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

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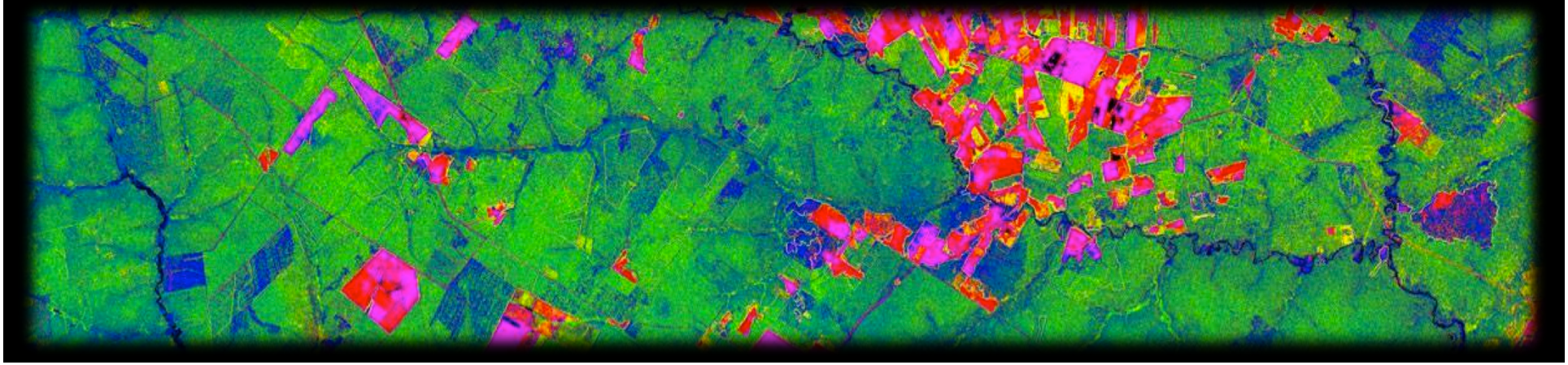


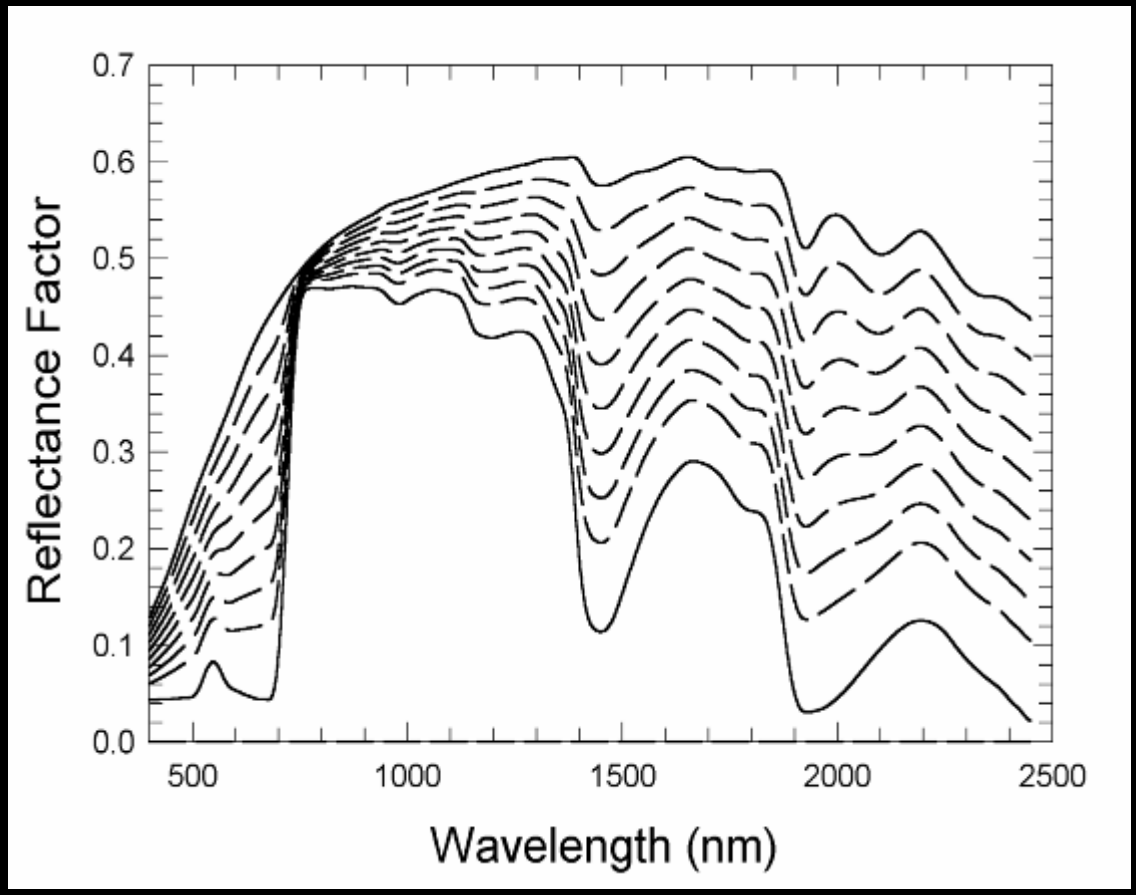
HyspIRI Science Questions

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?

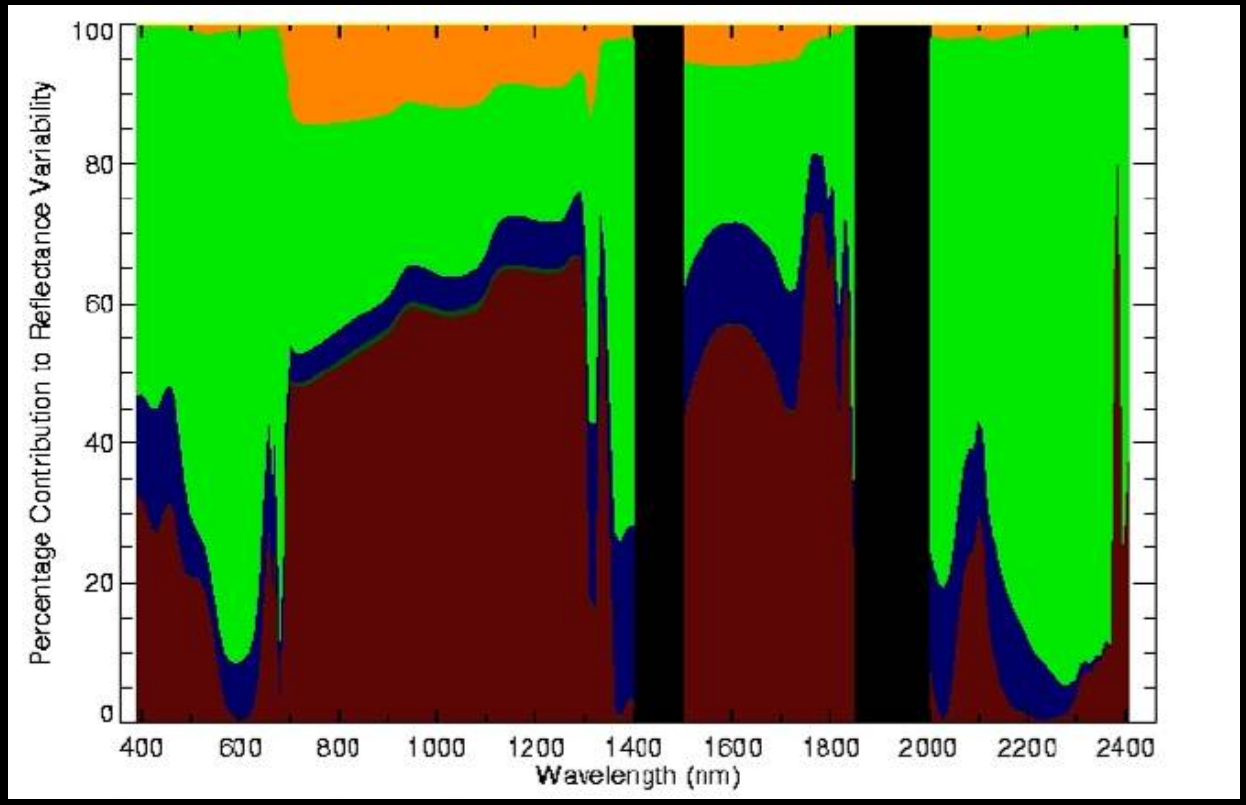
VQ3. How are the ***biogeochemical cycles*** that sustain life on Earth being altered/ disrupted by ***natural and human-induced environmental change***?

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

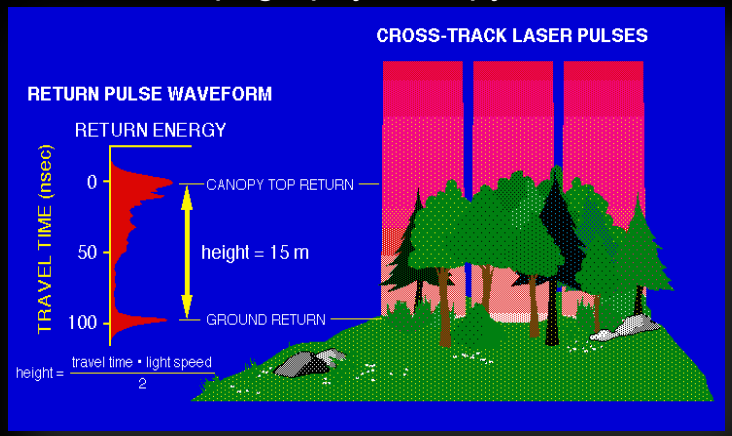
Leaf Reflectance/Chemistry

Leaf Transmittance/Chemistry

Carnegie Airborne Observatory (CAO)

3-D functional imaging of ecosystems

LiDAR for topography, canopy structure, LAI, etc.



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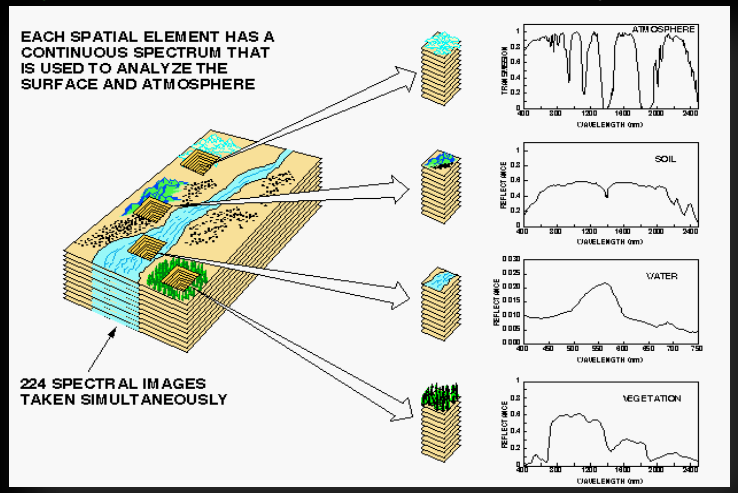
Hyperspectral for species, chemistry, etc.



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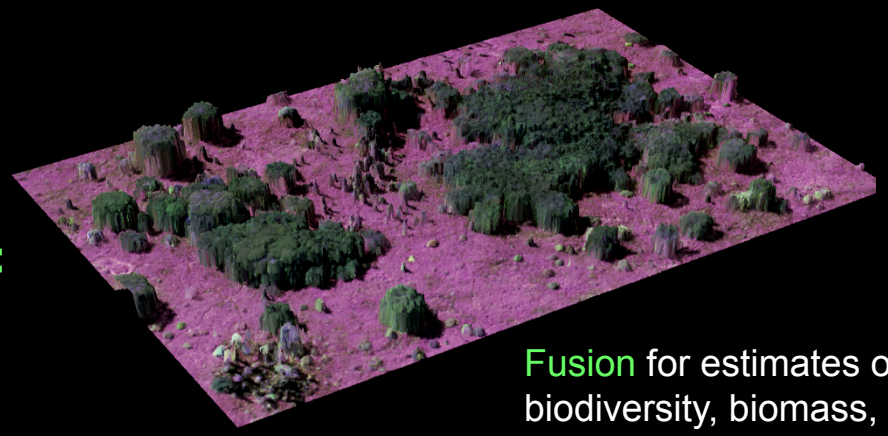
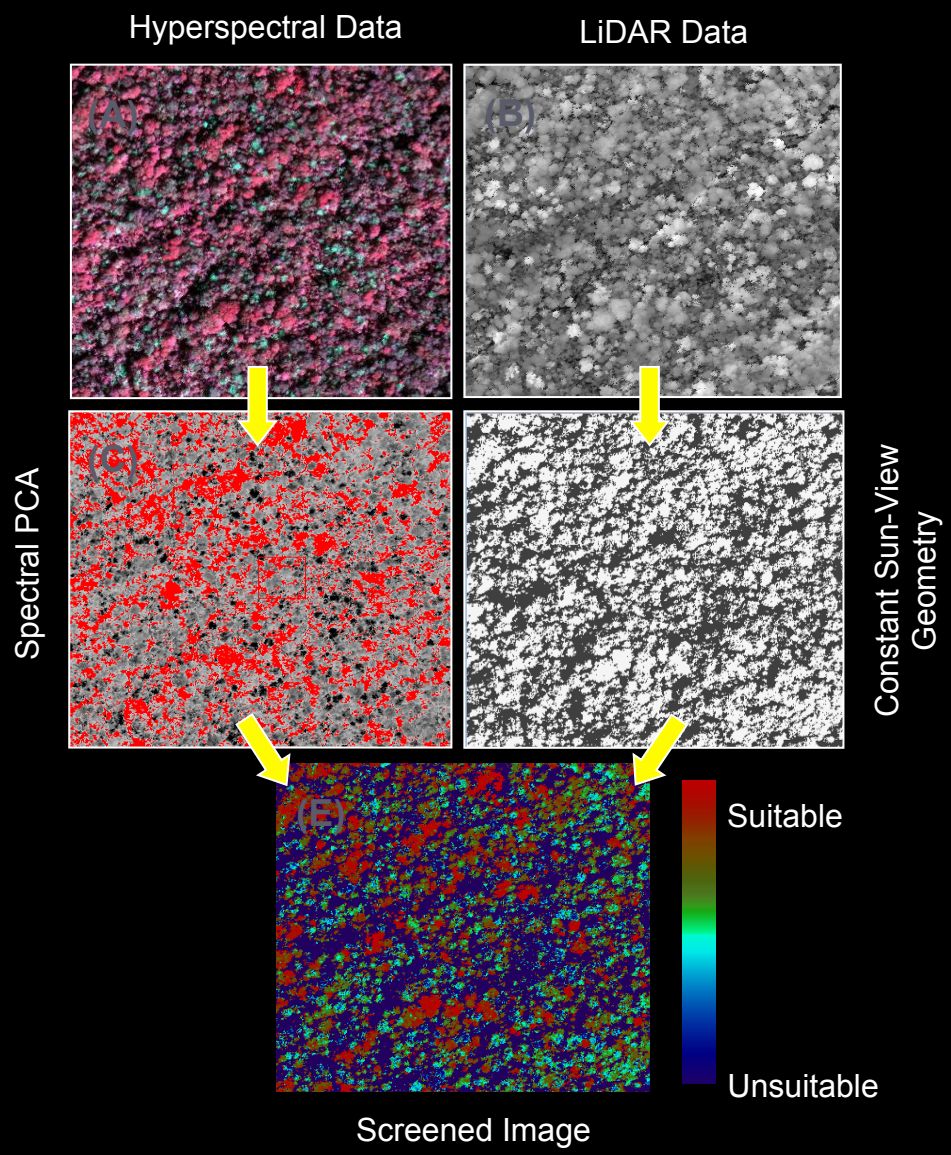
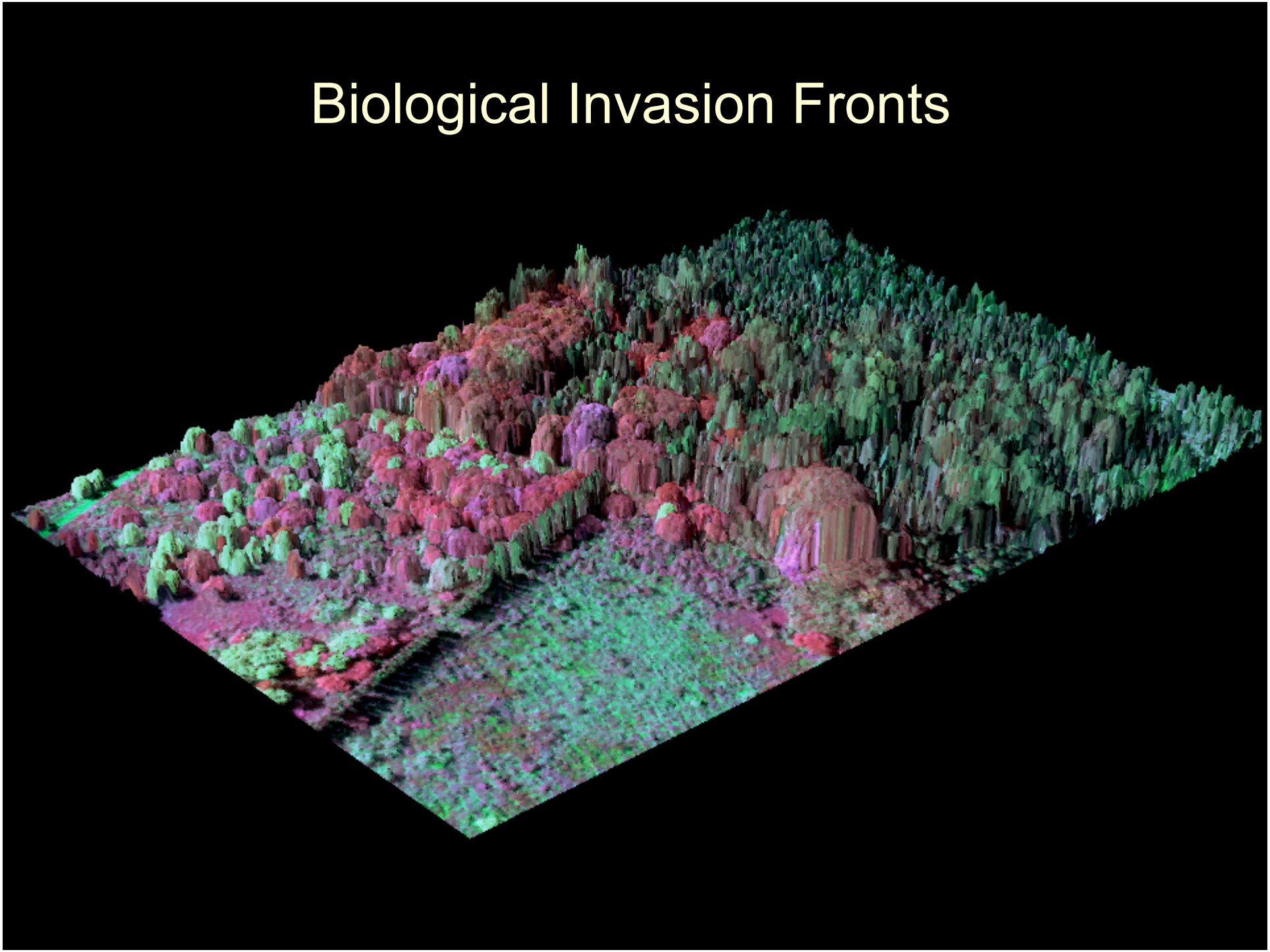


Fusion for estimates of biodiversity, biomass, sun/shade fraction, habitat suitability, etc.

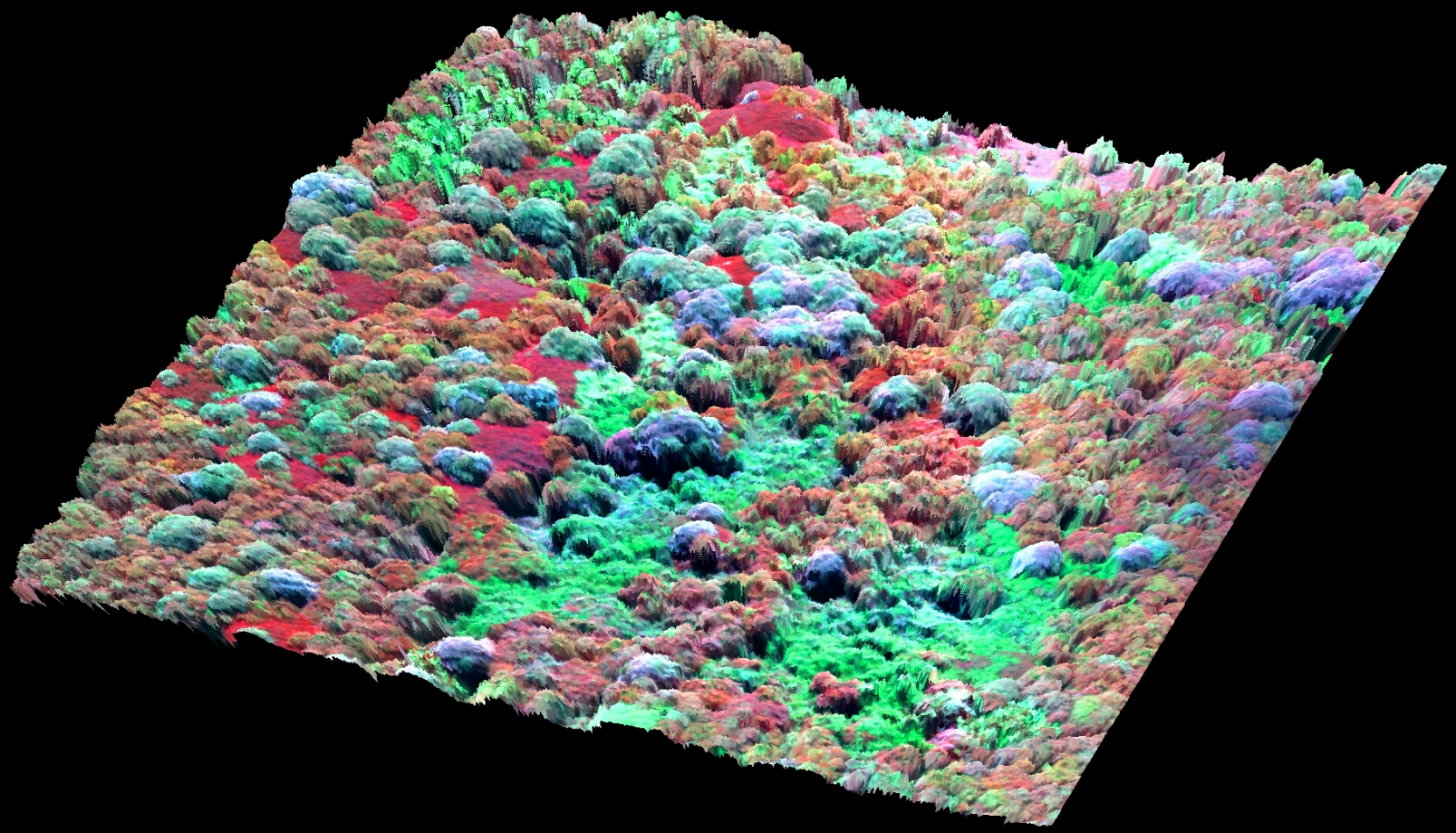
Carnegie Data Processing Stream



Biological Invasion Fronts



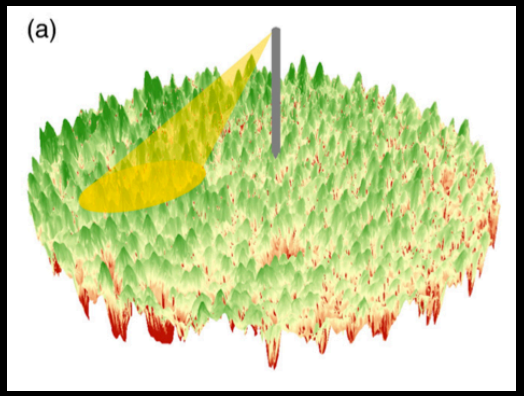
Canopy chemistry and biodiversity in tropical forest canopies



High-Temporal Tower-Based Studies

1) Thermal + LiDAR/Hyperspectral

2) Correcting hyperspectral observations for shadow fraction



Thermal + LiDAR/Hyperspectral

(Middleton, Cook, Corp, *et al.*, NASA-GSFC)

SPIE Optics Photonics, Optical Engineering plus Applications, Imaging Spectrometry, San Diego, CA August 2-6, 2009.

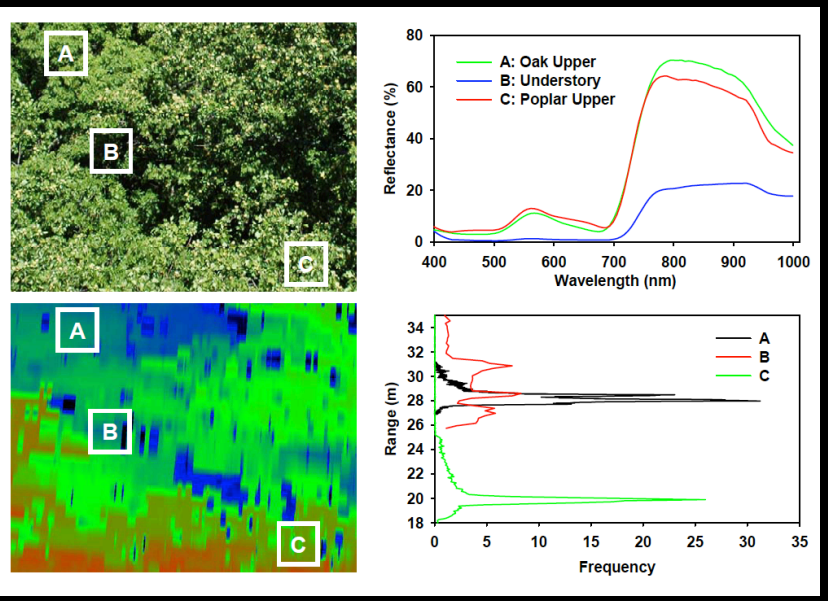
Hyperspectral-LIDAR system and data product integration for terrestrial applications

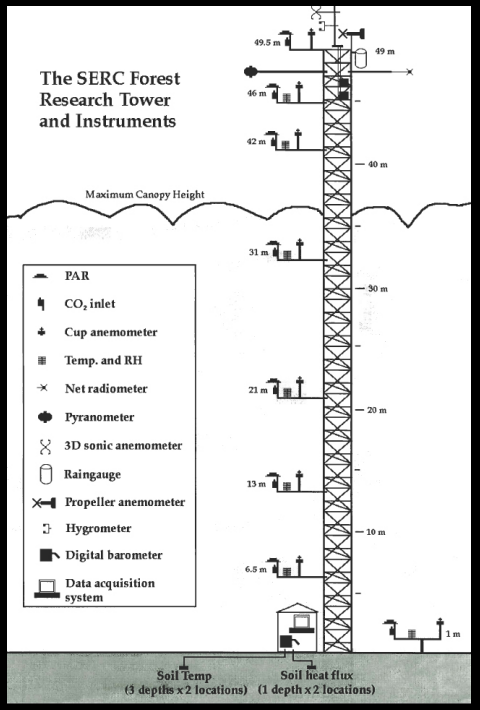
Lawrence A. Corp[1], Yen-Ben Cheng[2], Elizabeth M. Middleton[3], Geoffrey G. Parker[4]
K. Fred Huemmrich[5], Petya K. Entcheva Campbell[5]

Pan-tilt mount

Thermal imager (NEW!)

Continuous Sun/Shade Measurements

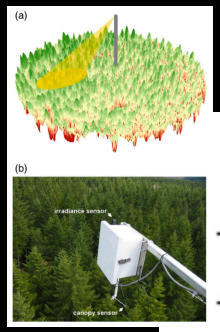




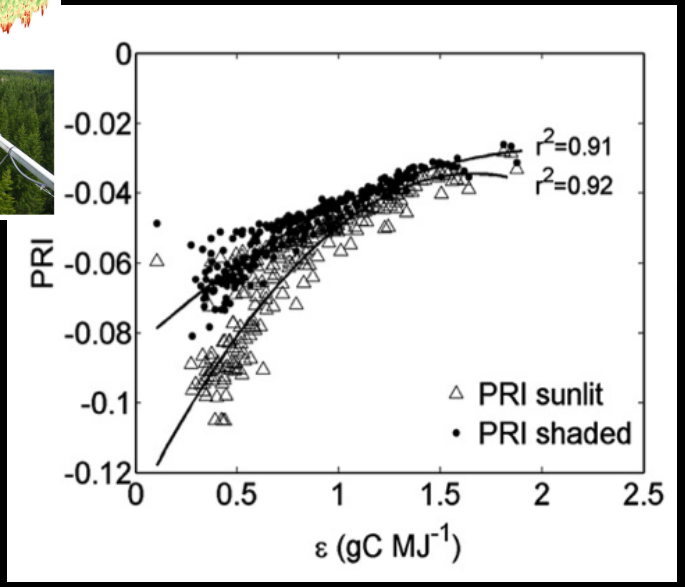
SERC Flux Tower

View Angle/Shadow Fraction Correction

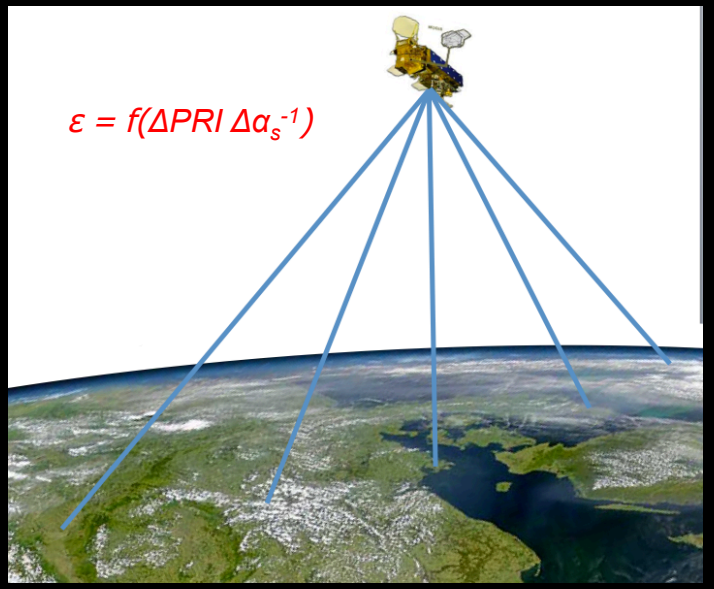
(Hilker and Hall, *et al.*; Univ. British Columbia, UMBC/NASA-GSFC)



Tower Observations



Space-Based Observations



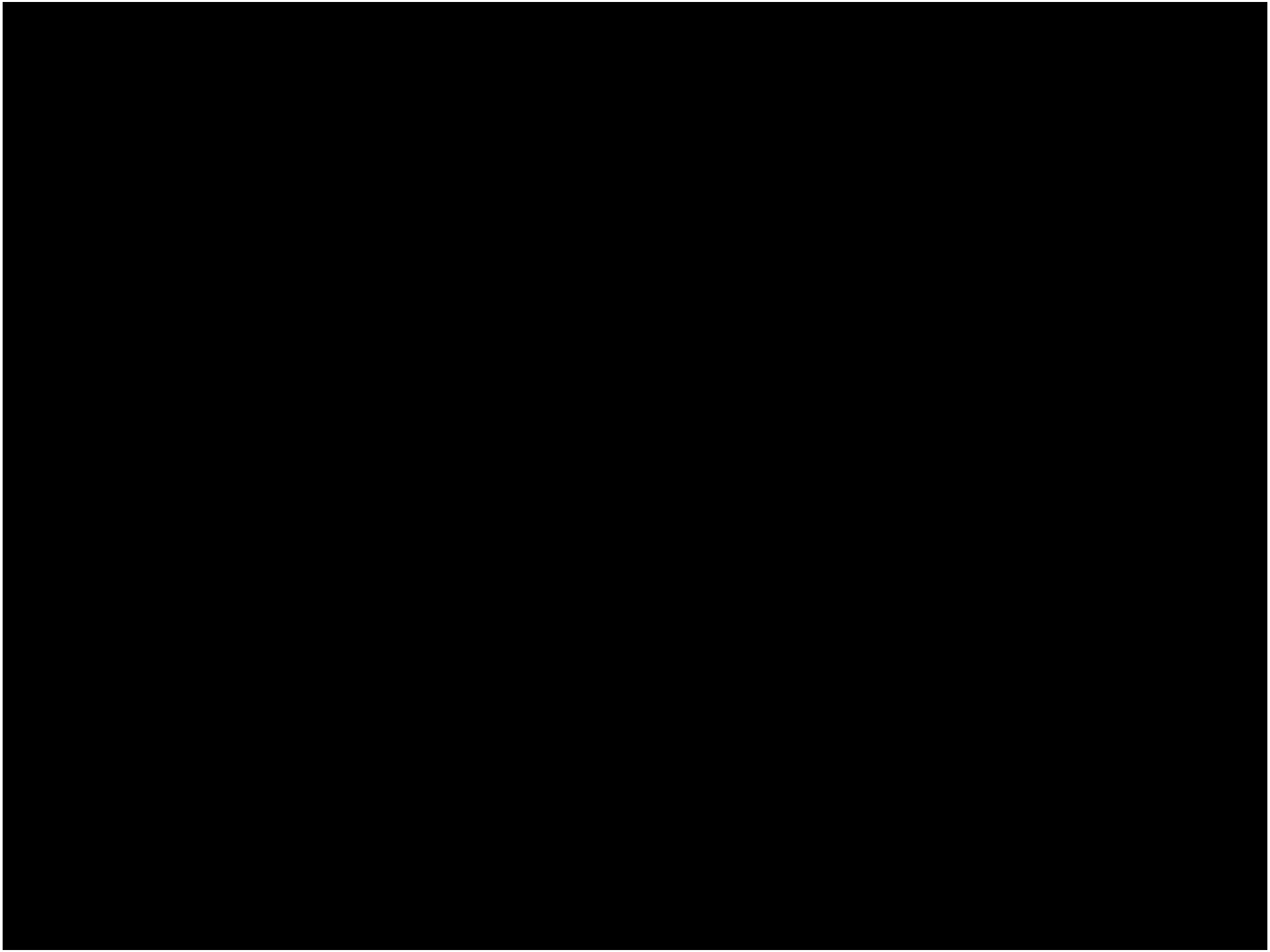
PRI = Photochemical Reflectance Index

ε = photosynthetic light-use efficiency

Photosynthetic light-use efficiency (ε) from multiple angles can be related to:

1) *direct measurements of PRI; and*
2) *shadow fraction (α_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*.