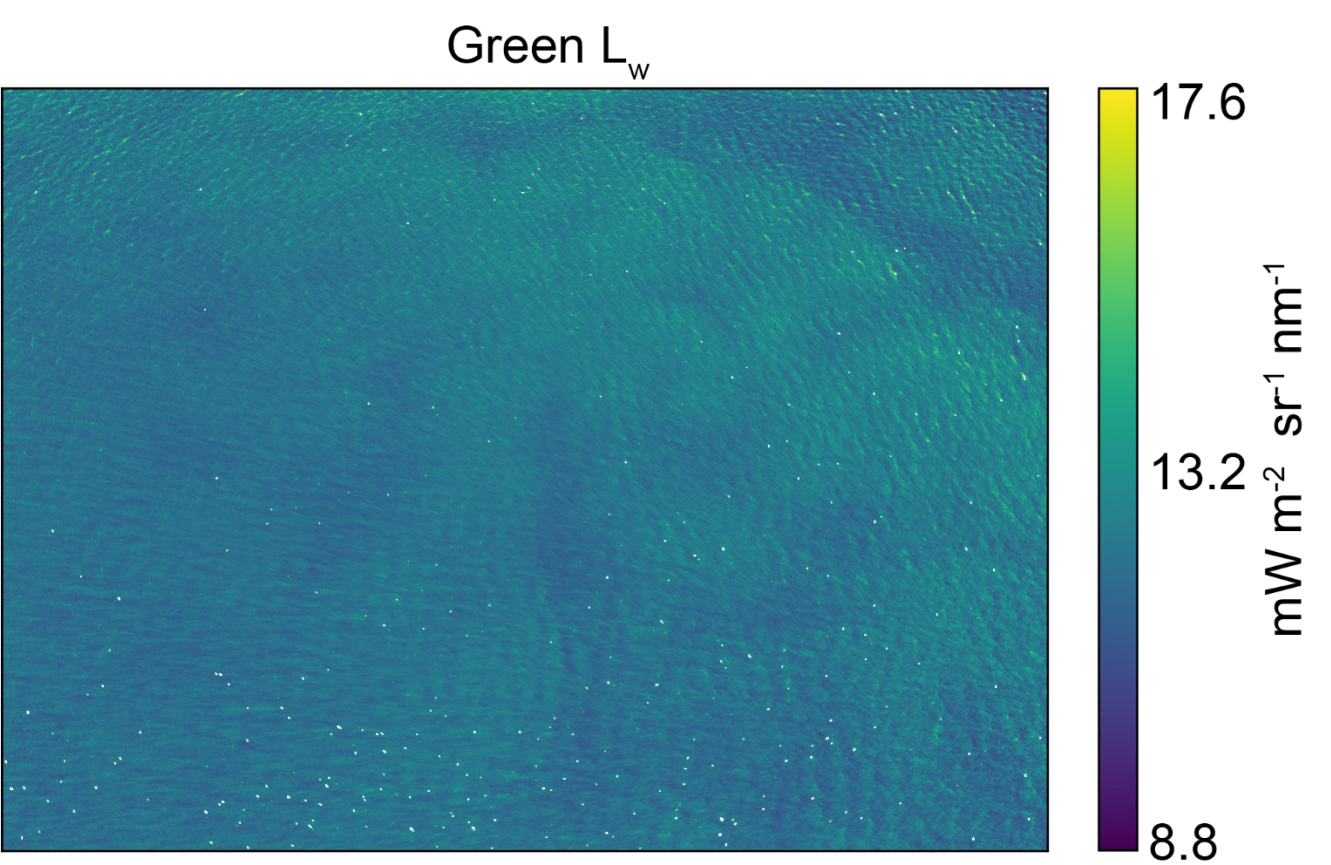
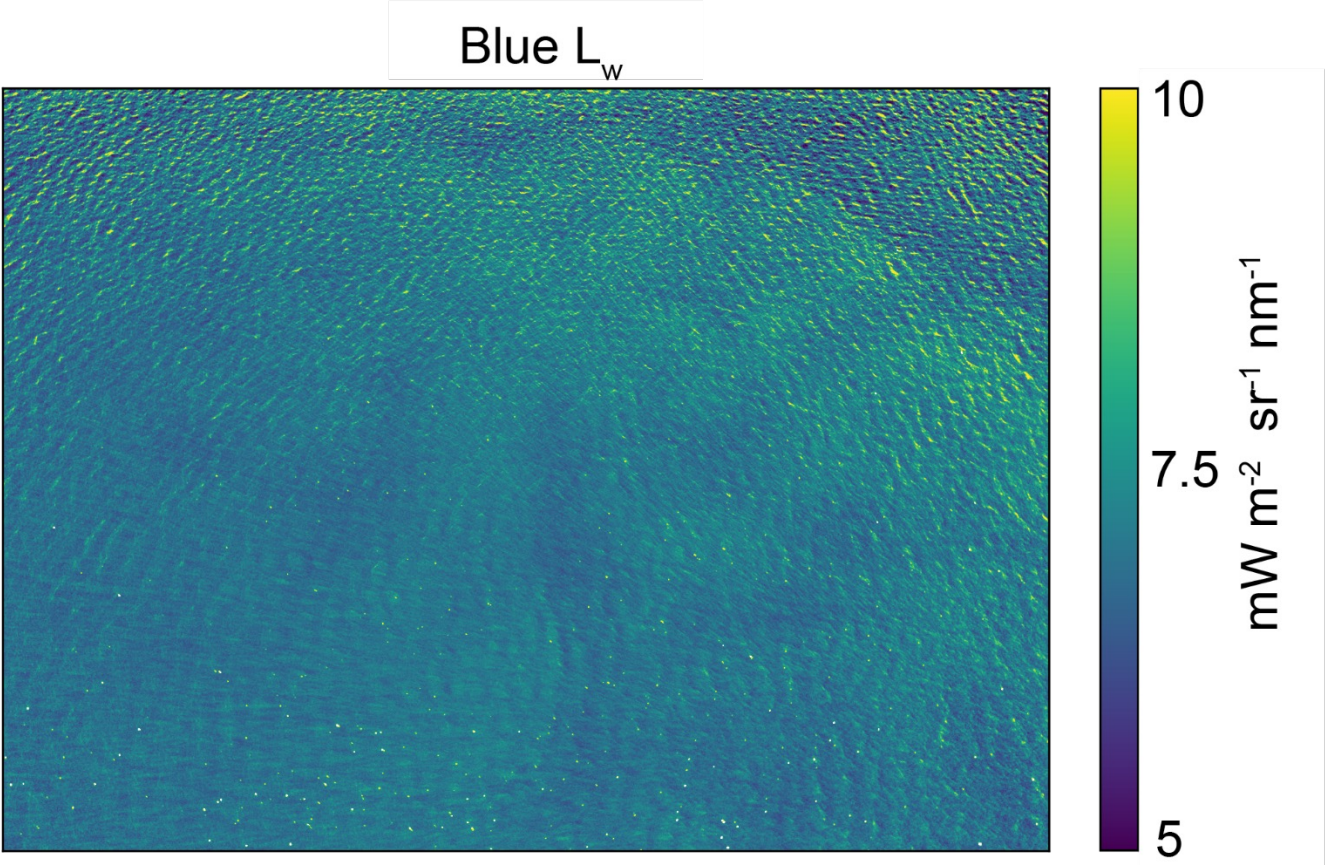
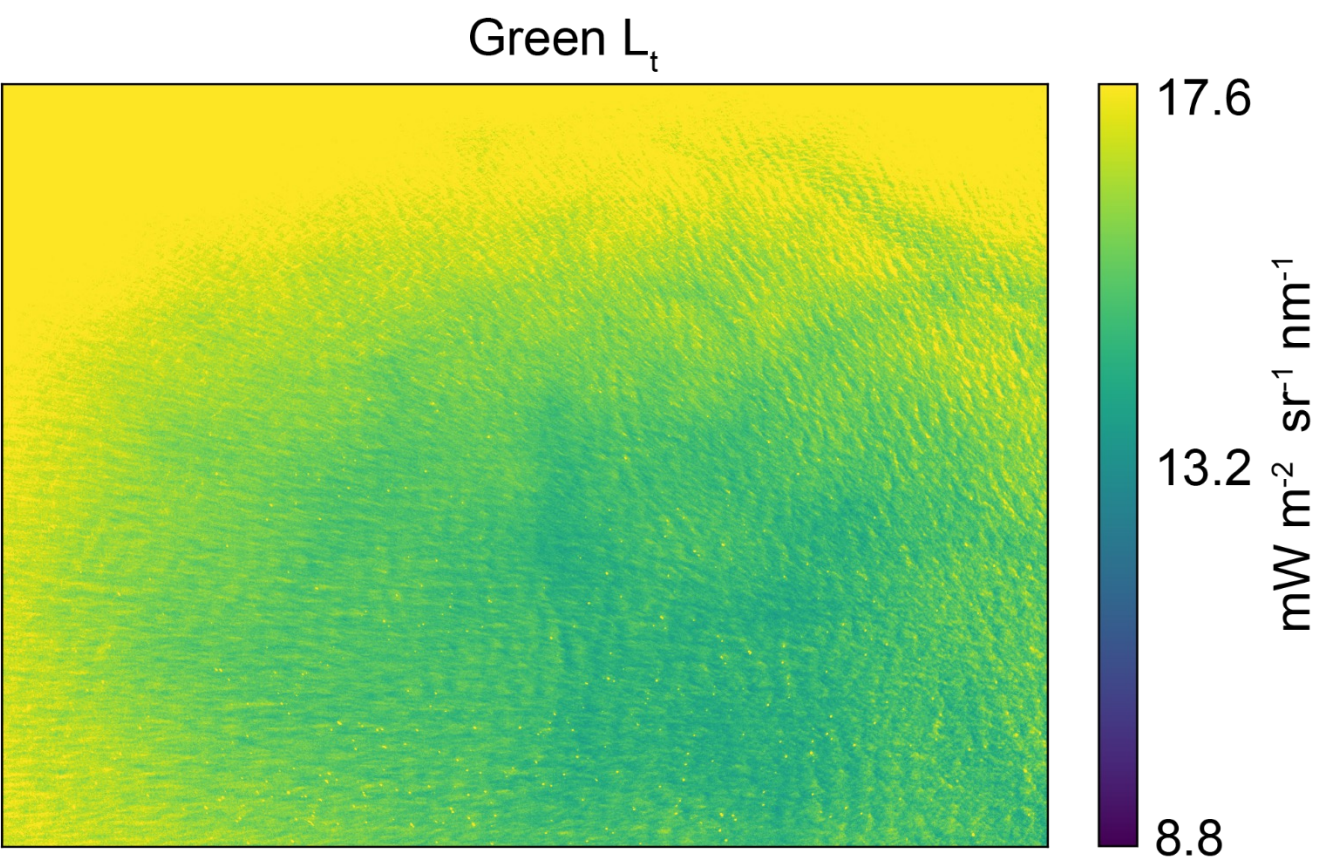
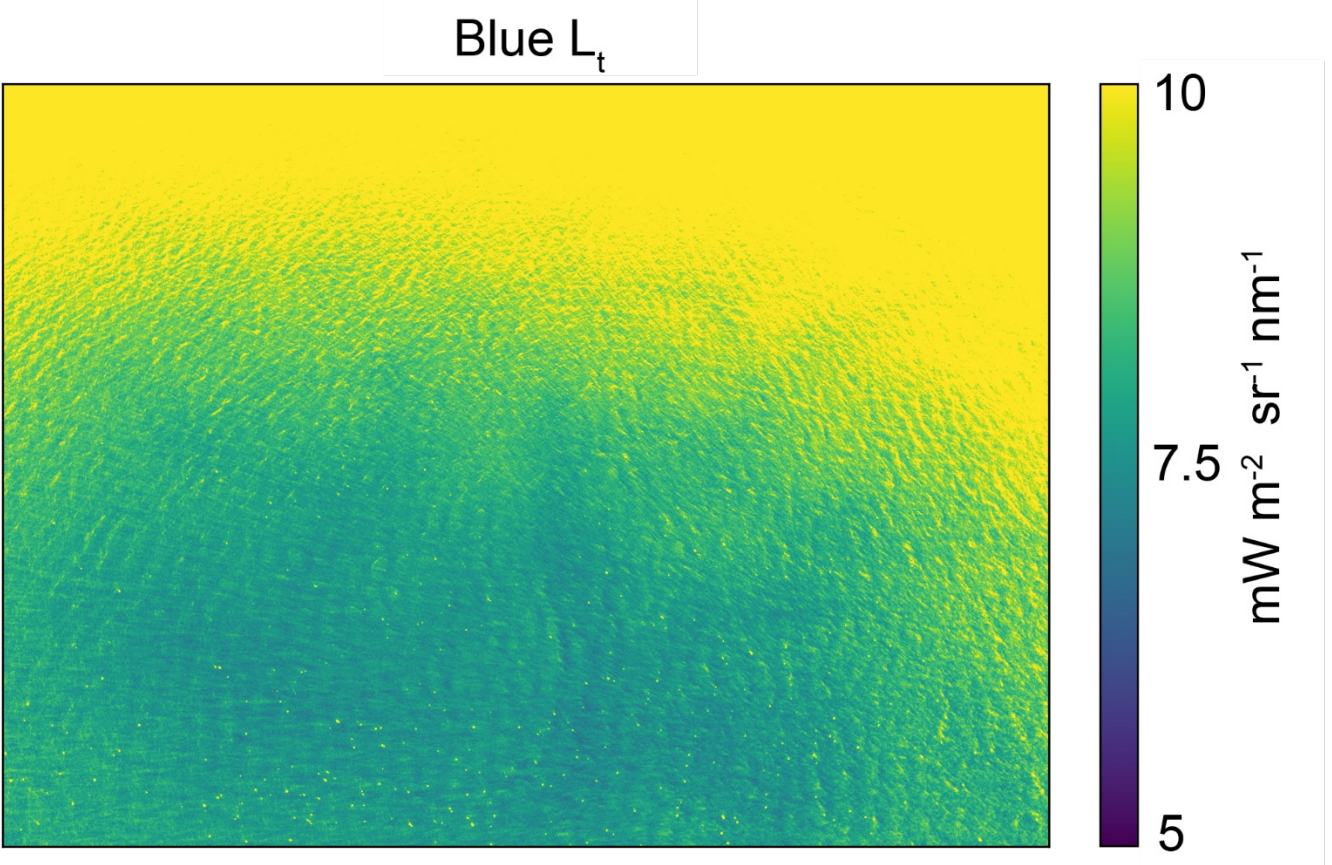
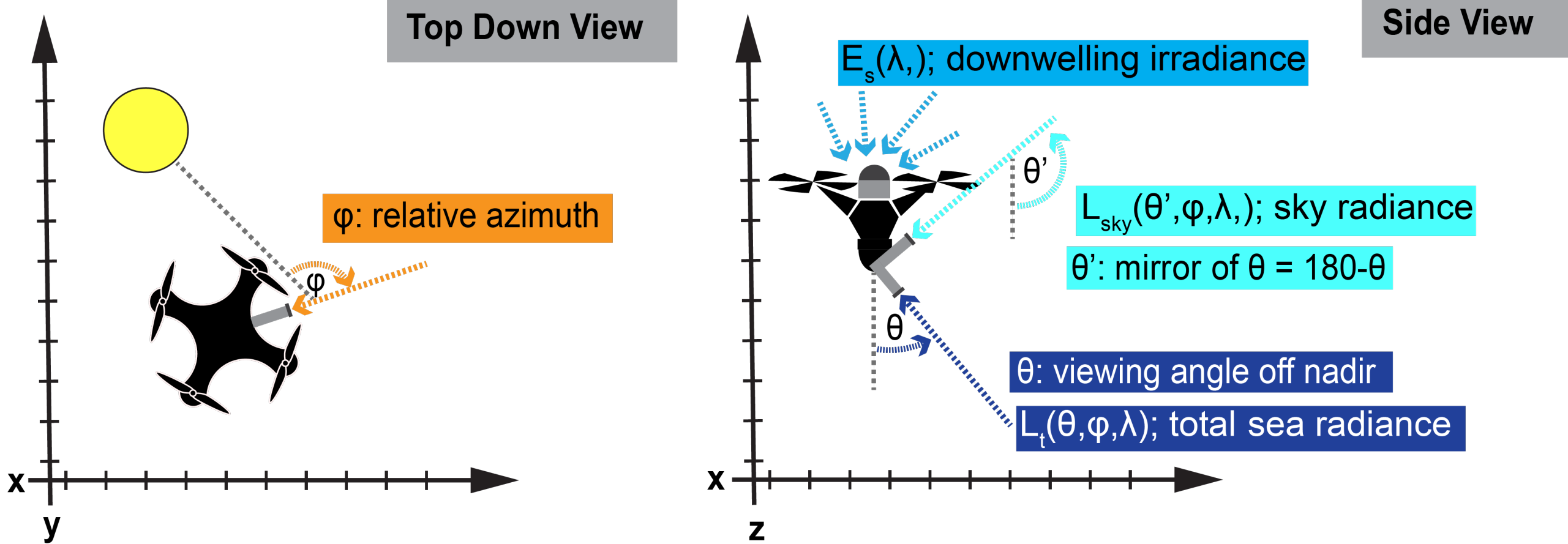






# Ocean Color

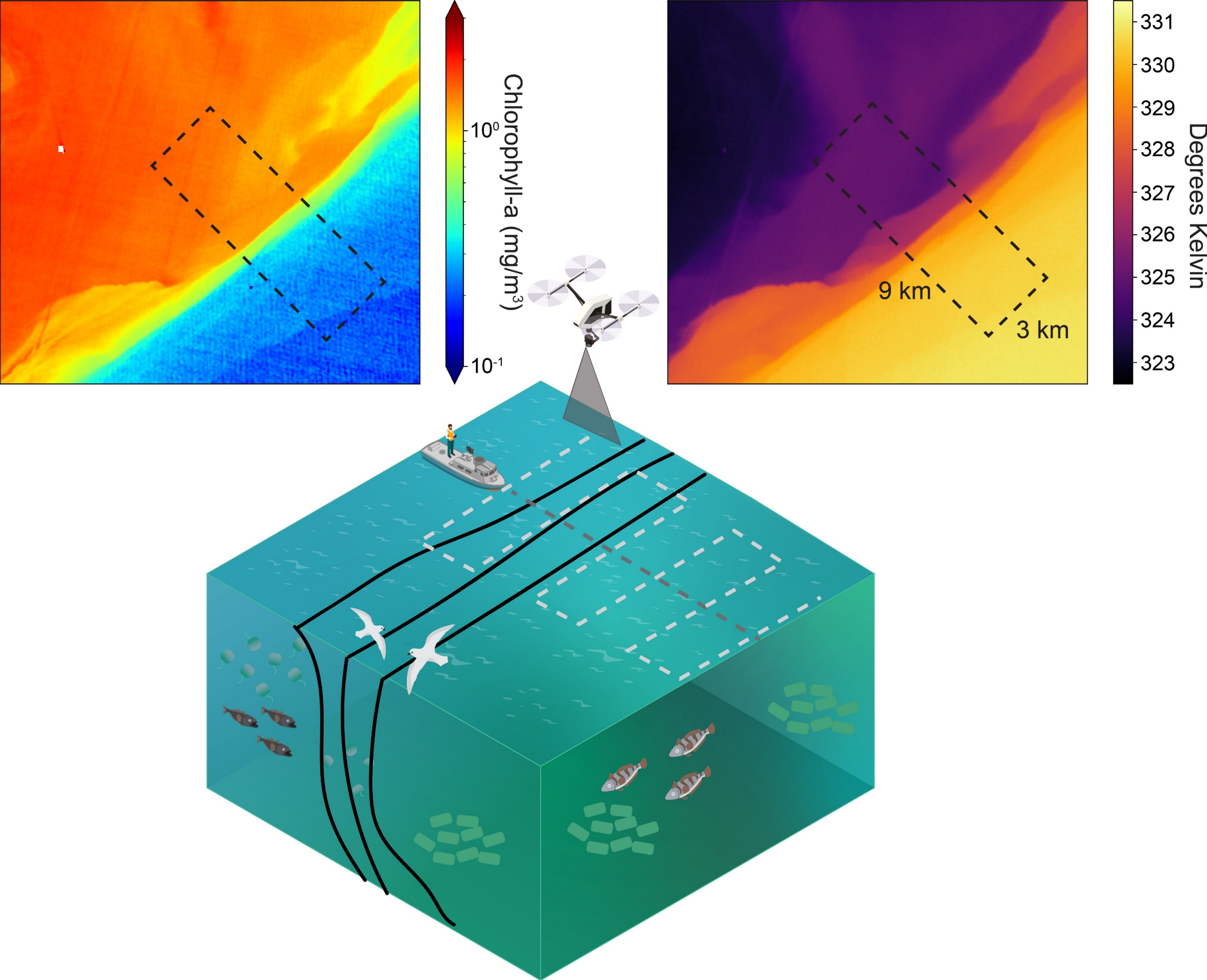
Determining proper viewing geometry and corrections for drone-based wide field of view radiometers.





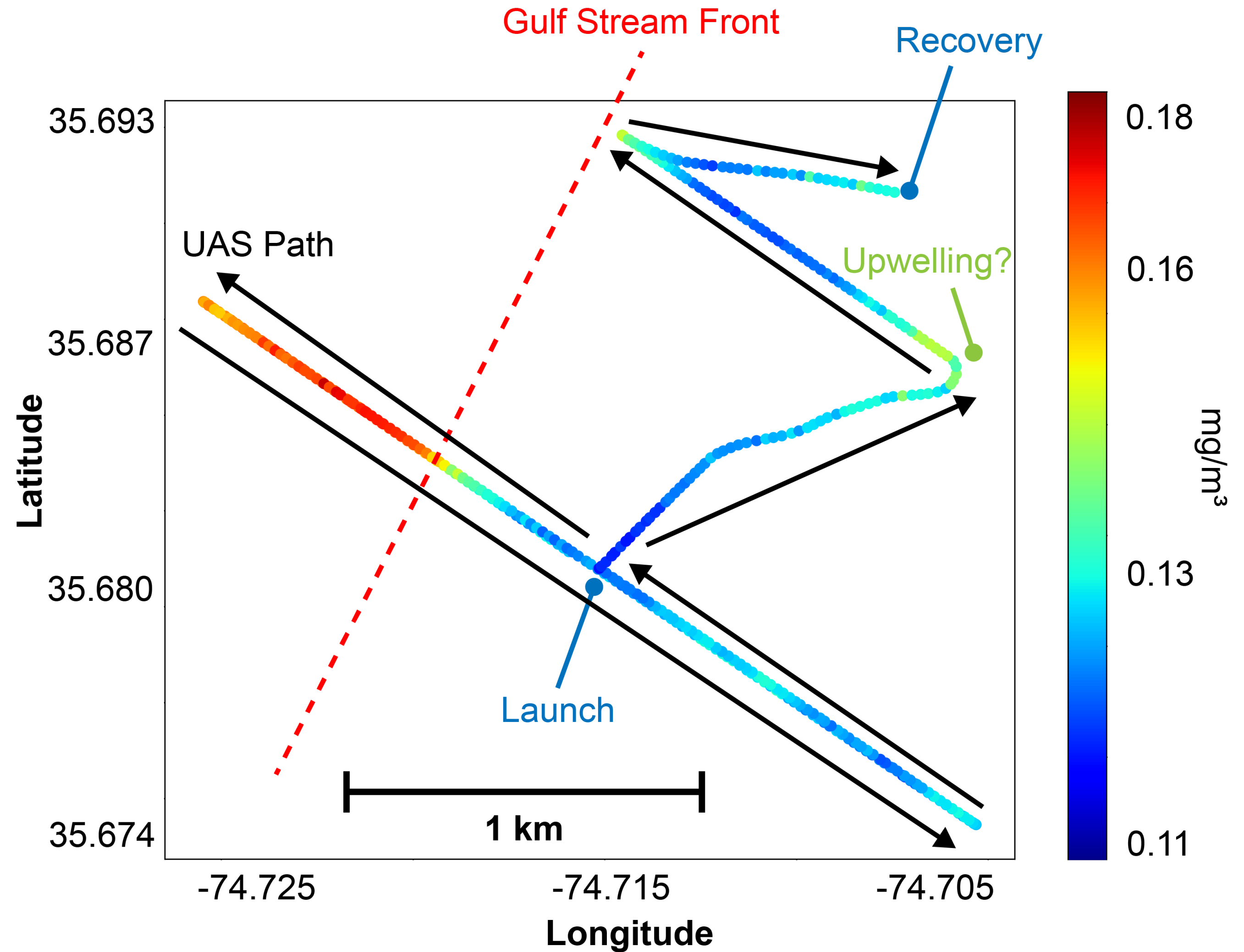
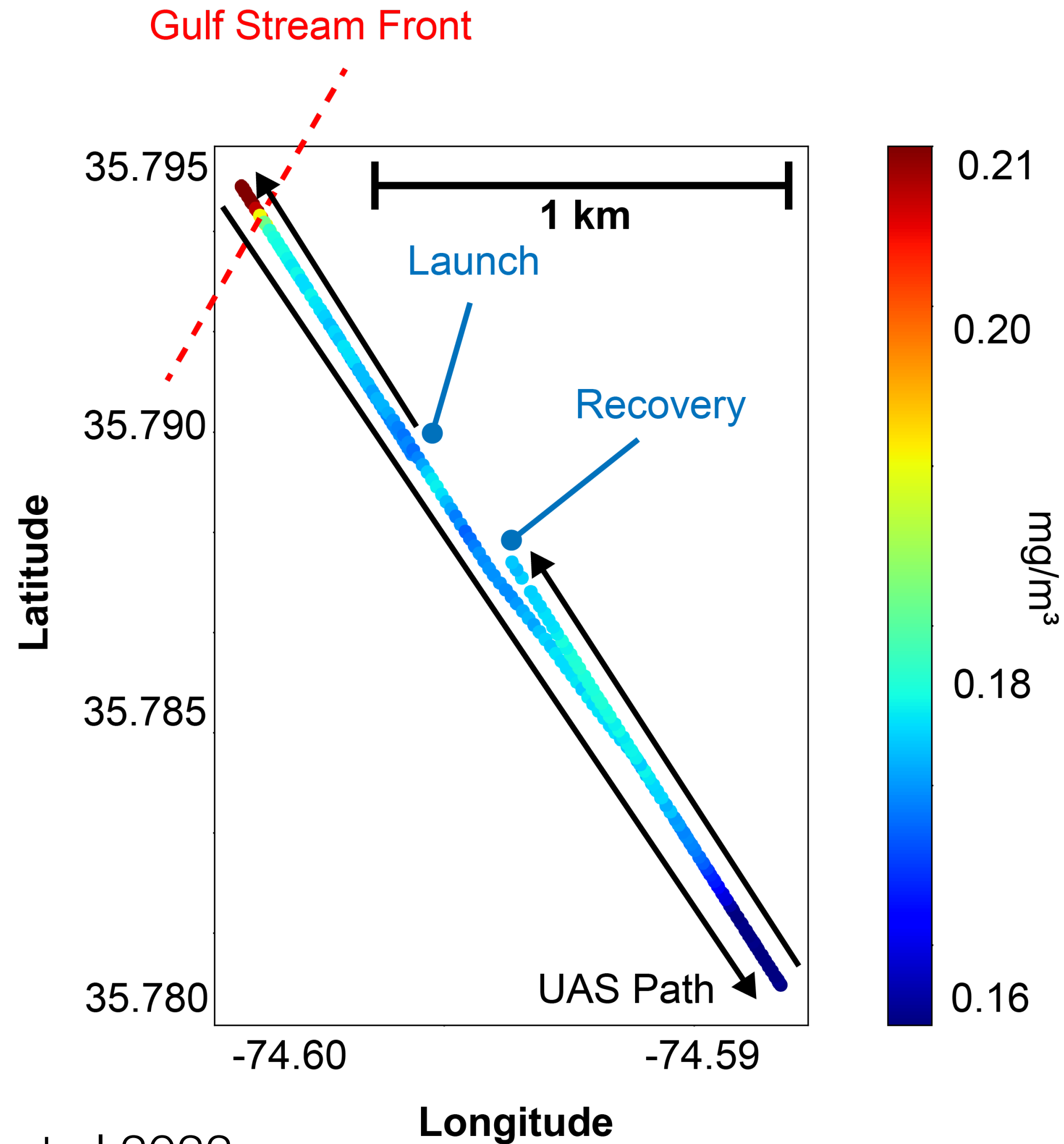
# Gulf Stream Frontal Surveys

Example of a combined drone and oceanographic vessel survey across the Gulf Stream front.

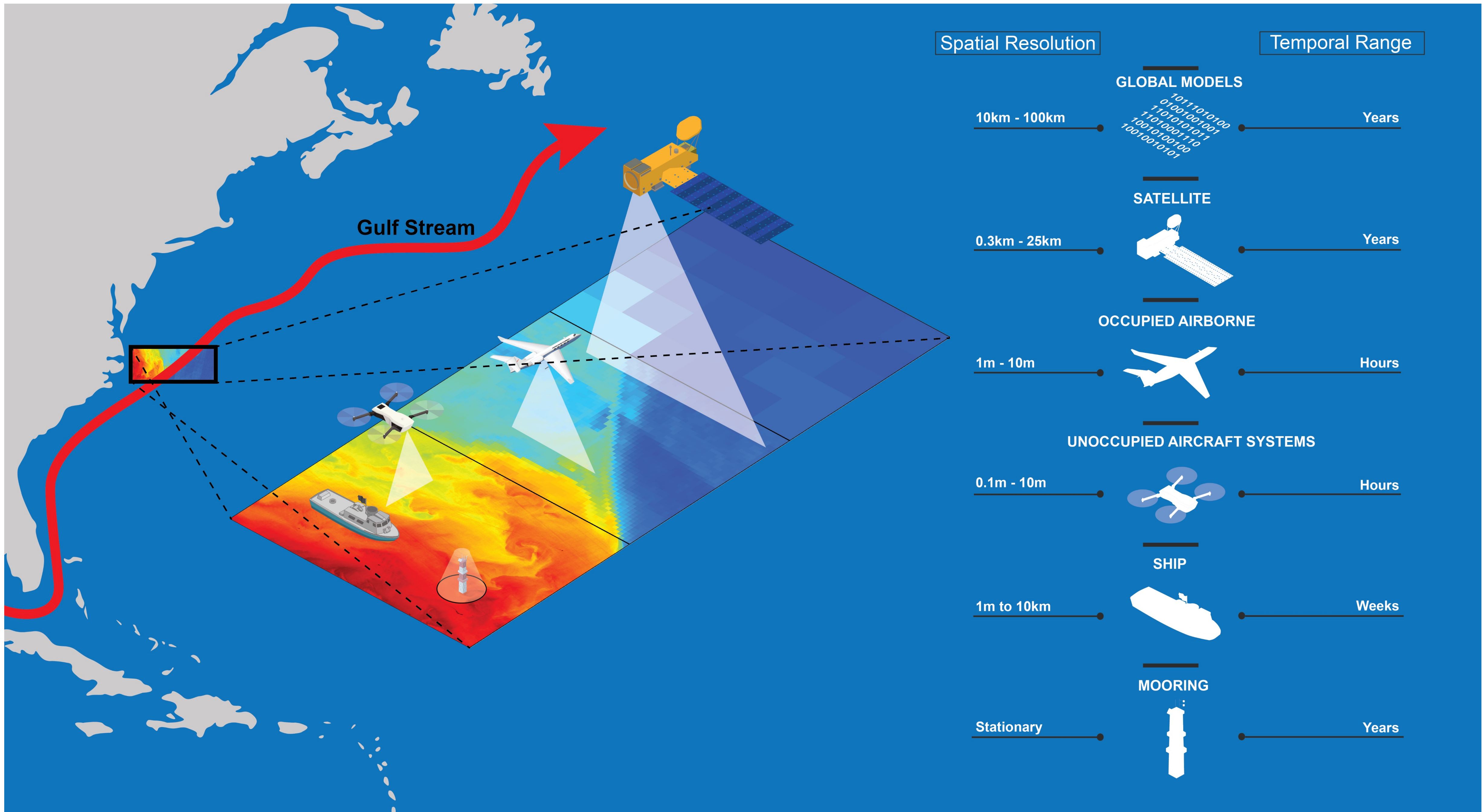




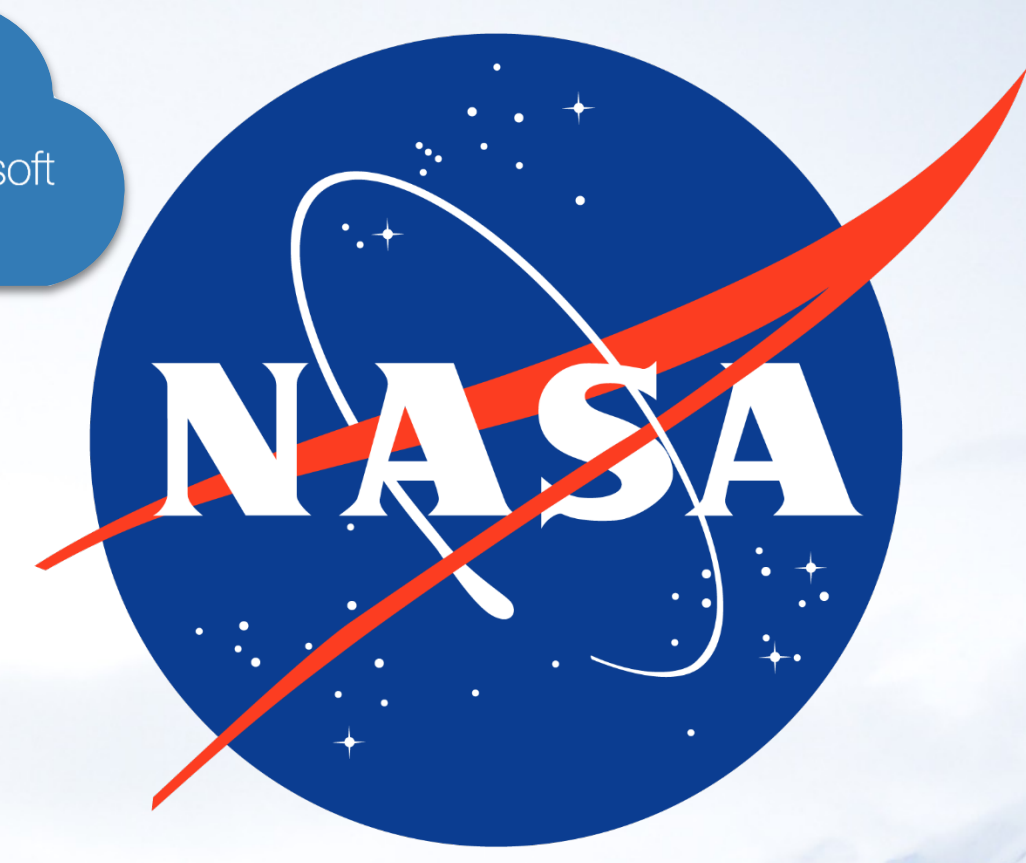
# Gulf Stream Frontal Surveys











Government of Canada







Thanks!!  
Questions?