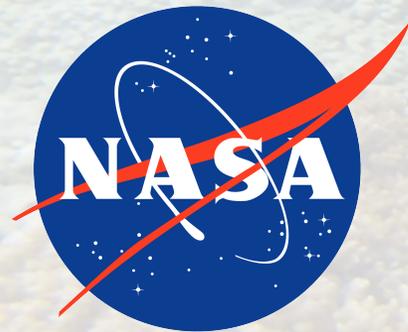


Using HypSIRI to Identify Benthic Composition and Bleaching in Shallow Coral Reef Ecosystems



Tom Bell
PIs: Kyle Cavanaugh & Gregory Okin



Overarching Question & Tasks

Will the spectral and spatial characteristics of HypsIRI-like data allow for the accurate retrieval of reef benthic composition, including bleached coral?

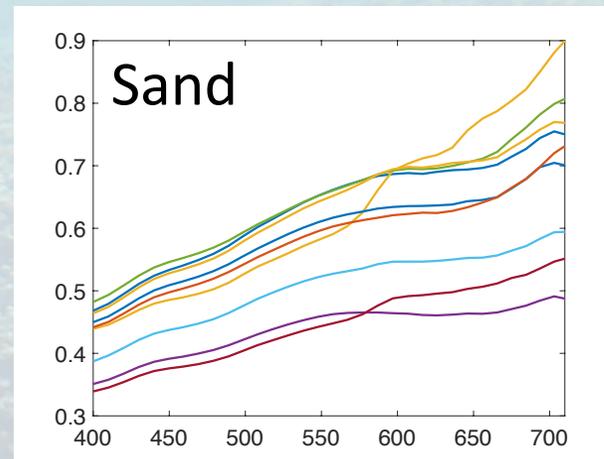
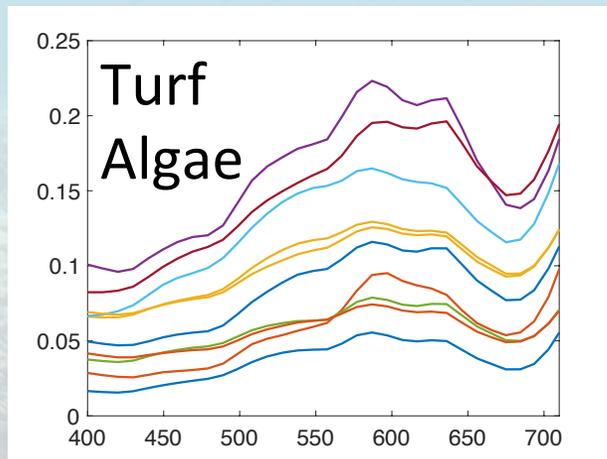
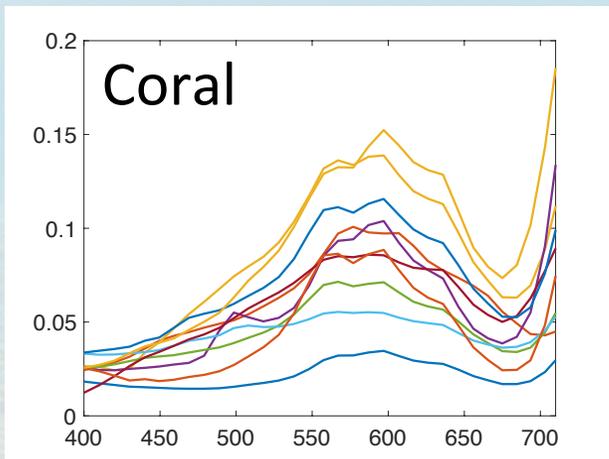
1. **Simulation analysis** to characterize the practical limits of discrimination of coral reef benthic composition.
2. **Validation** of benthic fractions from AVIRIS imagery using field observations.

Questions – Simulation Analysis

- What is the minimum fraction of live coral detectable under various water column conditions?
- Which benthic types are difficult to discriminate?
- Under what conditions can we expect good benthic discrimination – what are the no-go conditions?

Answer these questions by examining errors related to unmixing, water conditions, inversion modeling, and atmospheric effects.

Multiple Endmember Spectral Mixing Analysis (MESMA)

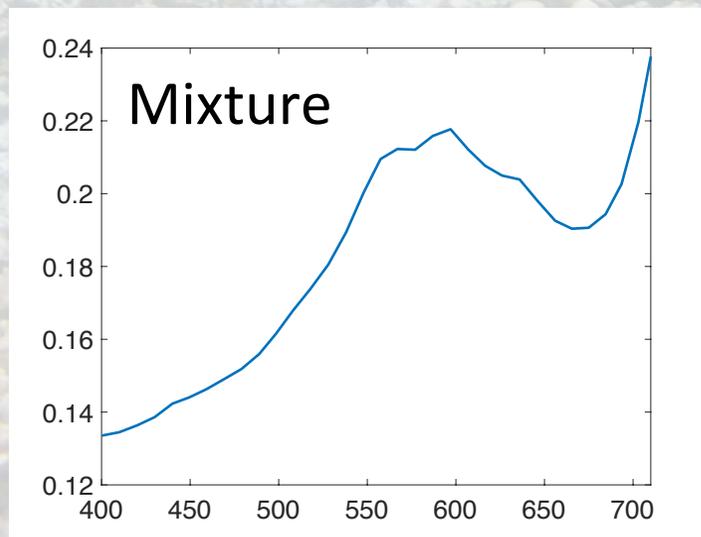


1/10 endmembers

1/10 endmembers

1/10 endmembers

Each Mixture Modelled w/
1000 Endmember
Combinations



Mixtures including:

Live Coral

Bleached Coral

Sand

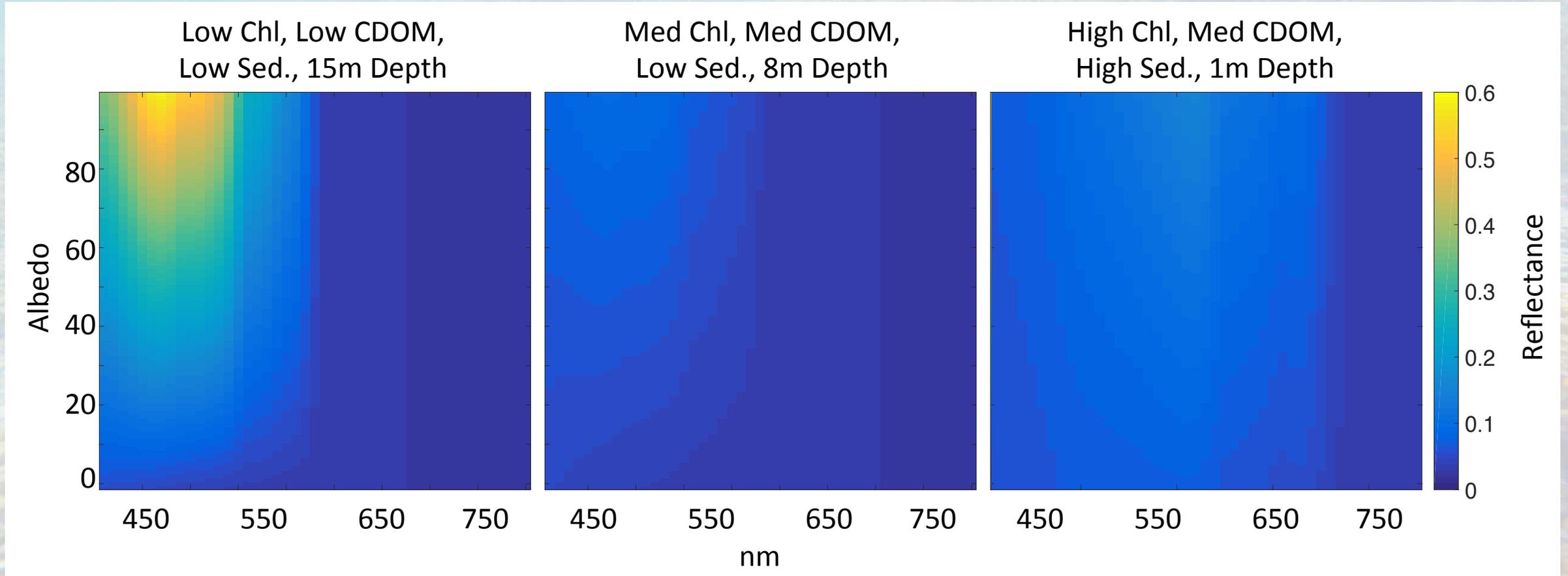
Algae (Turf, Brown, Green, Red, CCA)

Error Due to MESMA Unmixing

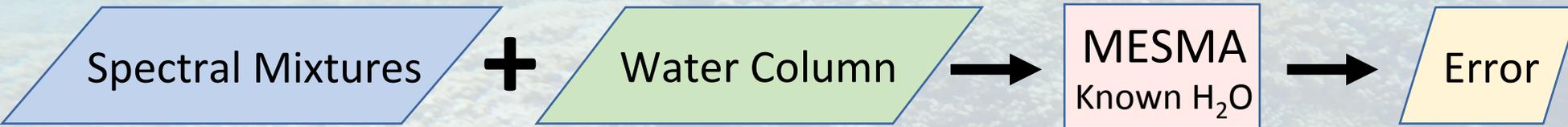


Changes in Reflectance Due to Water Properties

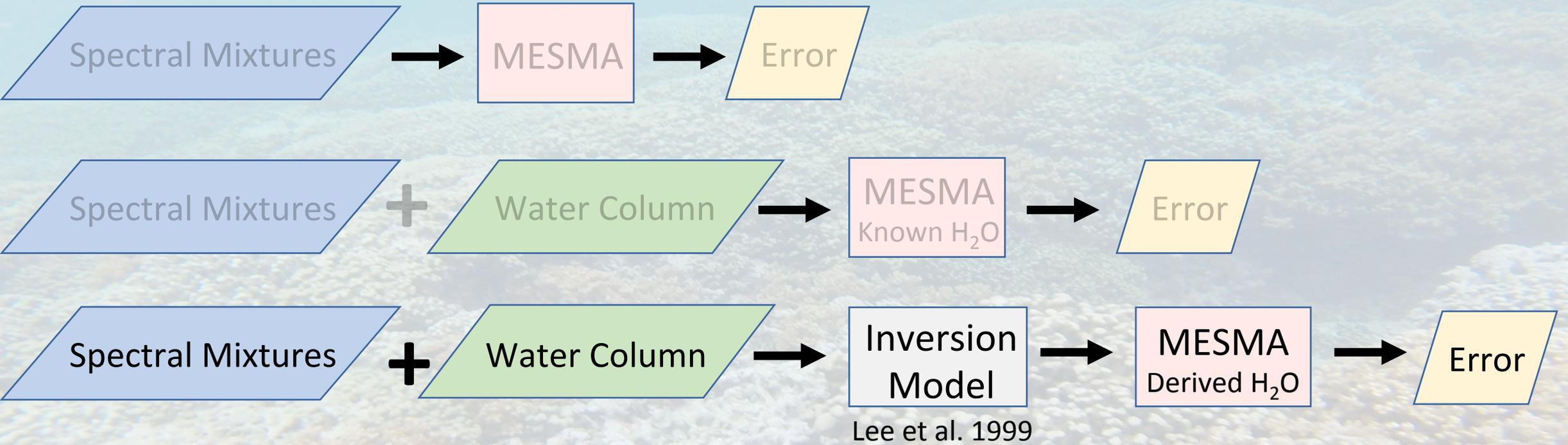
4375 Water Columns



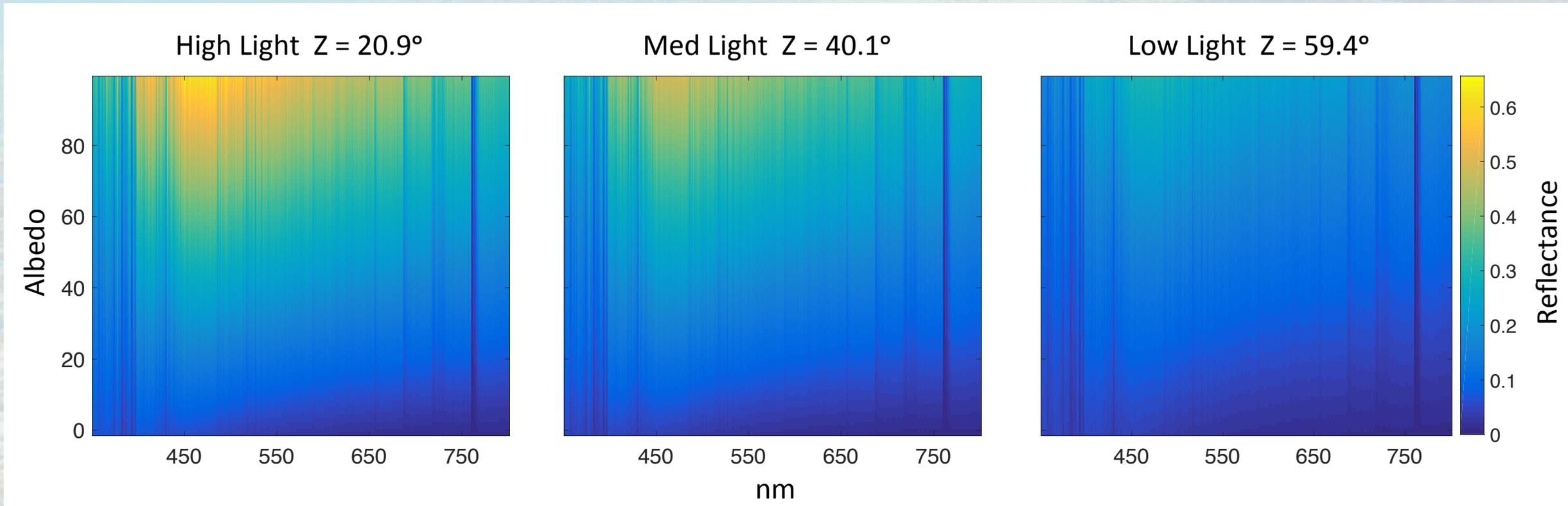
Error Due to Water Column



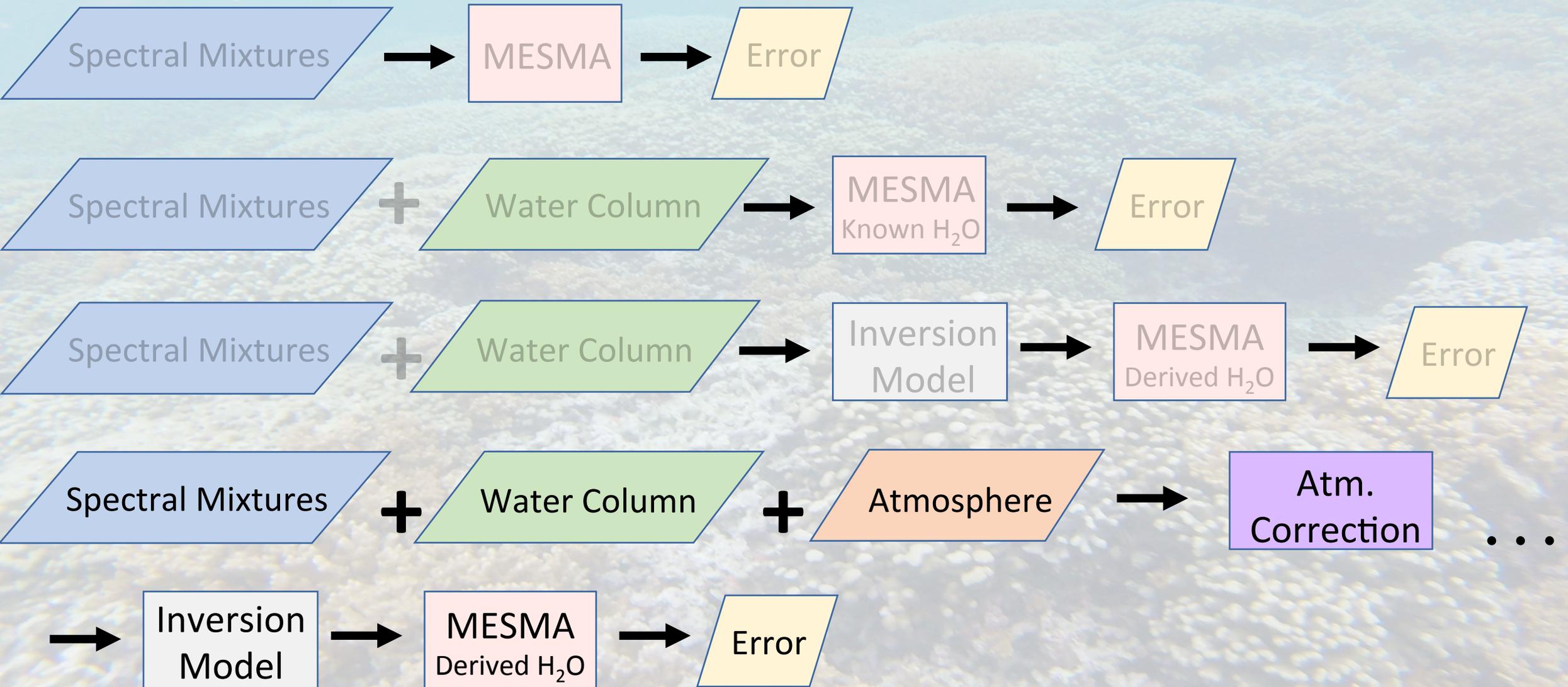
Error Due to Inversion Model



Atmosphere at 3 Solar Zenith Angles

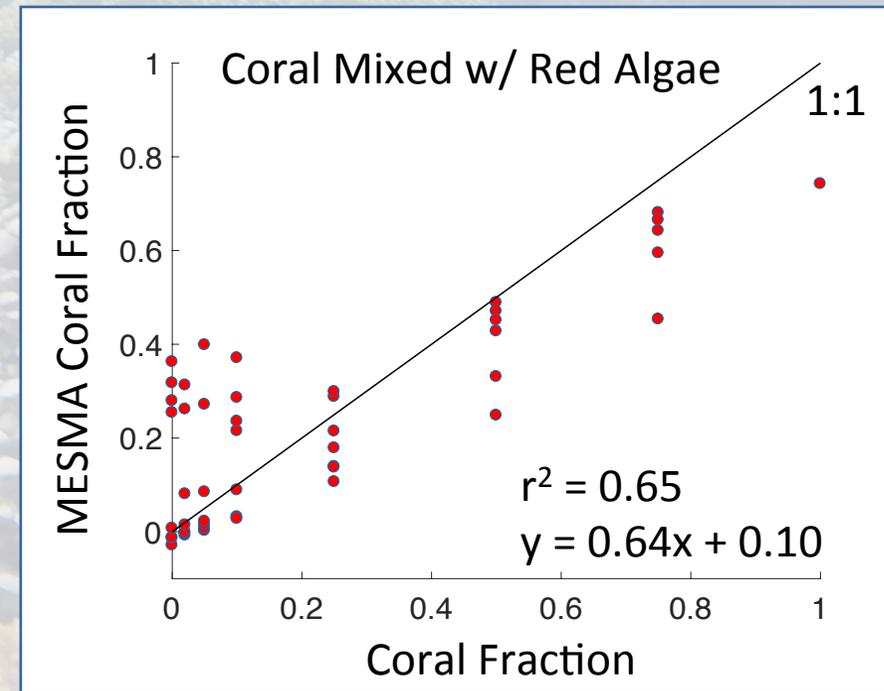
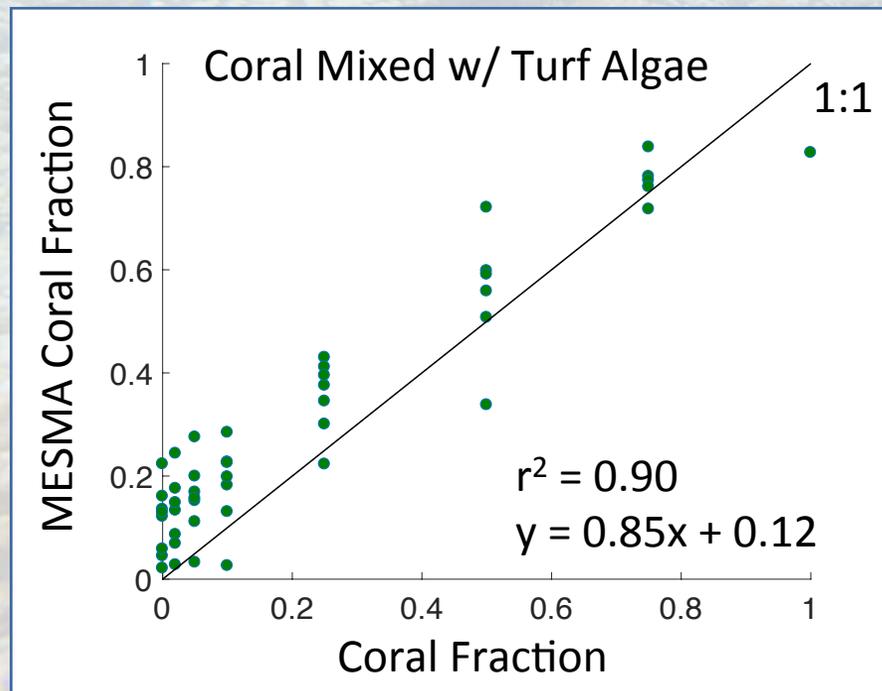


Error Due to Atmospheric Effects and Correction



Results so far...

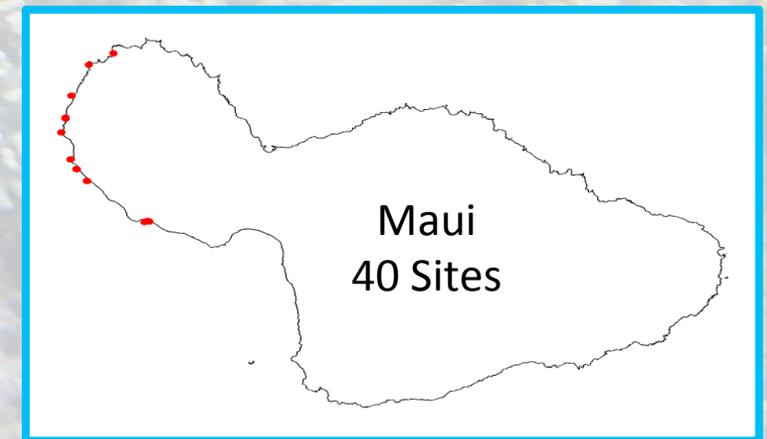
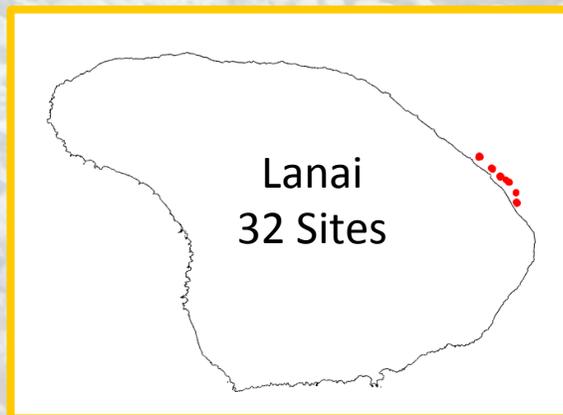
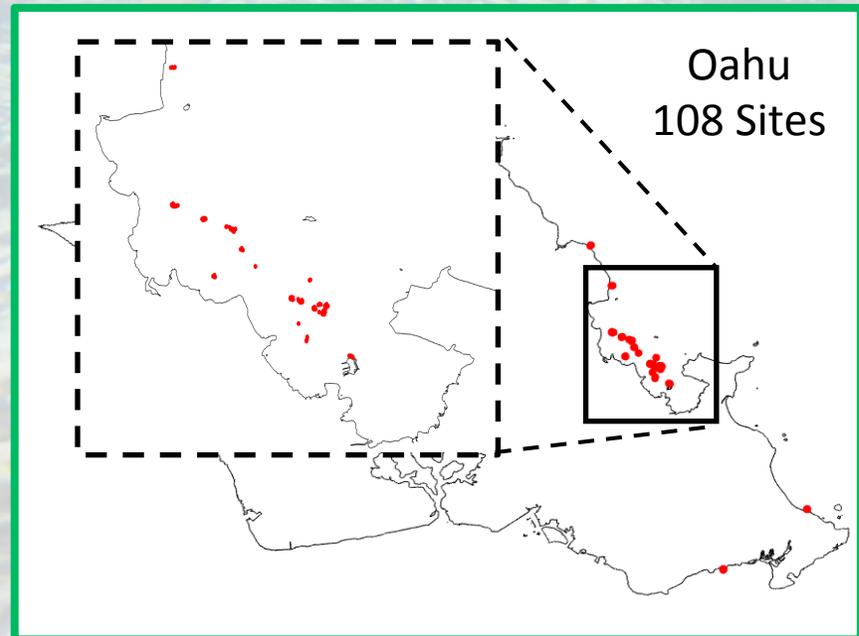
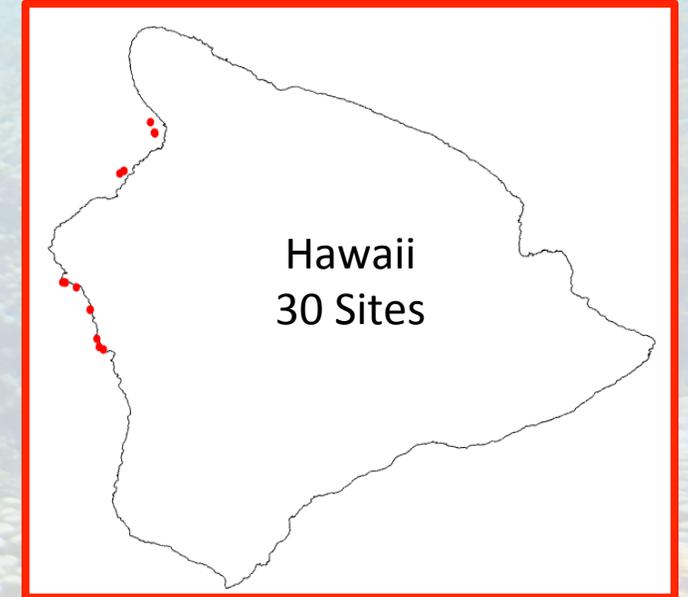
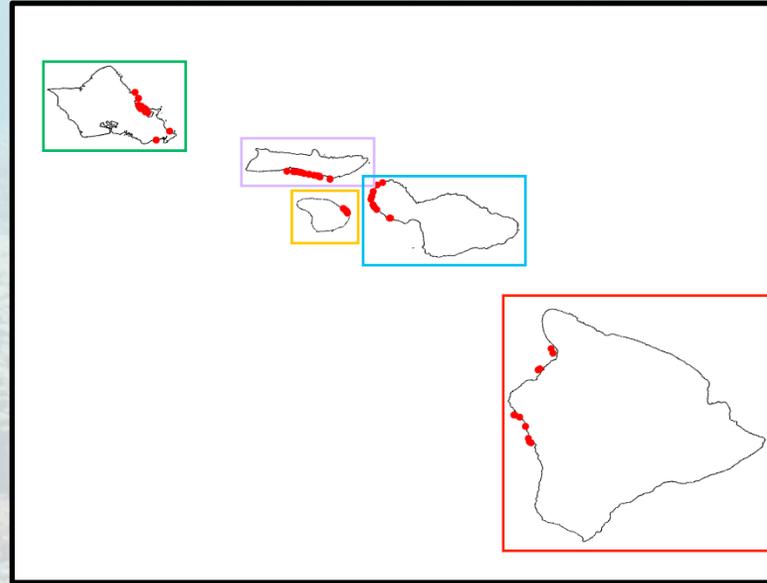
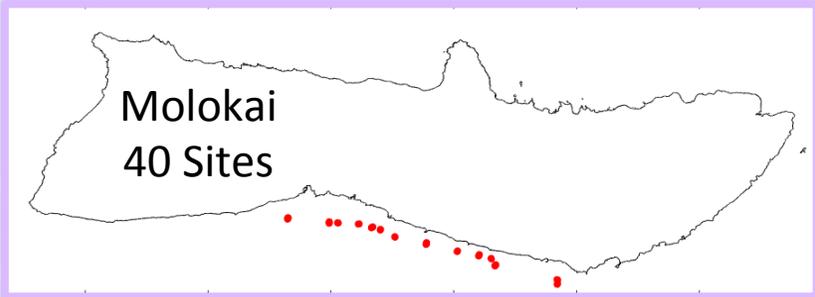
- Coral and algae are difficult to separate with MESMA, but not all algal types produce similar errors.
- Derivatives (1st & 2nd) of mixed spectra and endmembers produce better results.



Question – Validation

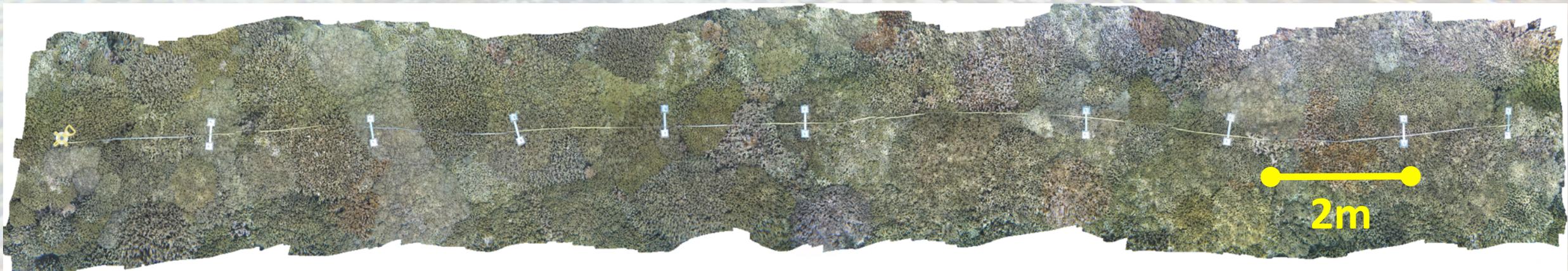
- How do spectra and modeled benthic fractions from HypsIRI-like imagery compare to field measurements?
 1. Benthic fractions derived from phototransects
 2. Spectral transects

250 Phototransects Across 5 Hawaiian Islands



Phototranssect Collection

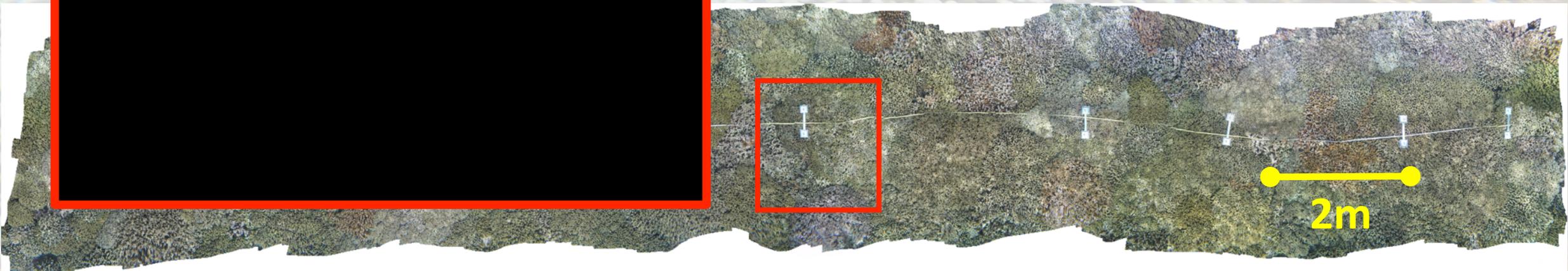
- 20 meter transects
- 9 GoPro Cameras
- Orthomosaics created with Photoscan Pro



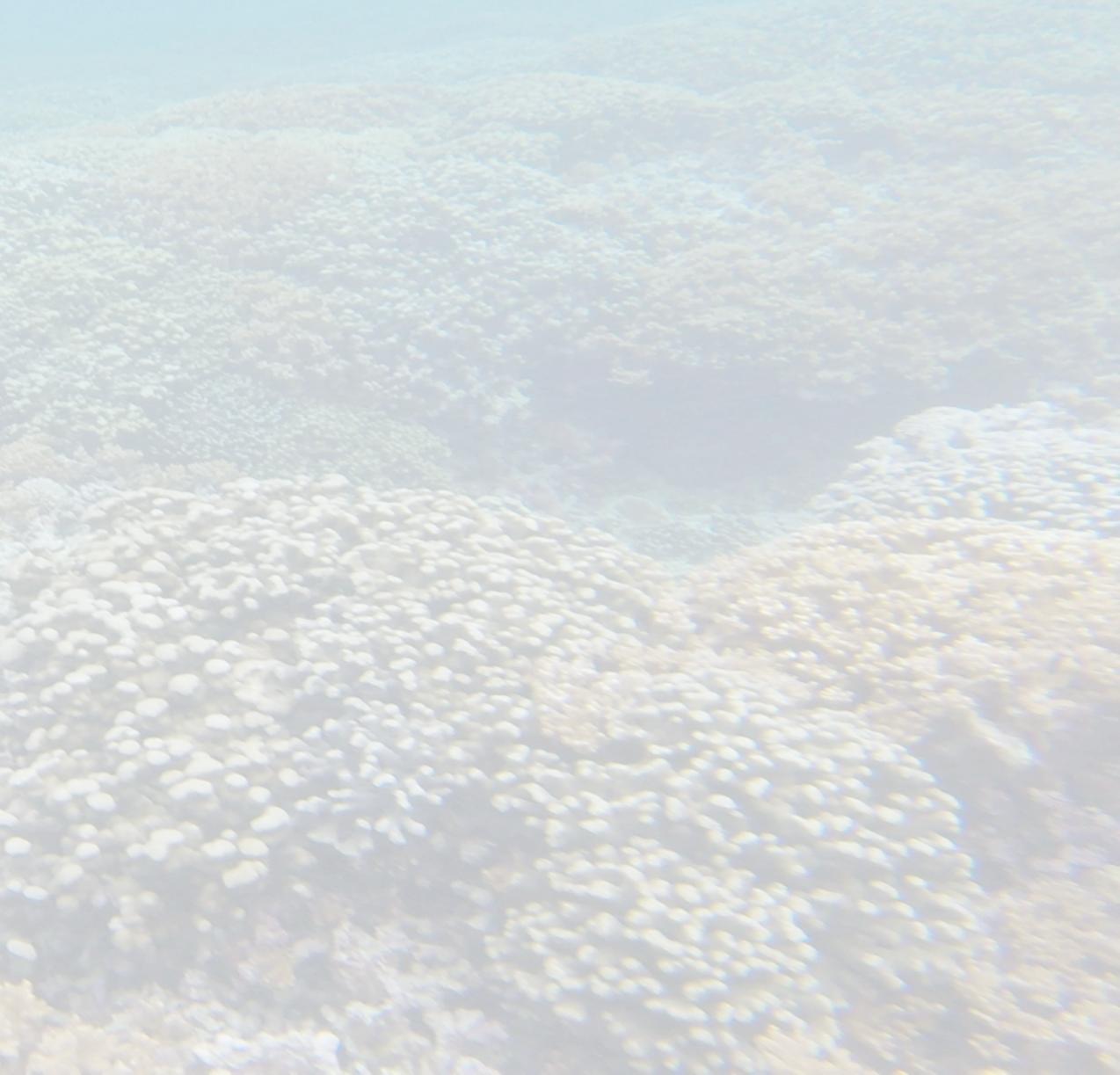
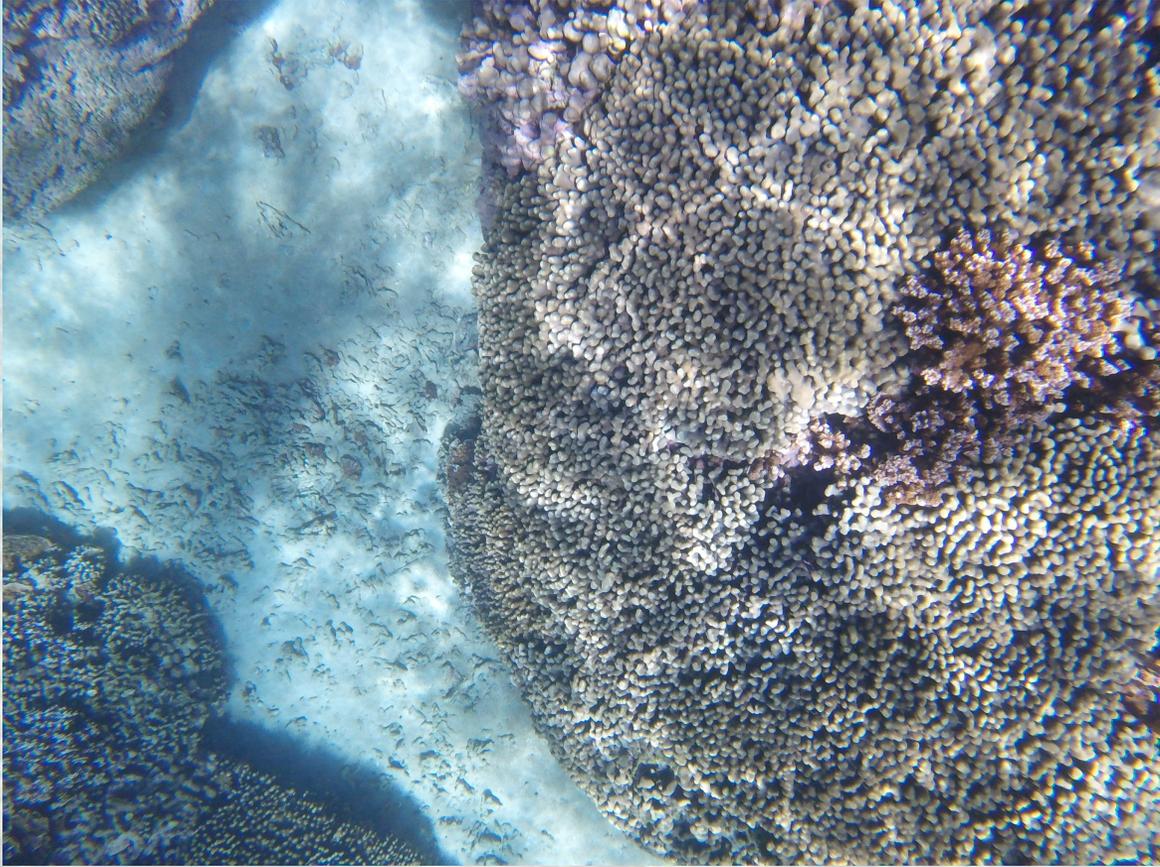
Phototranssect Collection



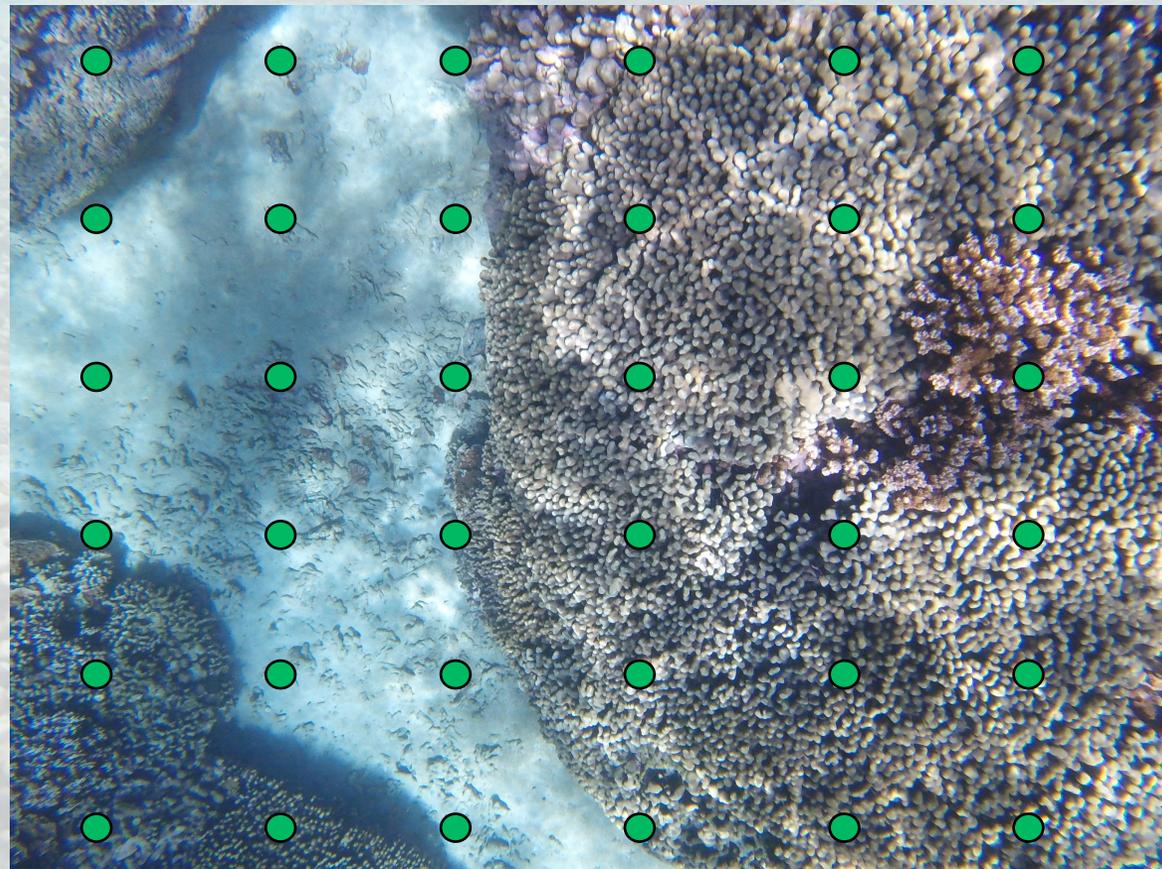
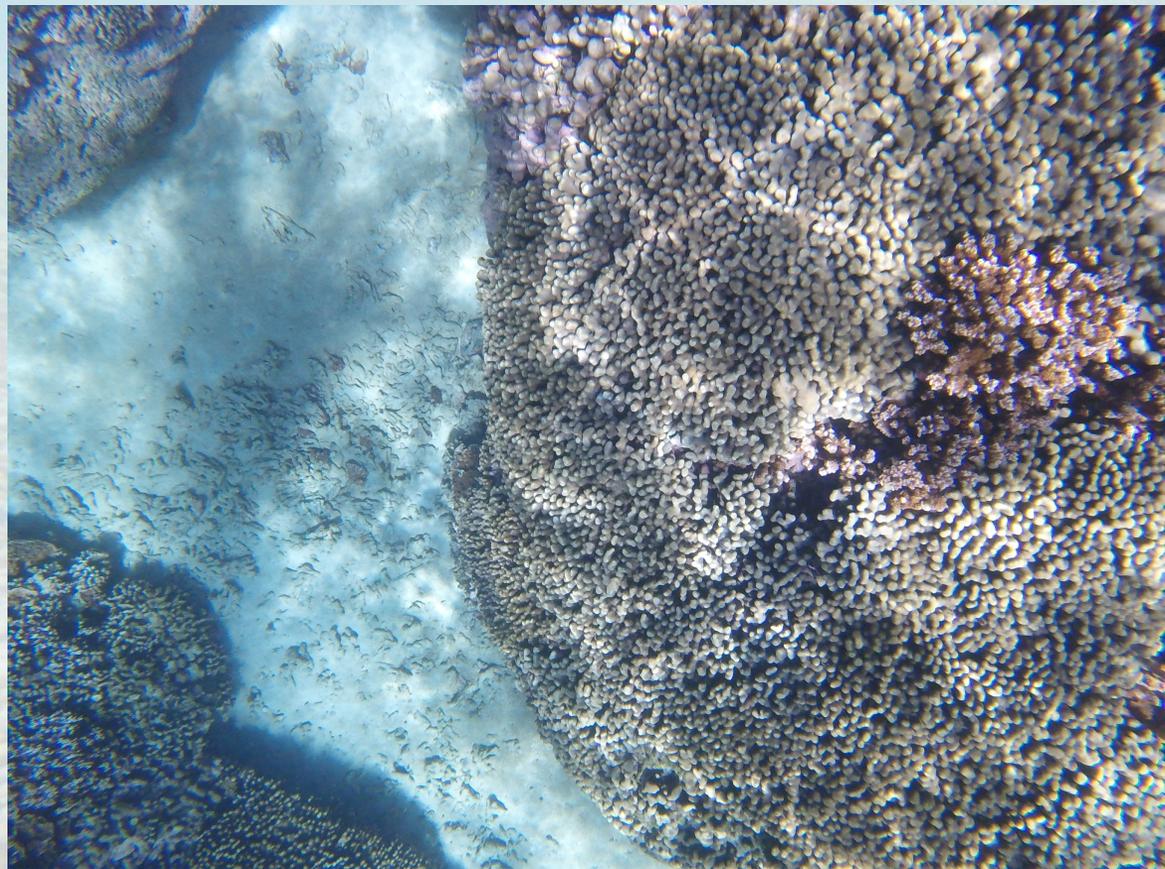
Photo: Juan Torres-Perez



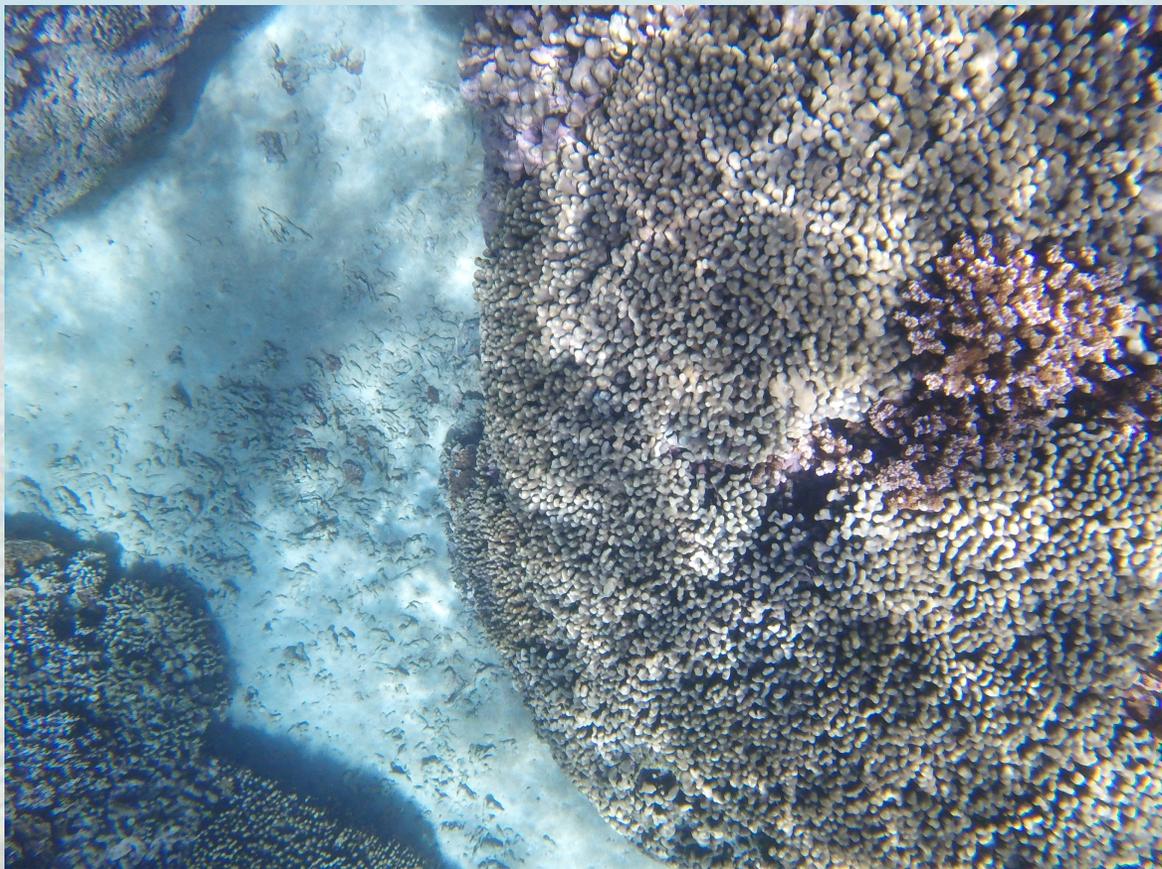
Classification Using Convolutional Neural Network



Classification Using Convolutional Neural Network



Classification Using Convolutional Neural Network





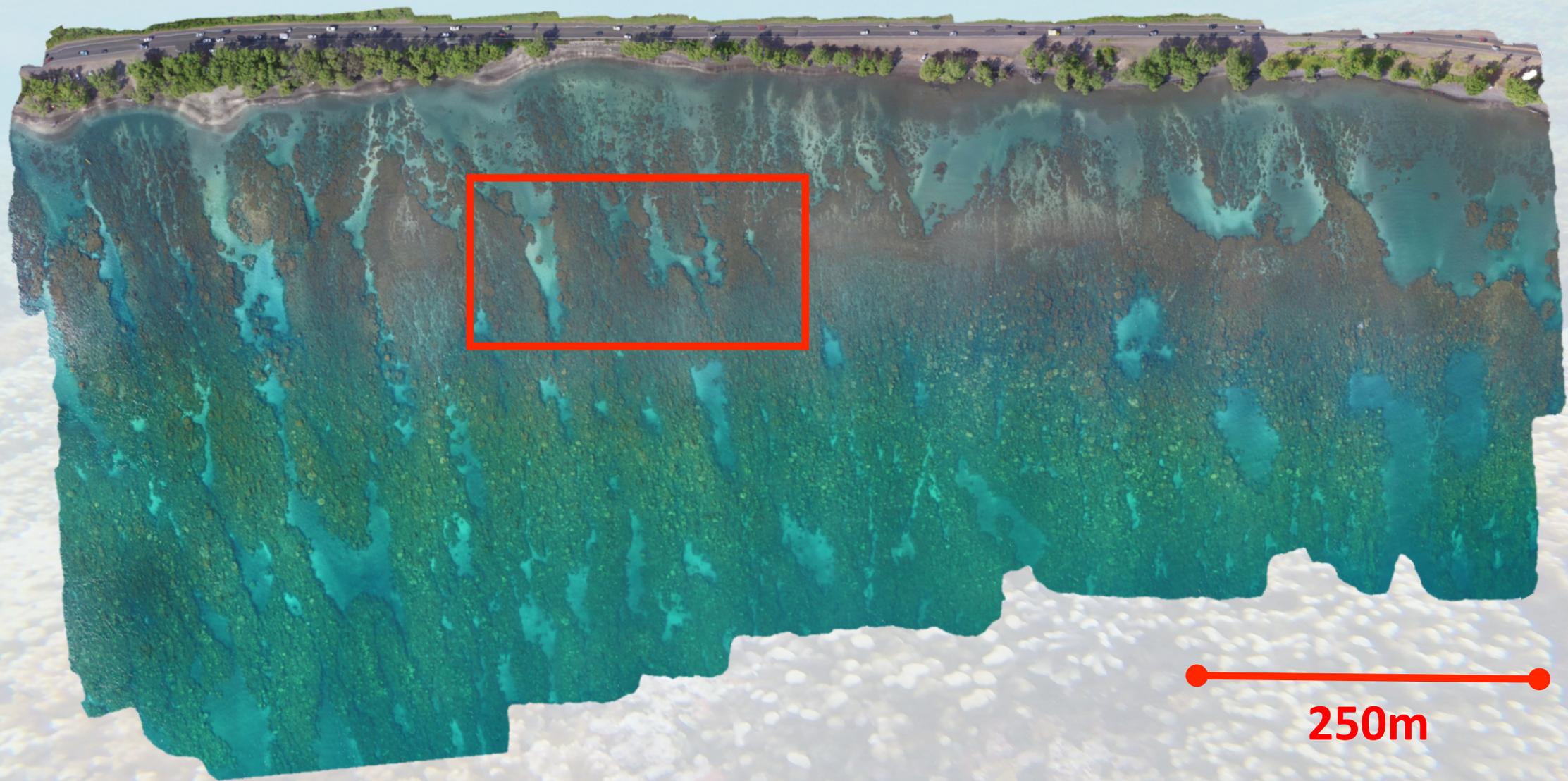
Olowalu Reef, Maui
AVIRIS 2/22/2017

1km

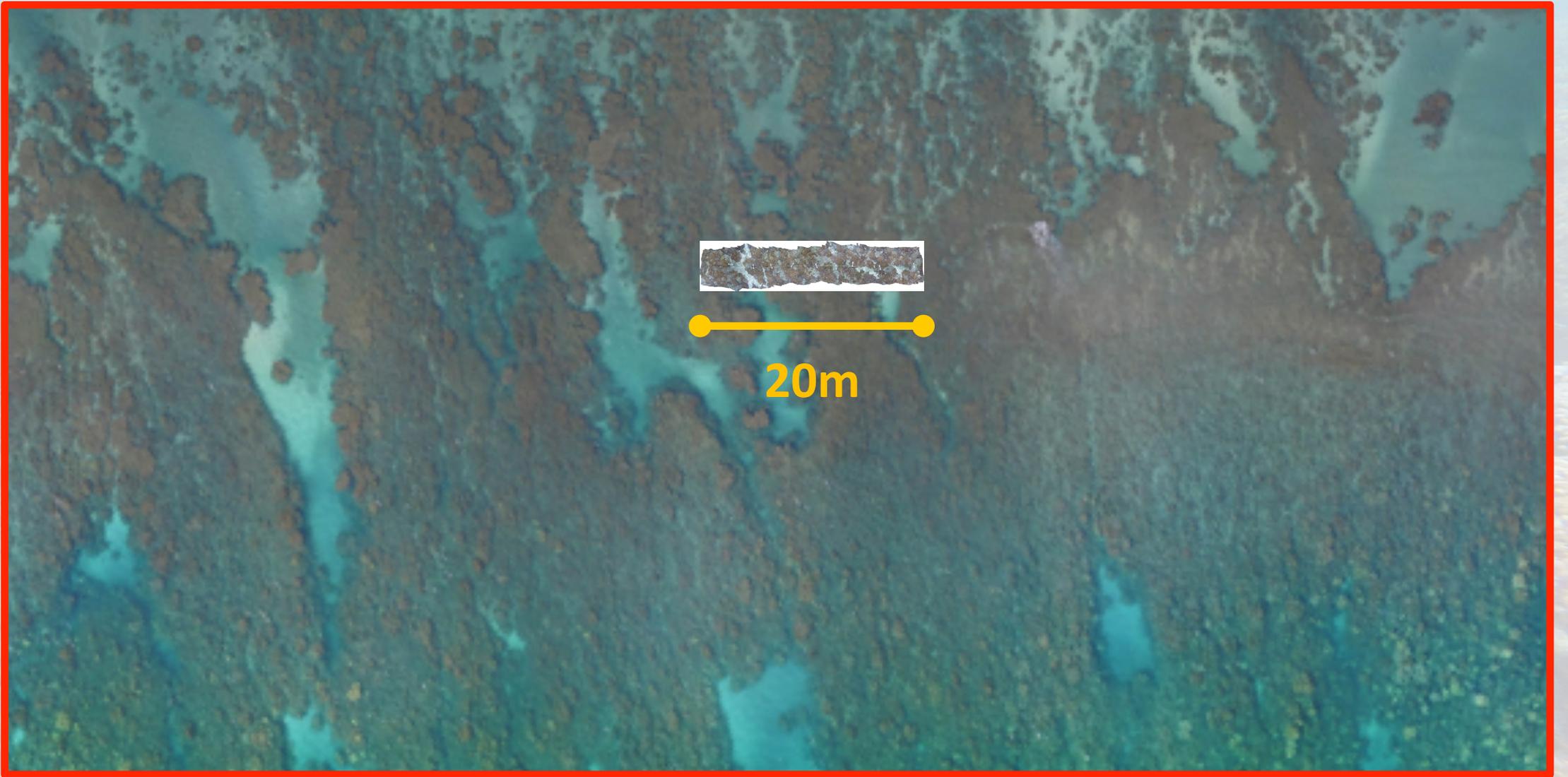


Olowalu Reef, Maui
AVIRIS 2/22/2017

1km

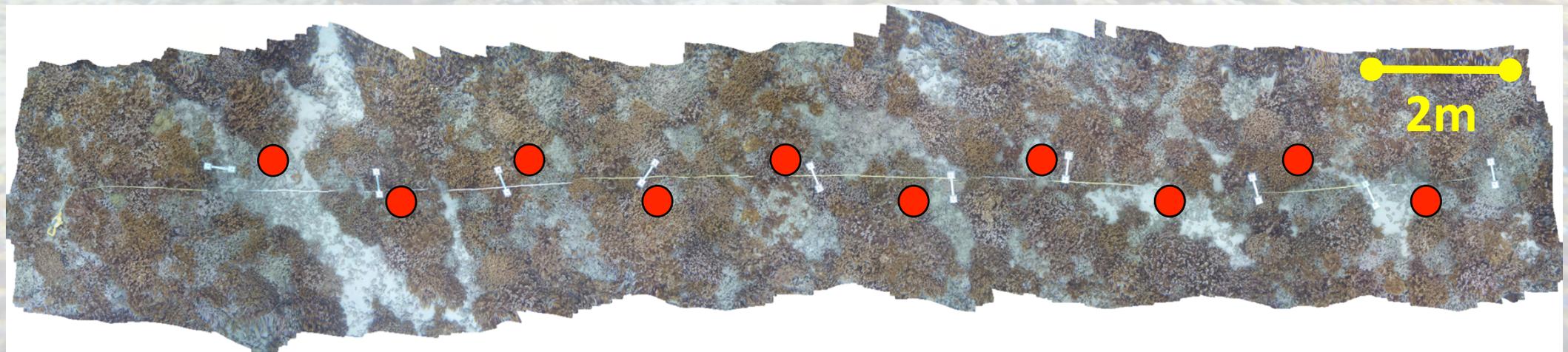
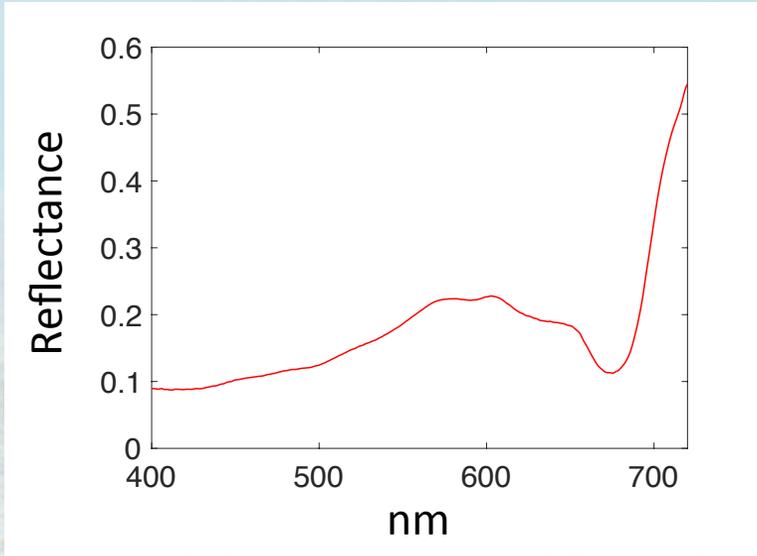


250m

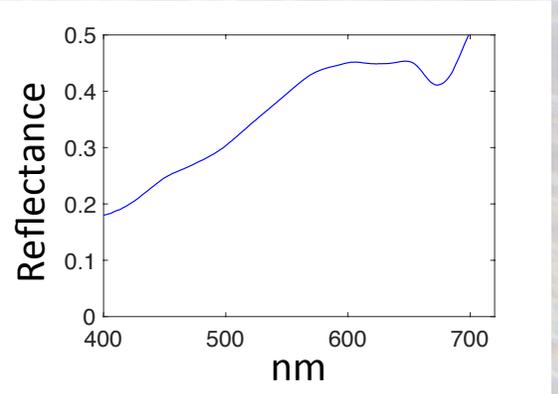
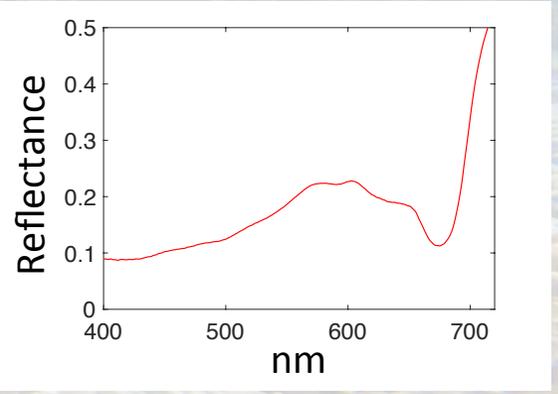
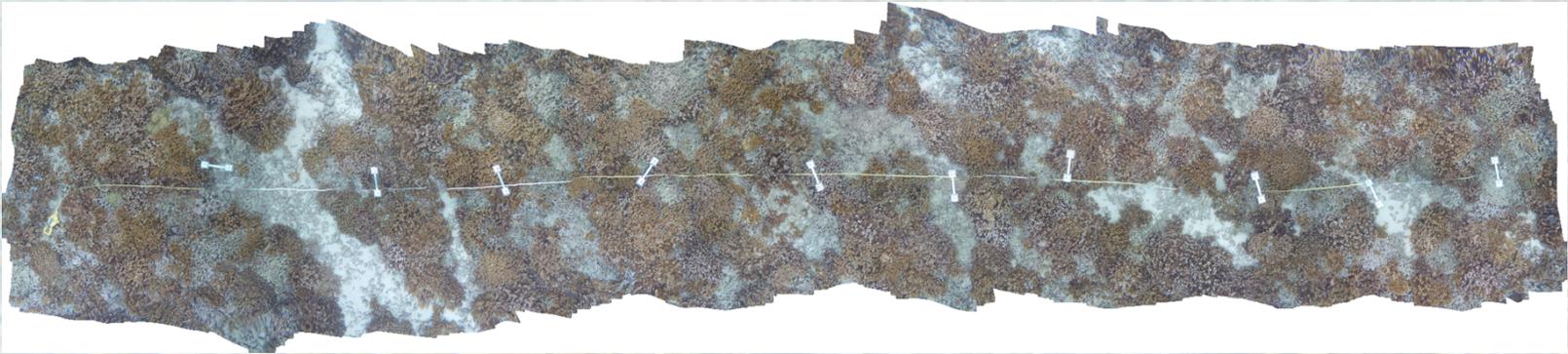
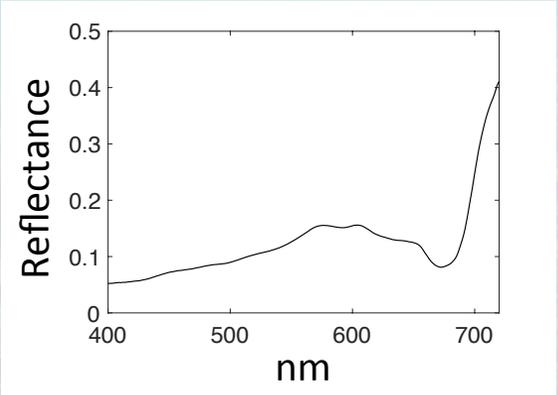
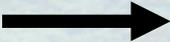
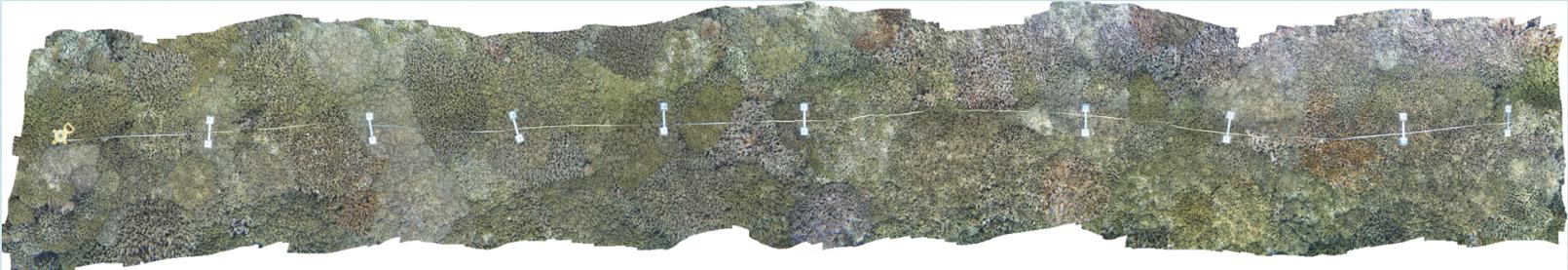


20m

Spectral Transects (56/250)



Phototransects w/ Spectra



Future Work

- Continue simulation analysis with water columns and atmospheres. We hope to submit a manuscript by the end of the summer.
- Assess relationship between field spectral transects and AVIRIS imagery.
- Continue processing phototransects and begin CNN training.
- Validate fractional cover maps derived from AVIRIS imagery and unmixed using MESMA with field fractional cover estimates.