Assessing Simulated HyspIRI Imagery for Detecting and Quantifying Coral Reef Coverage and Water Quality;

Autonomous In Situ Surveys In Support of Remote Sensing

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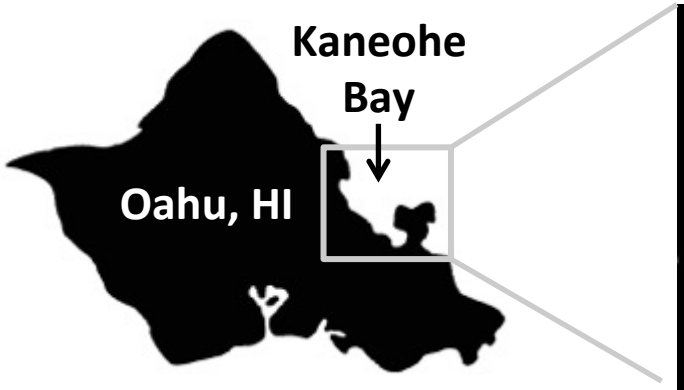
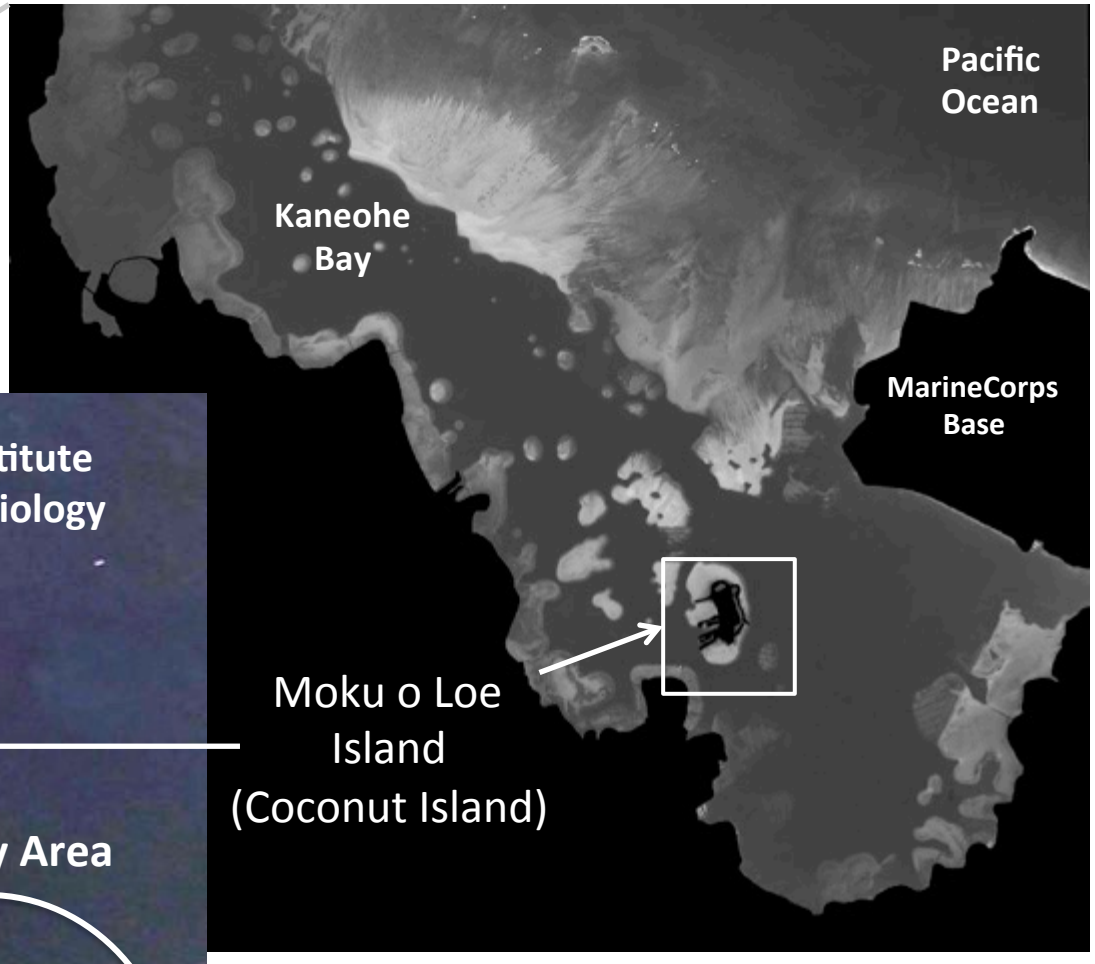
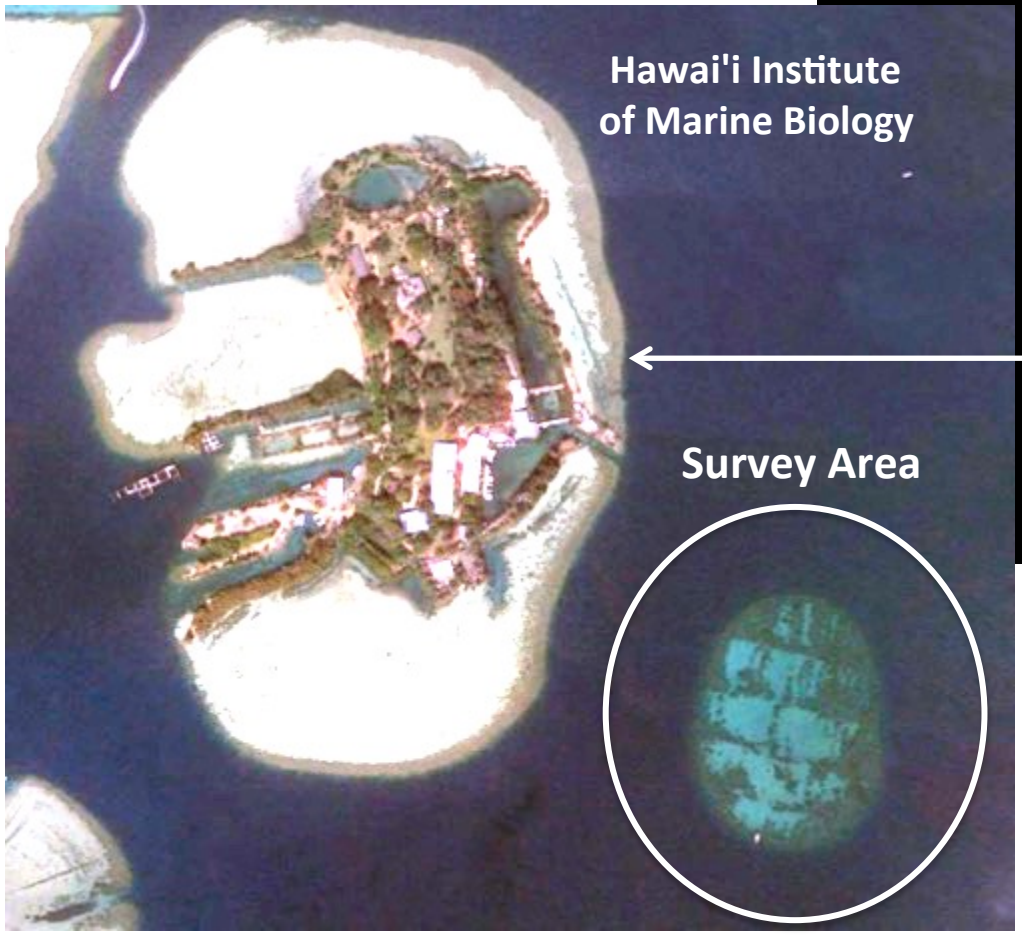
Primary Study Site

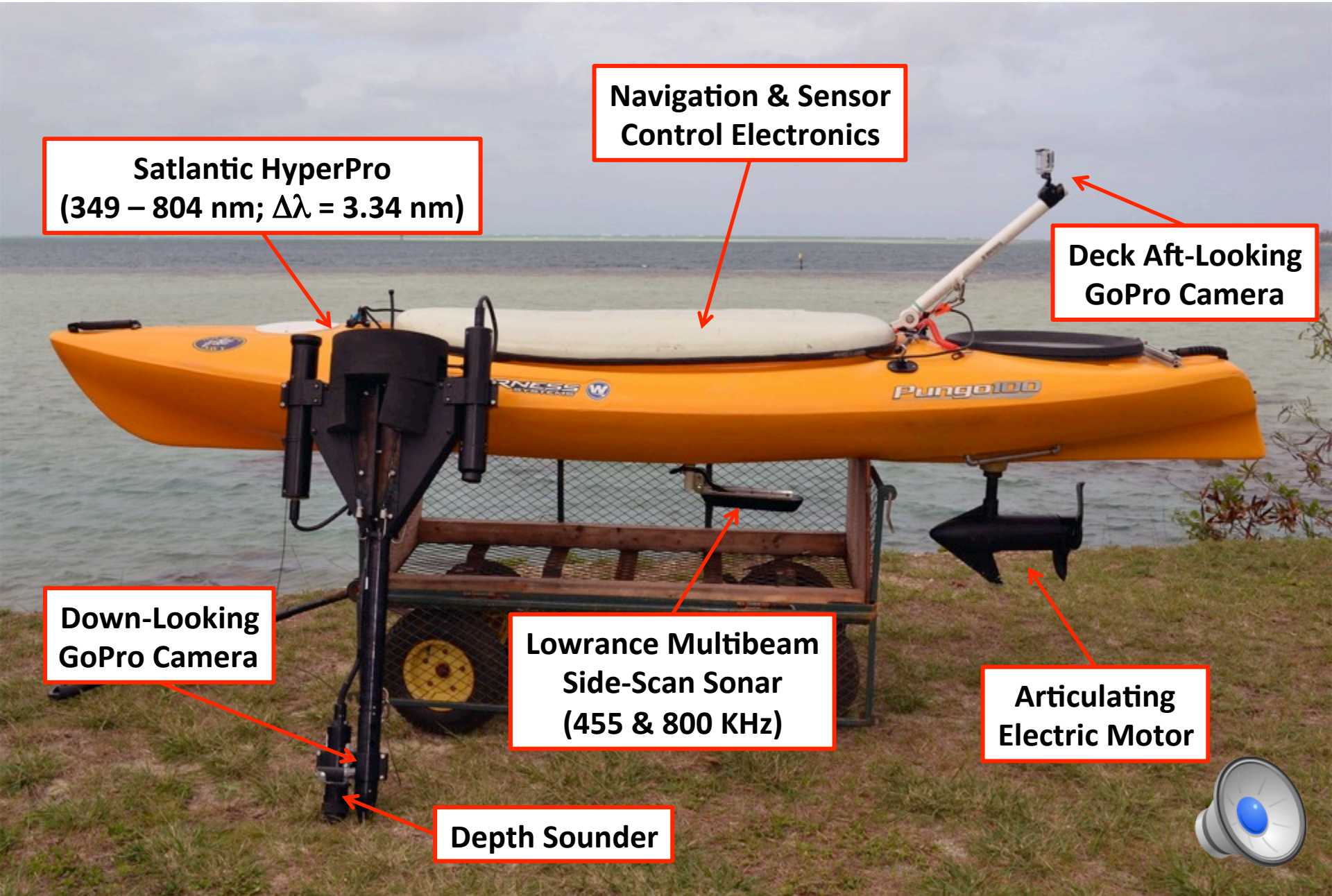




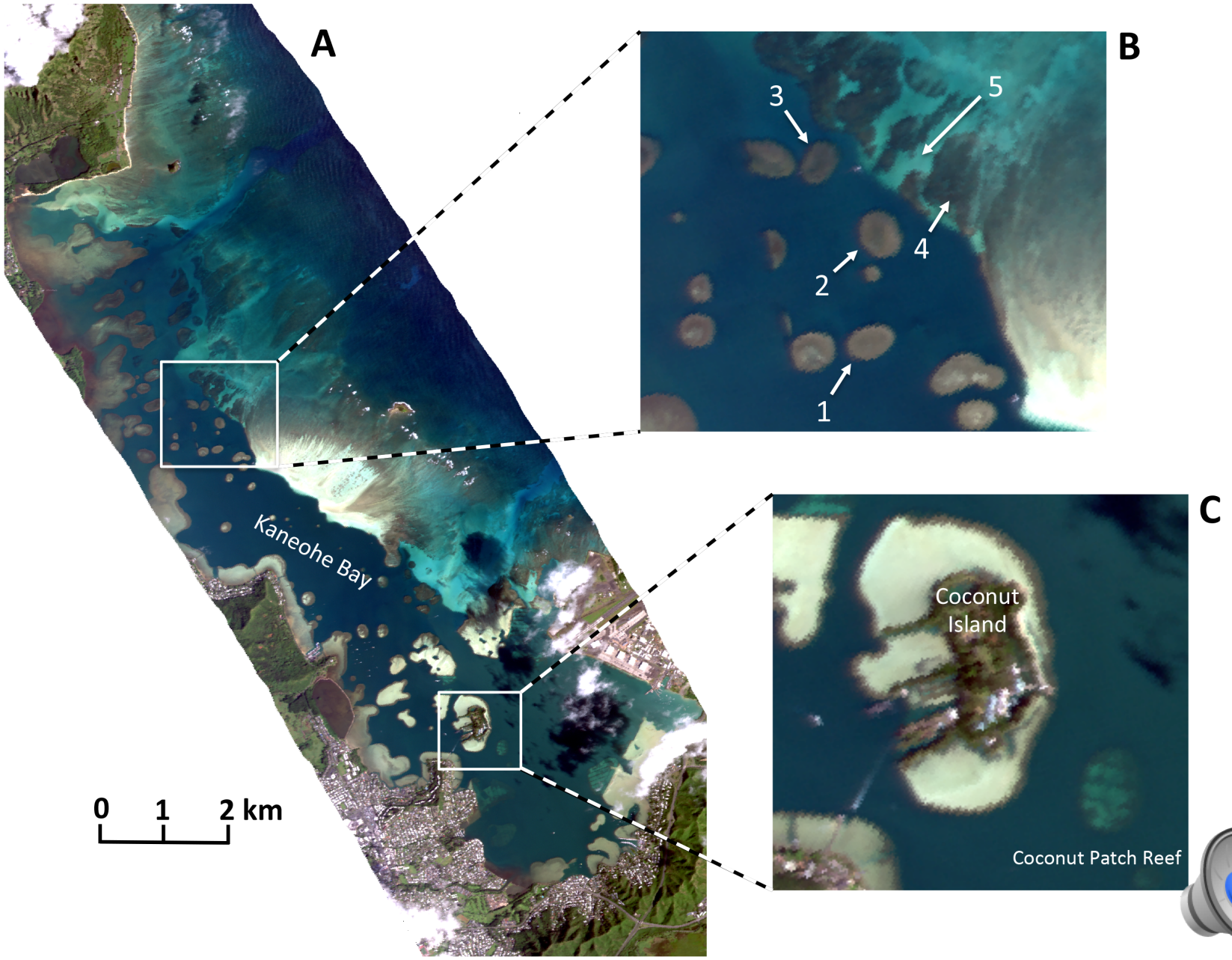


- Patch reef dredged during WWII
- Average Depth ≈ 4 m
- Reef Surveys: 12 & 18 February 20
- AVIRIS Overflights:
  Jan 27, Feb 7,8 & 22, and Ma

Autonomous Kayak and Sensors



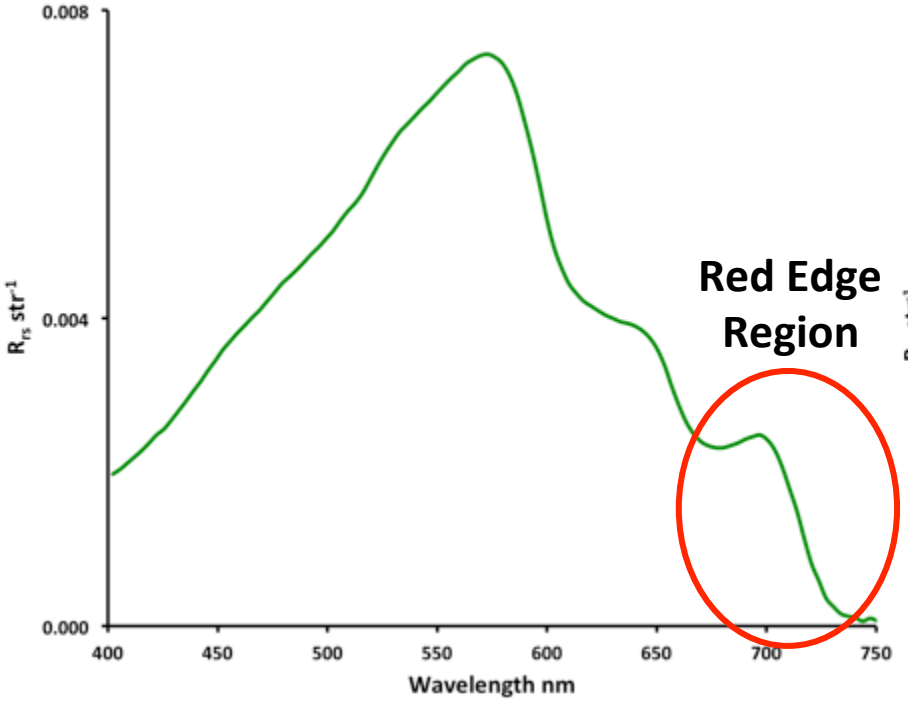
Kaneohe Bay AVIRIS Data: 3 March 2017

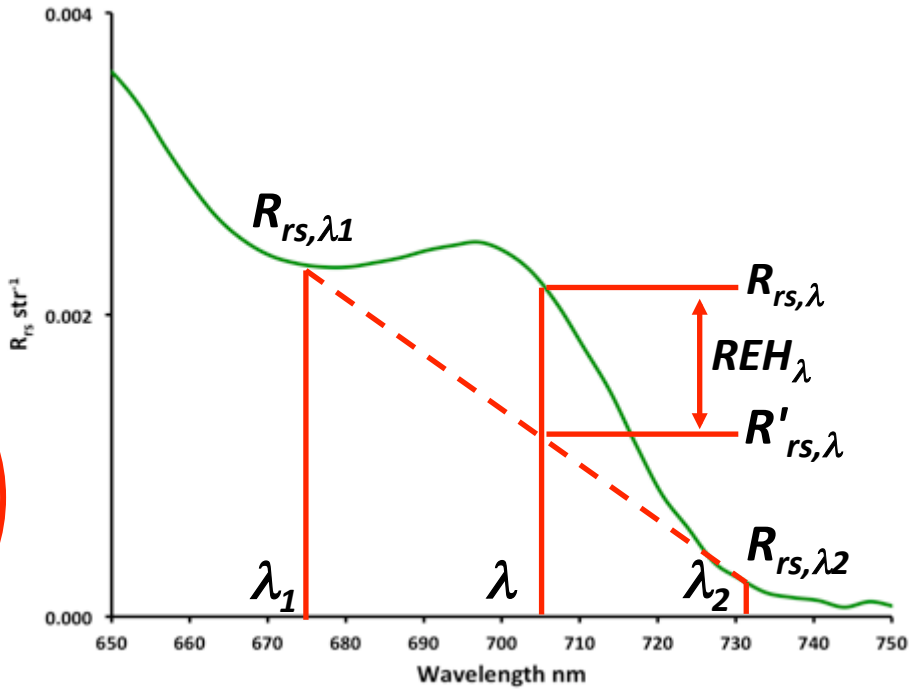


Results Reported at Biodiversity Workshop
(May 2017)

- The range of conditions represented within the autonomous data sets collected over the coconut patch reef permits many questions of consequence to remote sensing operations to be addressed compared with traditional approaches to field surveys.
- In situ reflectance was not significantly impacted by radiometer orientation or cloud cover.
- A preliminary comparison between AVIRIS and in situ reflectance is quite good in both magnitude and spectra.
- The red edge signal associated with live vegetative biomass was detected to a depth of between 3 and 4 m over healthy coral and algae.

The Red Edge Height Computation: REH_λ





$$REH = R_{rs,\lambda} - R'_{rs,\lambda}$$

$$R'_{rs,\lambda} = \frac{R_{rs,\lambda 2} - R_{rs,\lambda 1}}{\lambda_2 - \lambda_1} \bullet (\lambda - \lambda_1) + R_{rs,\lambda 1}$$

$\lambda_1 = 675$ nm; $\lambda_2 = 740$ nm

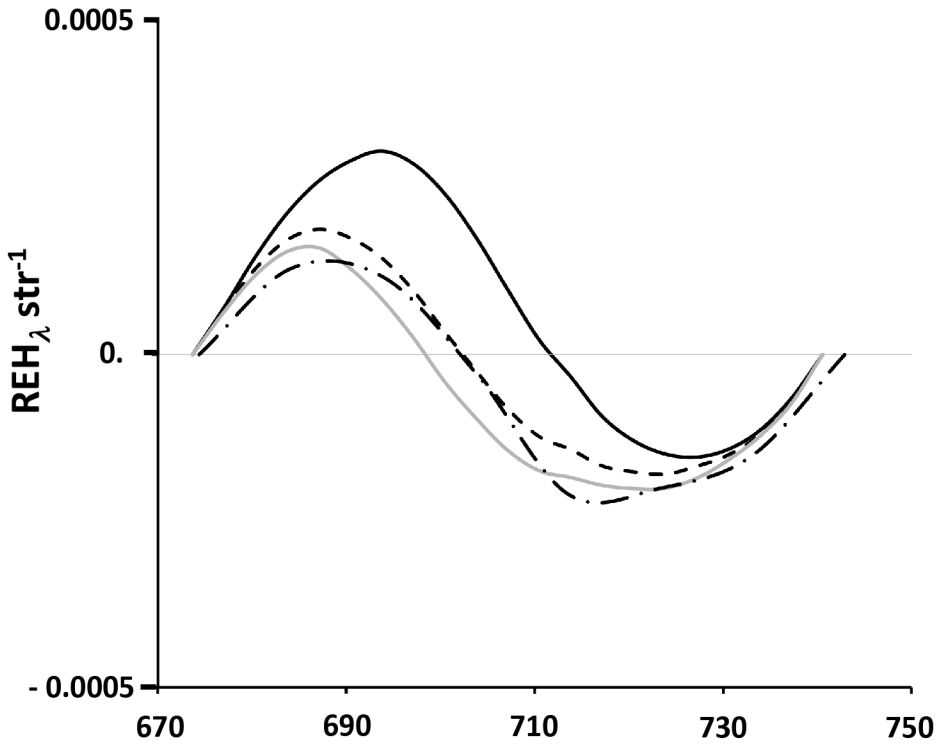
Red Edge Height

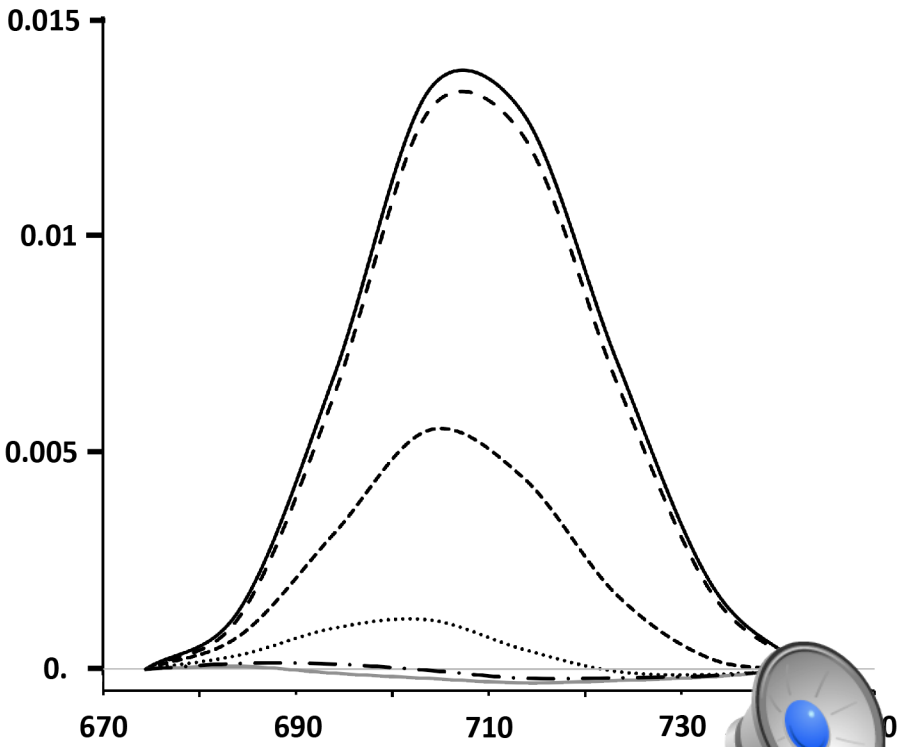
ASV Survey
(Coconut Patch Reef)

- Coral: D = 2 – 3 m
- Coral: D = 3 – 4 m
- Coral (AVIRIS): D = 2 – 5 m
- Sand: D = 3.5 – 4.5 m

AVIRIS Image
(Northern Kaneohe Bay Patch Reefs)

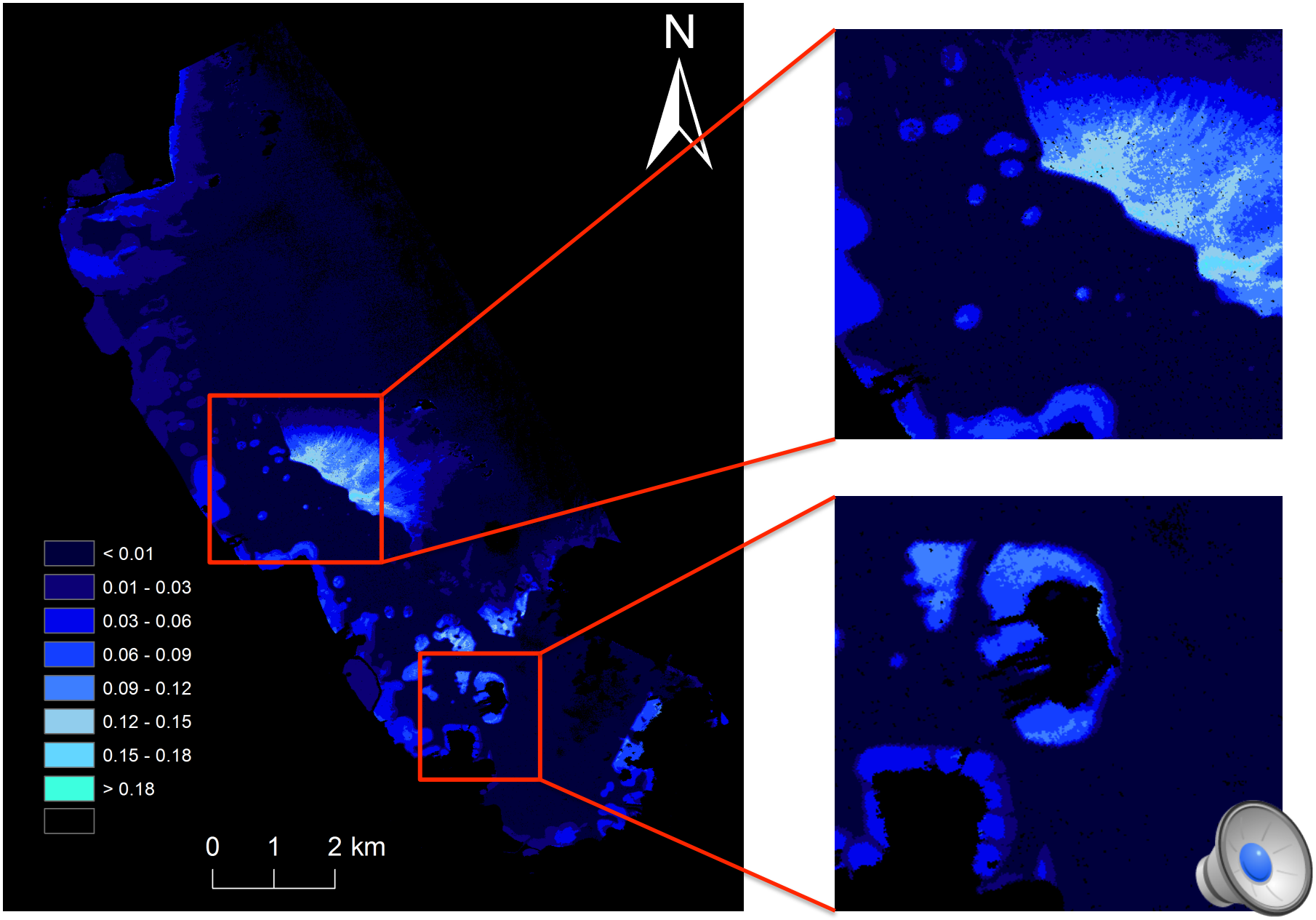
- Patch Reef (1)
- Patch Reef (2)
- Patch Reef (3)
- Patch Reef (4)
- Sand (5)
- Coconut Patch Reef





Wavelength nm

AVIRIS REH_{705}: Kaneohe Bay, 3 March 2017



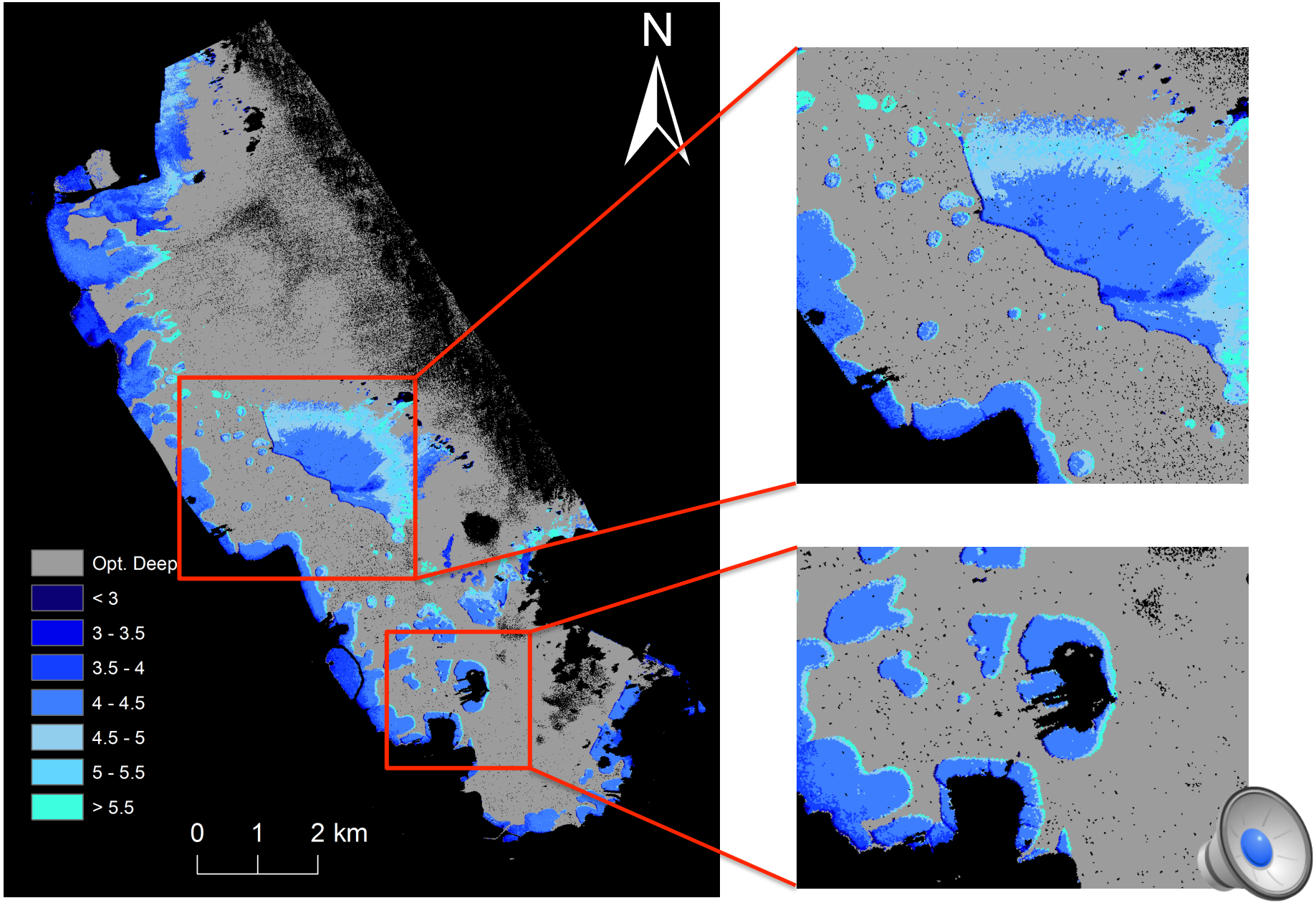
Normalized Red Edge Height: REH_N

$$REH_{N,\lambda} = REH_{\lambda} / R'_{rs,\lambda o}$$

$$REH_{\lambda o} = R_{rs,\lambda o} - R'_{rs,\lambda o}$$

$$R'_{rs,\lambda o} = \frac{R_{rs,\lambda 2} - R_{rs,\lambda 1}}{\lambda_2 - \lambda_1} (\lambda_o - \lambda_1) + R_{rs,\lambda 1}$$

AVIRIS REH_N: Kaneohe Bay, 3 March 2017

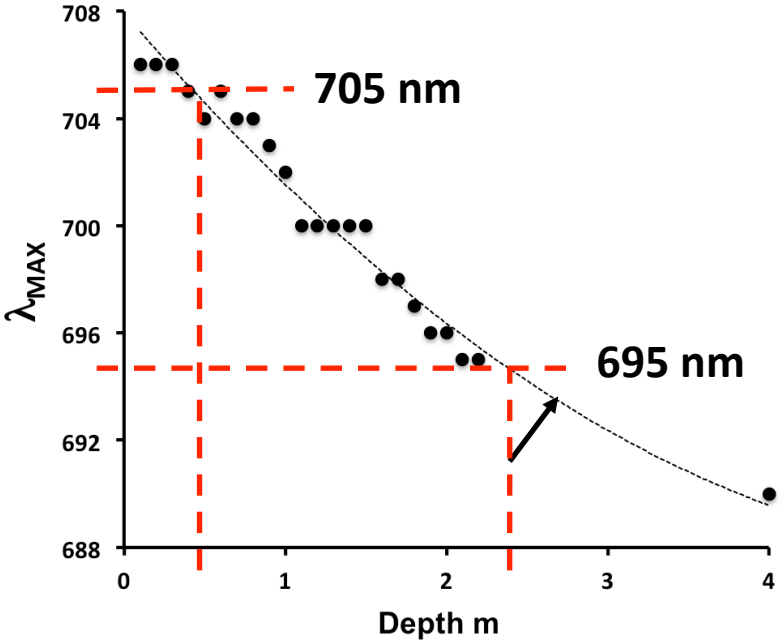


Maximum REH_N Wavelength, λ_{MAX}

Model

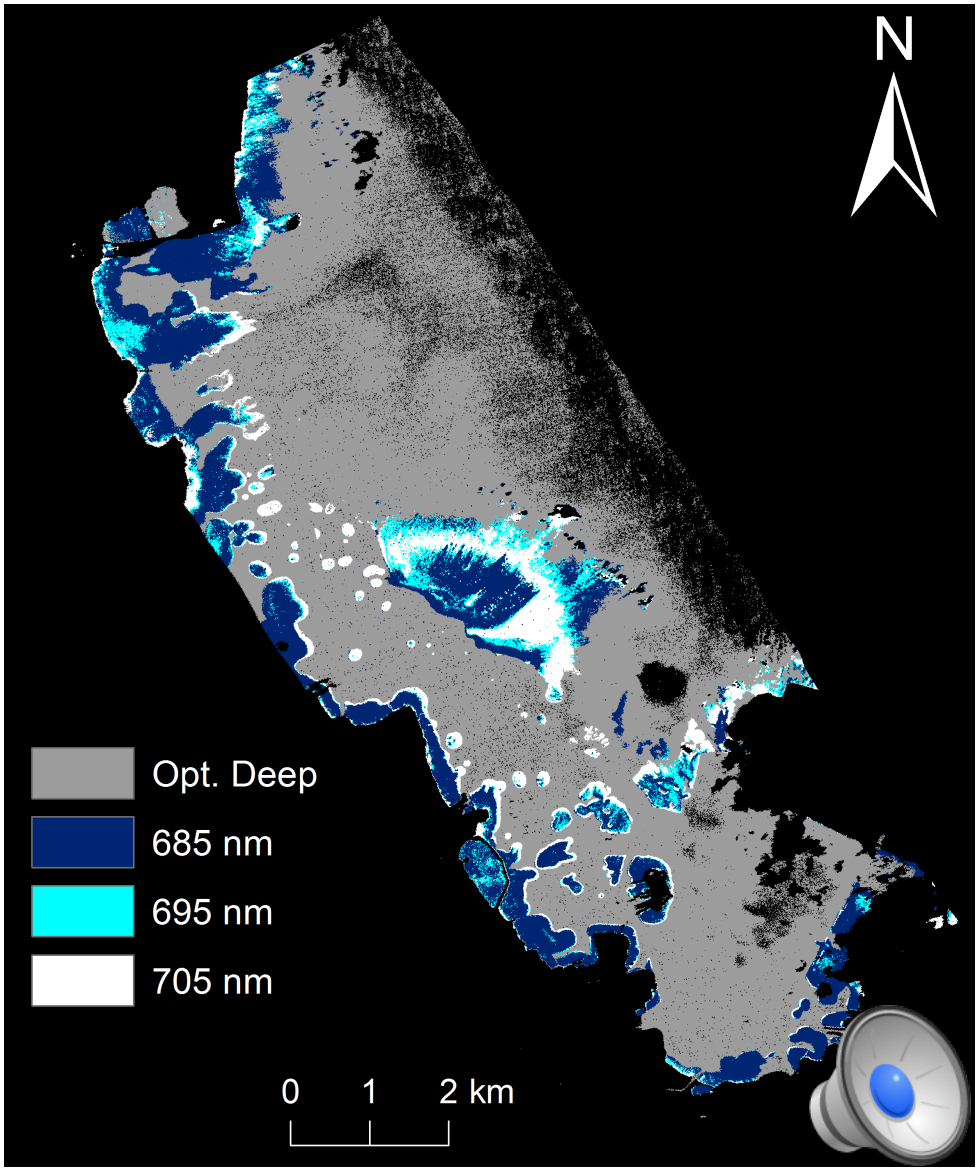
$$R_w = R_{od}\,(1 - e^{-KD}) + \frac{\rho_b}{\pi} e^{-KD}$$

R_w = water column reflectance
R_{od} = optically deep water
D = water depth (m)
$K = K_d + K_u$
ρ_b = Bottom reflectance



$$D = 0.64\,\lambda_{MAX}^2 - 6.77\,\lambda_{MAX} + 707.72$$

AVIRIS



Conclusions

- The red edge signal, characteristic of live vegetation, can be detected from shallow coral and alga.
- In situ sensors can detect the REH signal to a depth of between 3 m and 4 m, but AVIRIS appears to be more limited in the range of detection depth.
- Normalizing the REH signal to the baseline reflectance appears to mitigate anomalously high signals over highly reflective substrates.
- The wavelength of maximum REH decreases with increasing water depth and AVIRIS determinations tend to match reality where REH signals are large.
- The REH signal indicates the presence of live, vegetative biomass, but does not discriminate between vegetation type.

frontiers in Marine Science (in press)

Autonomous Coral Reef Survey in Support of Remote Sensing

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Thank You!