National Aeronautics and Space Administration

Remote VSWIR Imaging spectroscopy for Global Discovery and Conservation Science

Principal Investigator: David Thompson (382); Co-Investigators: Charles Miller (329), Philip Townsend (University of Wisconsin), Gregory P. Asner (Arizona State University)

Program: FY22 SURP
Strategic Focus Area: Earth Science Data Analysis

Objectives: This project applied advanced new imaging spectrometer algorithms for terrestrial ecosystem observations, advancing the science and practice of imaging spectroscopy for global conservation. Specifically, it aimed to demonstrate new measurement methods based on spectral diversity and intrinsic dimensionality for quantifying information content in both terrestrial and urban environments to answer ecological questions.

Background: Intrinsic dimensionality is a value that quantifies the number of distinct degrees of freedom in a process under study, or roughly speaking, the spectral diversity or information content. We first decided to focus this research effort on a case study involving characterization of an indigenous tree species, Metrosideros polymorpha, also known as Ohi'a, across the island of Hawai'i. We also considered a broader study of varied urban and wilderness land cover classes. We sought to characterize how intrinsic dimensionality changed as a function of ecological controls, and how it was preserved at different spatial scales.

Approach and Results: We quantified spectral variation between and within six uniform stands of Metrosideros polymorpha across elevation and soil substrate age gradients on Hawai'i Island. Airborne imaging spectroscopy and light detection and ranging (LiDAR) data were merged to capture and isolate sunlit portions of canopies at the six M. polymorpha-dominated sites. Both intra-site and inter-site spectral variation was quantified. Coefficients of variation among spectra, as well as the intrinsic spectral dimensionality technique, demonstrated the hierarchical effect of soil substrate age followed by elevation in determining intra-site variation.

The second study sought to understand how information content varied as a function of spatial sampling. Leveraging data collected by the Global Airborne Observatory (GAO), the team investigated the spectral dimensionality of common landscape types (i.e., urban, suburban, rural, agriculture, forest, shrub/grass and wetland) across several GSDs (i.e., 1-5 m, 10 m, 20 m and 30 m). They resampled the aircraft data to simulate these different satellite measurements, and then calculated the intrinsic dimensionality for each dataset. Thi demonstrates that fine spatial sampling is needed to capture the majority of information content in Urban environments, while wilderness environments are more adequately measured by 30m GSD instruments.

Significance/Benefits to JPL and NASA: The O'hia project demonstrates the power of imaging spectroscopy to measure intra-species trait variation across environmental gradients. It further demonstrated the utility of imaging spectroscopy for mapping intra-species variability. The spatial scales project largely corroborates unpublished results from JPL's Surface Biology and Geology science team, validating this mission's point design. It further points toward areas where orbital missions may not be sufficient – such as urban or human-affected rural areas – as a potential target for EV-S campaigns and other joint activities.

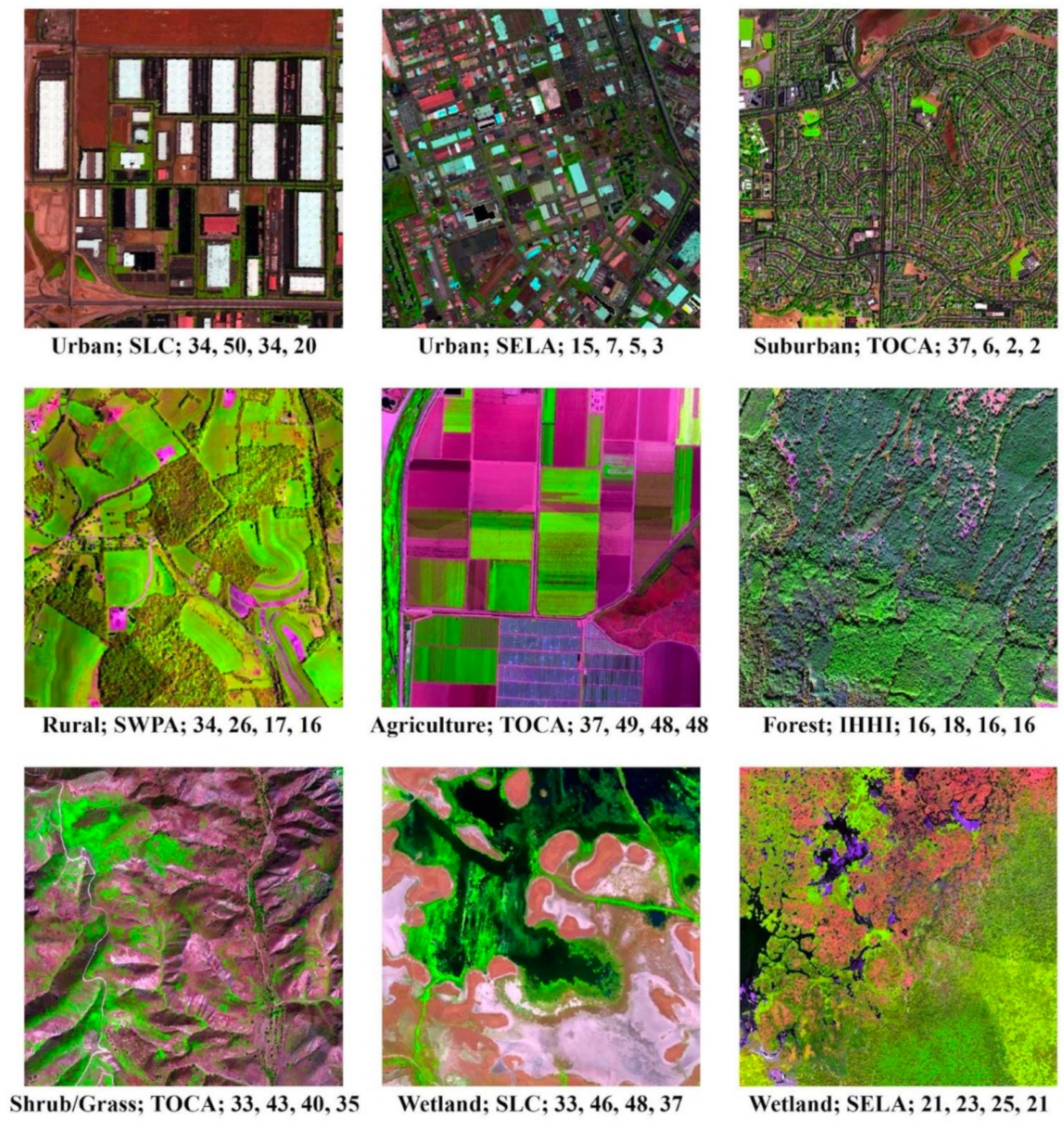
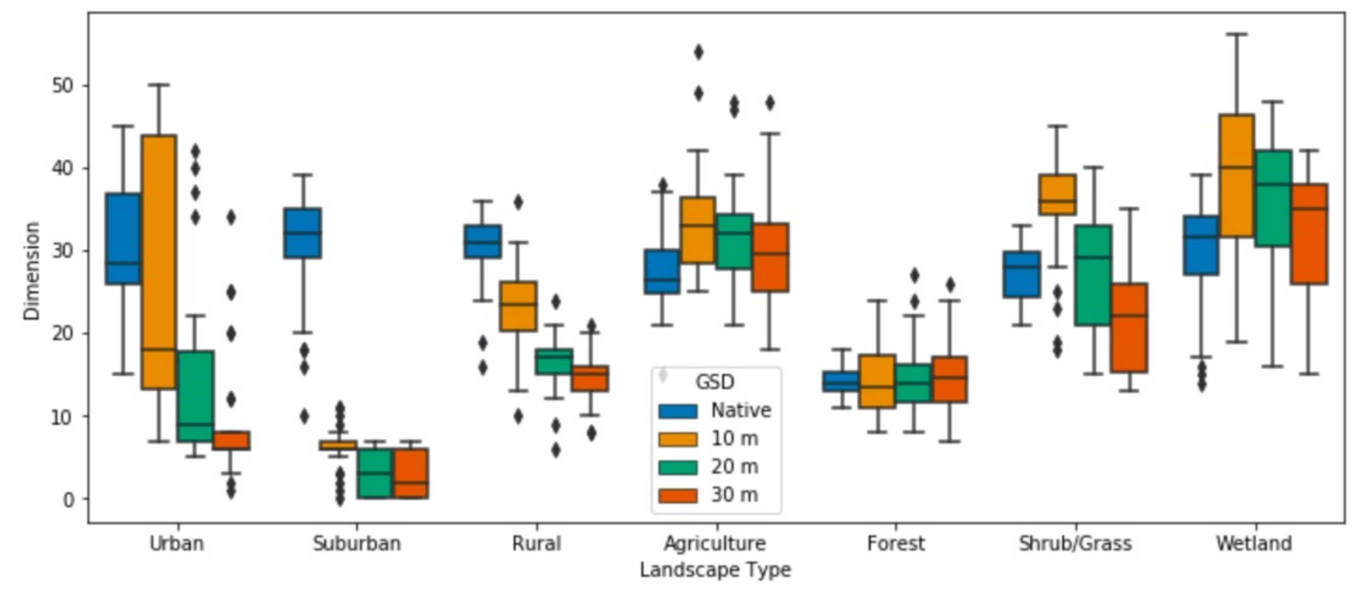


Figure 1: Landscape types used for the intrinsic dimensionality study of imaging spectrometer data.

Figure 2: Intrinsic dimensionality vs. spatial scale for each land cover type



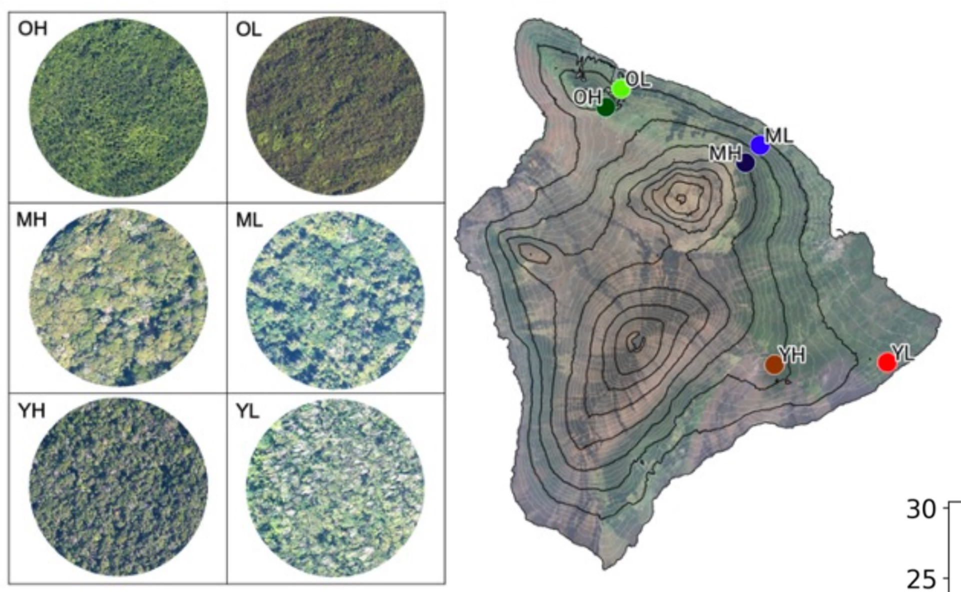


Figure 3: Six O'hia forest sites selected for analysis, spanning three different substrate ages and two different elevations

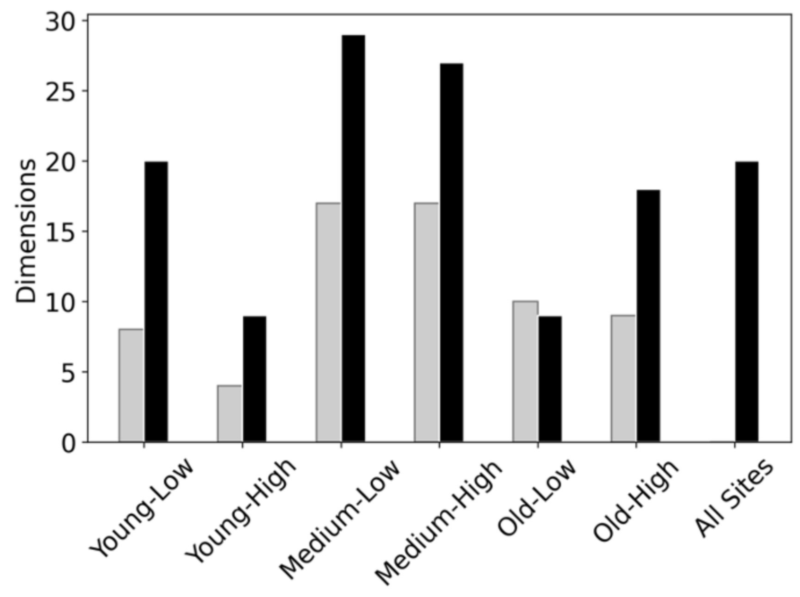


Figure 4 More spectral diversity in medium age regions may reflect nutrient availability. Old depleted sites show less spectral diversity.

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

Clearance Number: CL#
Poster Number: RPC#SP20001

Publications:

[A] Seeley, M., Martin, R. E., Vaughn, N., Thompson, D. R., Dai, J., & Asner, G. P. Quantifying the spectral variation of Metrosideros polymorpha canopies across environmental gradients. Remote Sensing in Ecology and Conservation, in review.

[B] Dai, J., Vaugn, N. Seeley, M., Heckler, J. Thompson, D. R., & Asner, G. P. Quantifying the spectral variation of Metrosideros polymorpha canopies across environmental gradients. Journal of Applied Remote Sensing, in review.

PI/Task Mgr. Contact Information: David.R.Thompson@jpl.nasa.gov