National Aeronautics and Space Administration

FY24 Strategic University Research Partnership (SURP)

Automated Mapping of Kelp Forest Productivity for Carbon Storage Estimation

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Background

Kelp forests support highly diverse ecosystems worldwide, such that shifts in their abundance and distribution in association with climate change have significant impacts on the coastal and anthropogenic communities that rely on them. Current assessments are largely conducted via scuba surveys that are limited in space and time and may not be globally representative. To-date, differentiation between kelp species and their contributions to the blue carbon budget are lacking.

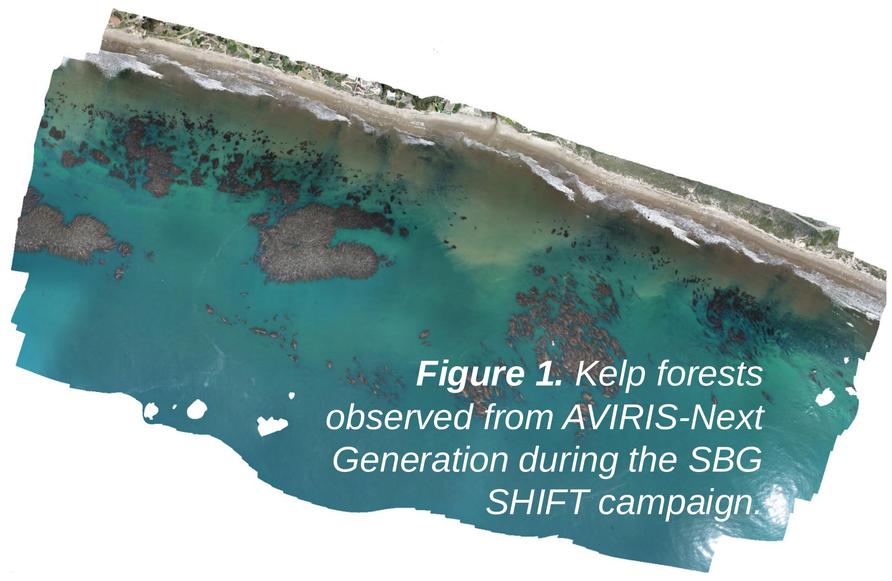

Figure 1. *Kelp forests observed from AVIRIS-Next Generation during the SBG SHIFT campaign.*

Objectives

The objective was to develop automated methodologies to estimate and distinguish the productivity of two nearshore marine foundation species along the coast of California, bull kelp (*Nereocystis luetkeana*) and giant kelp (*Macrocystis pyrifera*), from AVIRIS-NG imaging spectroscopy data (Figure 1).

Significance

- First application of imaging spectroscopy to distinguish kelp species and estimate their physiological condition.
- Data and models developed will enable linkage between kelp forest productivity and standing carbon stocks in California, informing a component of the blue carbon budget that has been largely omitted.
- Aligns with the needs and directions of NASA/JPL and our existing and upcoming missions, including the Western Diversity Time Series and the Surface Biology and Geology mission.

Approach & Results

Year 3 of the project focused on:

1) Developing a robust partial least squares regression (PLSR) models to estimate kelp canopy pigments from lab spectra, including chlorophyll-a, chlorophyll-c, and fucoxanthin (Figure 2);
2) Collecting a monthly time series of drone-based imaging spectrometer data (~ 7 cm resolution) to determine the feasibility of using high resolution airborne imaging spectroscopy to understand local-scale, seasonal patterns in kelp canopy pigments;
3) Building a deep learning classifier to detect kelp canopy along the State of California using a high-resolution CubeSat constellation dataset (2016-present) that can be used in collaboration with these models to help better understand primary production patterns (e.g., age, temporal trends, etc).

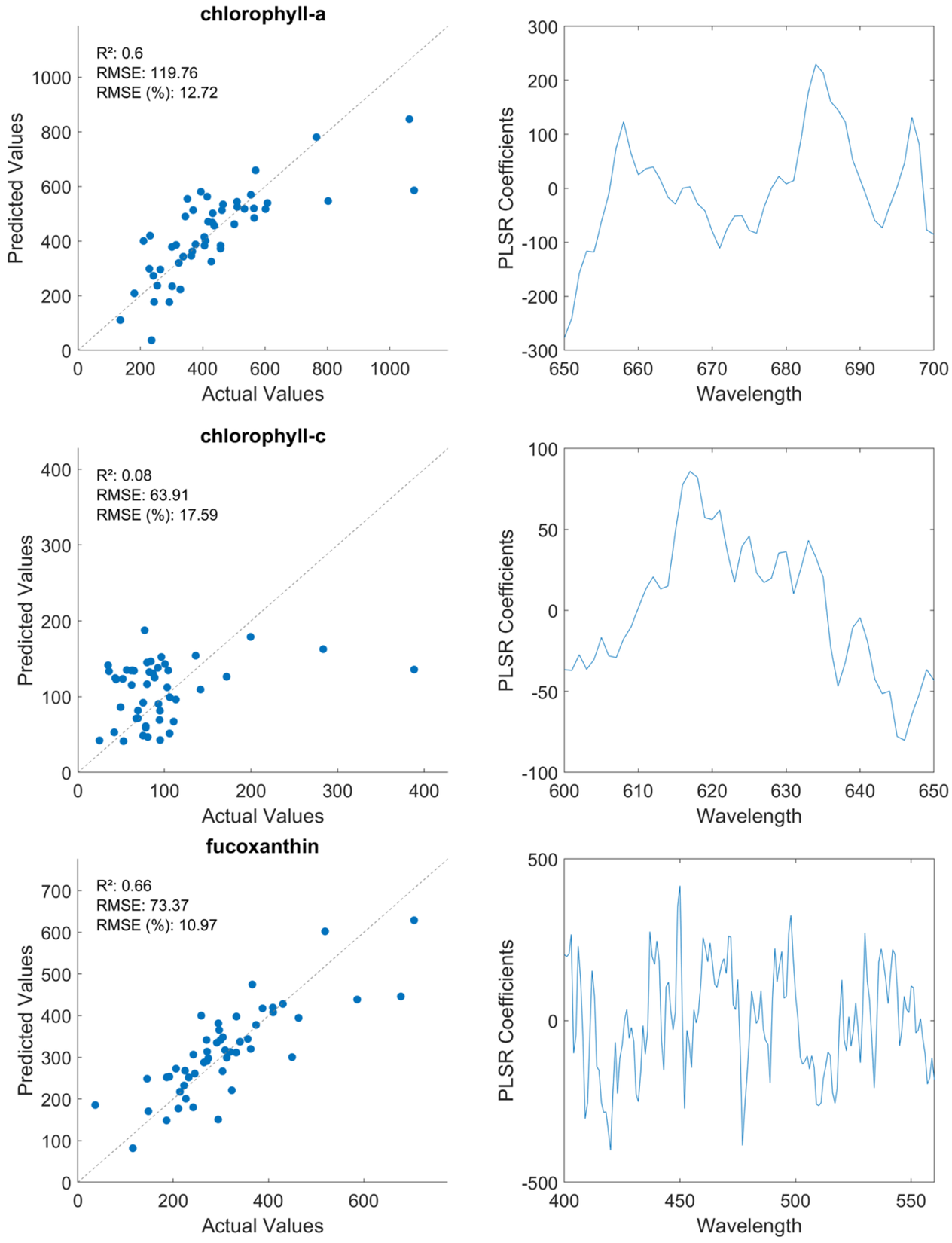

Figure 2. Robust PLSR models to estimate kelp canopy pigments from lab spectra, including chlorophyll-a, chlorophyll-c, fucoxanthin.

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