Synergy of VSWIR and LiDAR for Ecosystem Structure, Biomass, and Canopy Diversity

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HyspIRI Science Questions

VQ1. What is the global spatial pattern of ecosystem and diversity distributions and how do ecosystems differ in their composition or biodiversity?

VQ2. What are the seasonal expressions and cycles for terrestrial and aquatic ecosystems, functional groups, and diagnostic species?

VQ3. How are the biogeochemical cycles that sustain life on Earth being altered/disrupted by natural and human-induced environmental change?
Challenges to Imaging Spectroscopy

Plant chemical signatures are influenced by canopy structure and shadows
Spectral Dependence of Leaf and Canopy Properties

- Canopy gaps and shade
- Leaf Angle Orientation
- Leaf Reflectance/Chemistry
- Leaf Transmittance/Chemistry
Carnegie Airborne Observatory (CAO)

3-D functional imaging of ecosystems

**LiDAR** for topography, canopy structure, LAI, etc.

**Hyperspectral** for species, chemistry, etc.

Fusion for estimates of biodiversity, biomass, sun/shade fraction, habitat suitability, etc.
Carnegie Data Processing Stream

Hyperspectral Data

LiDAR Data

Spectral PCA

Constant Sun-View Geometry

Screened Image

Suitable

Unsuitable
Biological Invasion Fronts
Canopy chemistry and biodiversity in tropical forest canopies
High-Temporal Tower-Based Studies

1) Thermal + LiDAR/Hyperspectral

2) Correcting hyperspectral observations for shadow fraction
Hyperspectral-LIDAR system and data product integration for terrestrial applications

Lawrence A. Corp, Yen-Ben Cheng, Elizabeth M. Middleton, Geoffrey G. Parker, K. Fred Huemmrich, Petya K. Entcheva Campbell

Continuous Sun/Shade Measurements

Pan-tilt mount

Thermal imager (NEW!)
Photosynthetic light-use efficiency ($\varepsilon$) from multiple angles can be related to:

1) direct measurements of PRI; and
2) shadow fraction ($\alpha_s$) derived from LiDAR or mixture decomposition.
Conclusions

*Biophysical* information from LiDAR and *biochemical* information from hyperspectral remote sensing provides complementary data for:

1) describing *spatial patterns of vegetation and biodiversity*;
2) characterizing relationships between *ecosystem form and function*; and
3) Detecting natural/human-induced change that affects *biogeochemical cycles*. 