## Abstract

Vegetation structure has been identified as a key input for the improvement of terrestrial ecosystem modeling. Therefore, consistent and scalable estimation of vegetation structural parameters from imaging spectroscopy is essential to remote sensing for ecosystem studies, over and above the more typical physiological assessments. The goals of this project thus were to (i) evaluate and confirm the links between structure and imaging spectroscopy, followed by (ii) an evaluation of the scalability of such assessments to the HyspIRI spatial scale.

Following last year work, we are building three virtual scenes, which correspond to the real vegetation structure of the National Ecological Observatory Network (NEON) Pacific Southwest site. Then we simulated HyspIRI data (60m GSD), AVIRIS data (15m GSD), and NEONs high-resolution spectrometer data (1m GSD). We also simulated our field sensor that measures leaf area index (LAI) in order to better understand the spatial variation in such structural parameter (LAI). We are confident about our simulation results, since the geometric parameters and physical models were verified by the AVIRIS data, NEONs data, and field sensor measurements. More details will be presented at the workshop.

## Methodology

Three virtual scenes were first constructed, which correspond to the actual vegetation structure of our study area.

**Virtual scene**

The size of the virtual terrain is $180 \times 180$ meters, which corresponds to $3 \times 3$ HyspIRI pixels (60m GSD, red grid) or $12 \times 12$ AVIRIS pixels (15m GSD, cyan grid). The center $80 \times 80$ meters area corresponds to the actual vegetation structure of our study area.

**Terrain**

Elevation is derived from the airborne lidar data.

**Tree**

3D tree models are generated by OnyxTREE.

**Calibration panels**

Two black panels and two white panels are placed at the corners and used as reference objects for empirical line method (ELM) atmospheric compensation.

## Study Area

The National Ecological Observatory Network (NEON) Pacific Southwest site is located in the central part of California, 1. San Joaquin Experimental Range (core site) 2. Soaproot Saddle ( relocatable site)

## DIRSIG

The Digital Imaging and Remote Sensing Image Generation (DIRSIG) model is a first principles based synthetic image generation model developed by the Digital Imaging and Remote Sensing Laboratory at Rochester Institute of Technology. The model can produce passive single-band, multi-spectral or hyper-spectral imagery from the visible through the thermal infrared region of the electromagnetic spectrum. The model also has a mature active laser (LIDAR) capability and an evolving active RF (RADAR) capability. The model can be used to test image system designs, to create test imagery for evaluating image exploitation algorithms and for creating data for training image analysts.

## Conclusion

Early results indicate that HyspIRI is sensitive to sub-pixel vegetation structural variation in the blue and red spectral regions due to pigment concentration changes, as well as the SWIR region due to water content variation. Therefore, the system's suitability for consistent global vegetation structural assessments could be improved by adapting calibration strategies to account for this variation in sub-pixel structure.

## Future Work

Next year, we plan to increase the number of simulations to investigate the impact of spatially explicit sub-pixel structural variation on the spectroscopy data. We will then employ statistical methods (e.g., wavelength pair-wise comparisons, derivative analyses, etc.) to verify our hypotheses:

1. Fine-scale, within-pixel structural assessments can be used to improve our understanding of HyspIRI-based estimates of leaf area, leaf area index (LAI), and vegetation biomass;
2. From a systems perspective, the spatially explicit within-pixel structural variations are quantifiable when it comes to their impact on the HyspIRI systems response (point spread function);
3. An improved understanding of (1) and (2) will lead to proper calibration of HyspIRI based vegetation structure estimates.

## Acknowledgements

This material is based upon work supported by the NASA HyspIRI Mission under Grant No. NNX14AG21G. Special thanks to the first team: Jan van Aardt, Ashley Miller, Teresa Nihoul, Paul Romanczyk, Martin van Leeuwen, Claudia Pohl, and Alexander Fabel. Thanks to CIRES/DEWcision for building virtual scenes. Thanks to NEON AOP team for providing airborne and ground data.