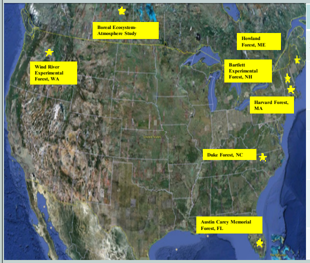
UNCERTAINTIES IN THE RELATIONSHIP BETWEEN HYPERSPECTRAL DATA AND LEAF NITROGEN CONTENT

Yuri Knyazikhin, Mitchell A. Schull, Liang Xu, Ranga B. Myneni and Robert Kaufmann

Department of Geography and Environment, Boston University, Boston, MA

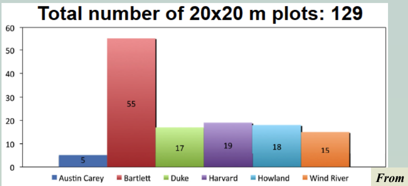
Abstract. **A strong positive correlation between canopy Bidirectional Reflectance Factor (BRF) in the Near InfraRed (NIR, 800-850 nm) spectral range and canopy foliar nitrogen concentration, %N, in temperate and boreal forests has recently been documented [1]. This result was interpreted as an indicator of the direct relation between foliar %N and forest reflectivity. The significance of such a linkage, if true, is two-fold. First, it may indicate an unrecognized role of N in the climate system via its influence on vegetation reflectivity and shortwave surface energy exchange. Second, it may offer a basis for monitoring the foliar nitrogen from space using NIR surface reflectance data. This poster presents an analysis of the observed relationship. Our results suggest (1) canopy structure is the dominant factor that positively relates NIR BRF and %N; (2) the observed relationship does not indicate feedback in the Earth's climate system involving N cycle; (3) BRF spectra in the interval [700, 790] provide critical information needed to remove the effect of canopy structure; (4) foliage surface properties have an impact on forest reflectivity, lowering its sensitivity to leaf absorbing pigments. The use of polarization measurements may help to remove this source of uncertainty in relationship between forest reflectance and leaf biochemistry.**

1. STUDY AREA AND DATA



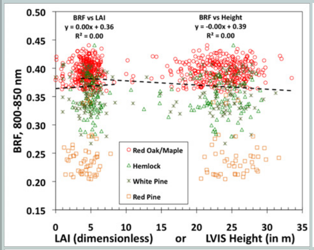
Site	Airborne data	Description
Austin Carey Memorial Forest, FL	AVIRIS	Planted and natural pine
Bartlett Experimental Forest, NH	AVIRIS AirMISR LVIS CHRIS/PROBA	Mixed northern hardwood
Duke Forest, NC	AVIRIS	Pine, pine-hardwood
Harvard Forest, MA	AVIRIS AirMISR LVIS CHRIS/PROBA	Mixed temperate deciduous forest
Howland Forest, ME	AVIRIS AirMISR LVIS CHRIS/PROBA	Boreal-northern hardwood forest
Wind River Experimental Forest, WA	AVIRIS	Temperate evergreen

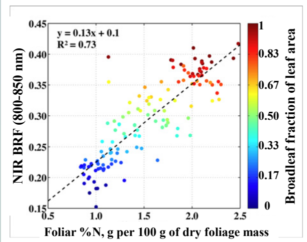
Ground data was collected at 20x20 m plots

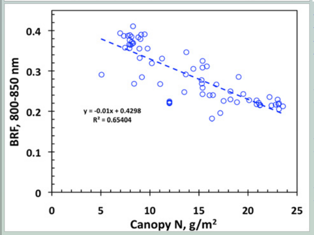


From [2]

2. FEATURES OF STUDY AREA

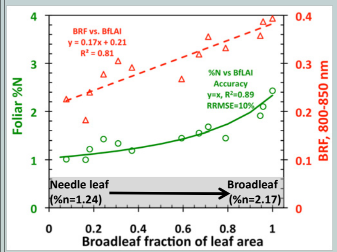






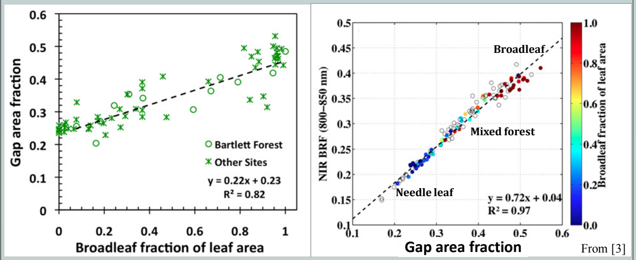
- closed canopy forests (LAI~5)
- no correlation between NIR BRF, LAI and canopy height
- 3D effects of canopy structure on canopy BRF
- positive correlation between NIR BRF and foliar nitrogen
- negative correlation between NIR BRF and total canopy N

3. IMPACT OF CANOPY STRUCTURE



- canopy structure is the dominant factor that positively relates NIR BRF and foliar %N
- the observed positive NIR BRF vs. foliar %N correlation can not be used to retrieve foliar %N
- effect of 3D canopy structure should be removed to relate reflectance data to leaf optics

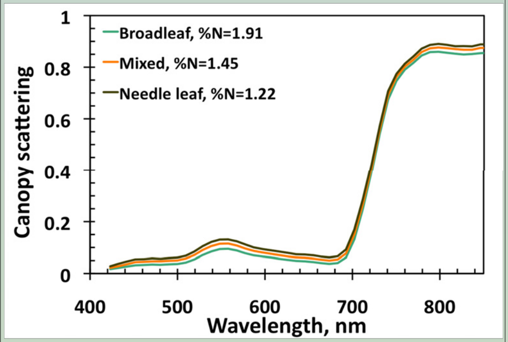
4. CANOPY STRUCTURE AND CANOPY REFLECTANCE



From [3]

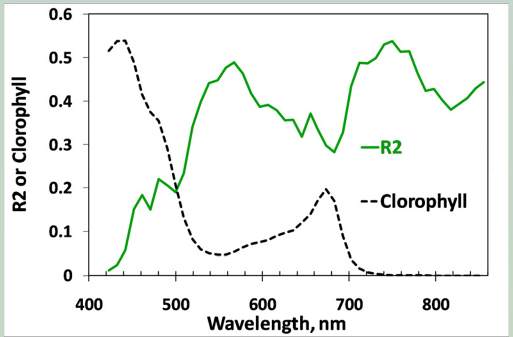
- reflectance data in the interval [710, 790 nm] are required to obtain Gap Area Fraction (fraction of the total leaf area that sensor "sees" in a given direction)
- GAP depends on species composition
- GAP fully explains variation in measured reflectance due to variation in canopy structure, suggesting that the observed NIR BRF vs %N positive relationship conveys no information about foliar nitrogen

5. CANOPY SCATTERING



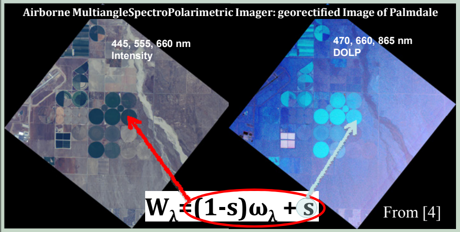
- spectral surface reflectances corrected for canopy structure effects mimic the shape and magnitude of leaf albedo spectra
- negatively related to foliar %N for all wavelength in the interval between 420 and 900 nm

6. SENSITIVITY TO LEAF ABSORBING CONSTITUENTS



- sensitivity (R^2) of the surface reflectance corrected for canopy structure effects mirrors the chlorophyll absorption spectrum
- foliar %N can explain up to 55% of variation in reflectance spectra in the interval between 400nm and 900nm

7. IMPACT OF FOLIAGE SURFACE PROPERTIES



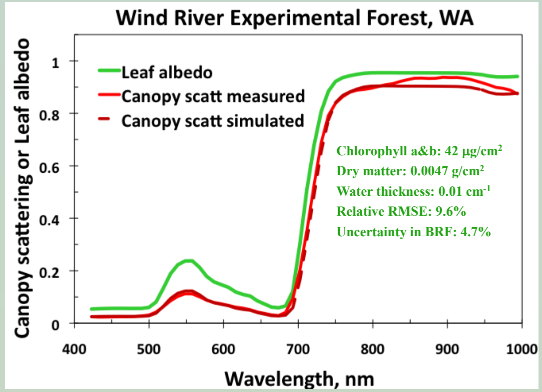
From [4]

Radiation scattered by a leaf includes two components

1) Radiation reflected at the air-cuticle interface
   - polarized; weak spectral variation; depends on the leaf surface properties; <u>no info about leaf interior</u>
2) Diffuse radiation due to "within leaf photon interactions"
   - non-polarized, depends on absorption spectra of leaf pigments; <u>conveys info about leaf interior</u>

Polarized reflectance of 9% can account for 68% of the total leaf reflection [5]. Foliage surface properties may have an impact on forest reflectivity, lowering its sensitivity to leaf absorbing pigments

8. RETRIEVING LEAF OPTICAL PROPERTIES



Information on leaf surface properties is required to retrieve leaf albedo spectra and concentrations of leaf absorbing constituents from measured hyperspectral reflectance

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