MONITORING CANOPY NITROGEN USING MULTIANGLE AND HYPERSPECTRAL DATA

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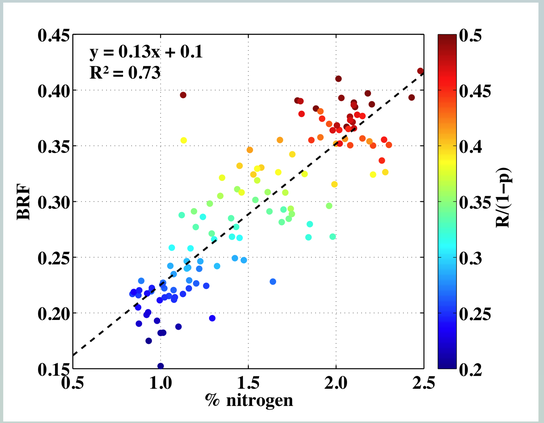
LCLUC PROJECT (NNX09AI30G): REMOTE SENSING OF FOREST STRUCTURE ACROSS MULTIPLE SCALES ROM LEAVES TO CANOPIES AND STANDS

INTRODUCTION

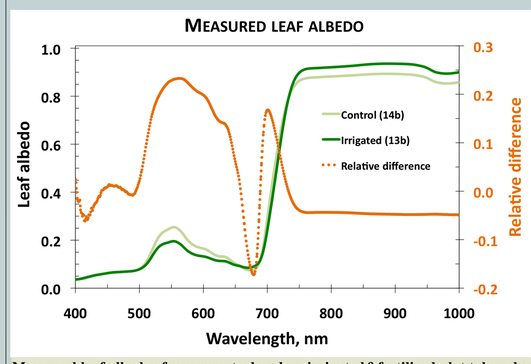


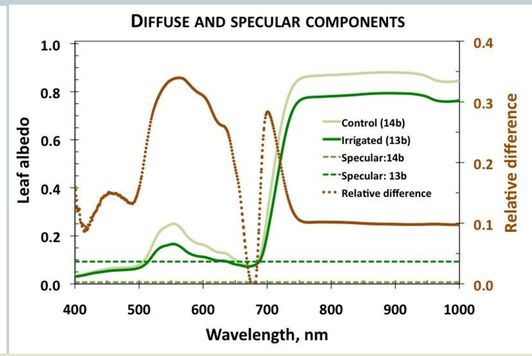
Correlation between canopy Bidirectional Reflectance Factor (BRF) and canopy nitrogen concentration. The BRF was derived from the AVIRIS hyperspectral sensor acquired over forested plots located in the eastern US and Washington state. The plots represent dense patches of forest over a 20 x 20 m plot [1]. The color bar represents canopy structure determined by the canopy gap density derived from the multi-angle reflectance and hyperspectral data data.

A high correlation has been found between canopy NIR reflectance and canopy nitrogen [1].

Question: **What is the mechanism behind the observed correlation?**

LEAF OPTICS AND NITROGEN

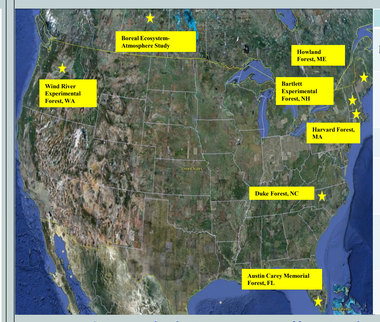




Measured leaf albedos from a control and an irrigated&fertilized plot taken during an international field campaign in Flakaliden, Sweden, June 25–July 4, 2002 [2]. The red dotted lines show relative differences of leaf albedo between the plots. A positive difference in the RED spectral interval (left plot) is due to positive difference in the specula reflection.

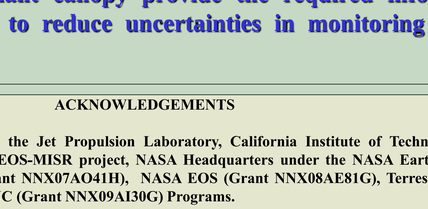
The light reflected by a leaf comes from interaction with the leaf surface and with leaf interior. The surface scattered light (specular reflection) never enters the leaf, displays no spectral dependency and its fraction (3-10%) is determined by the properties of the leaf surface. Light that diffusely reflected by the leaf interior varies spectrally according to the absorption spectra of leaf biochemical constituencies.

STUDY AREA AND DATA



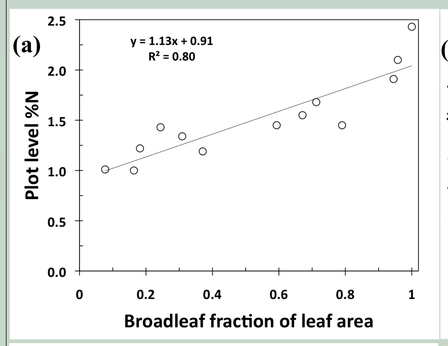
Site	Airborne data	Description
Austin Carey Memorial Forest, FL	AVIRIS	Planted and natural pine
Bartlett Experimental Forest, NH	AVIRIS AirMISR LVIS CHRIS/PROBA	Mixed northern hardwood
Duke Forest, NC	AVIRIS	Pine, pine-hardwood
Harvard Forest, MA	AVIRIS AirMISR LVIS CHRIS/PROBA	Mixed temperate deciduous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

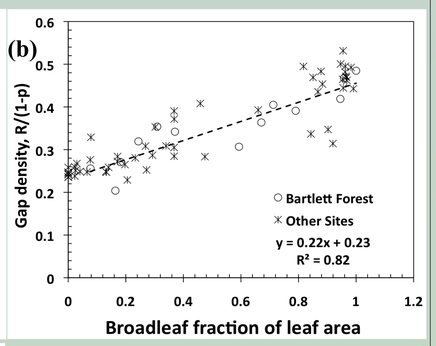
Ground data was collected at 20x20 m plots

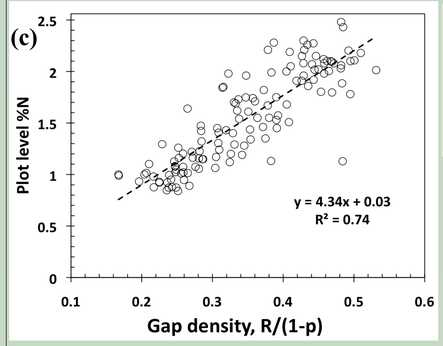


From [3]

CANOPY STRUCTURE AND NITROGEN



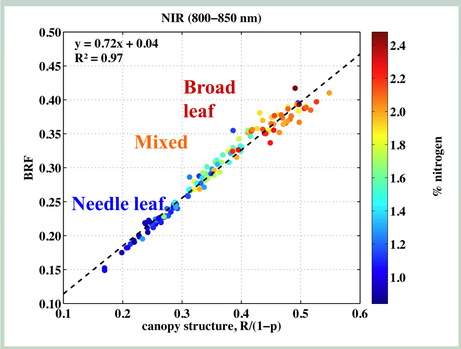


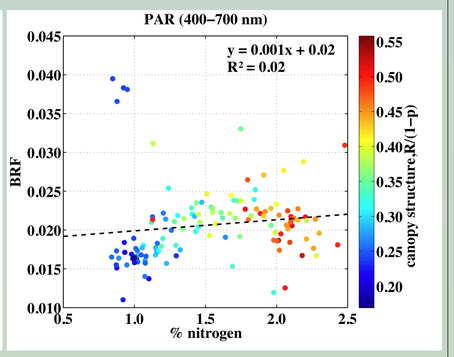


Panel (a). Correlation between canopy nitrogen and *in-situ* Broadleaf fraction of LAI (BfLAI). The positive tendency is due the positive difference in nitrogen content of an average leaf (2.17 g per 100 g of dry leaf mass) and needle (1.24 g per 100 g of dry leaf mass). *From* [4].
Panel (b). Correlation between canopy gap density (CGP) and *in situ* BfLAI. The CGP was derived from AirMISR and AVIRIS data. Note that the BfLAI is labor intensive while the ratio not. [5-7]
Panel (c). Correlation between canopy nitrogen and CGP. (*From* [4])

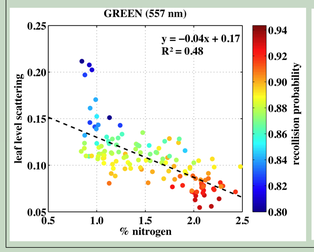
Leaf nitrogen content can vary by the species type. Species fractions therefore become an important factor responsible for variation in the canopy nitrogen concentration. This information can be obtained from hyperspectral and multi-angle data.

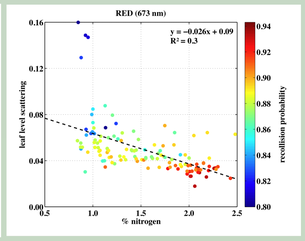
CANOPY REFLECTANCE, STRUCTURE AND NITROGEN

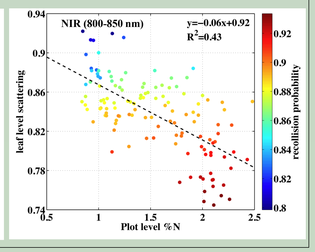




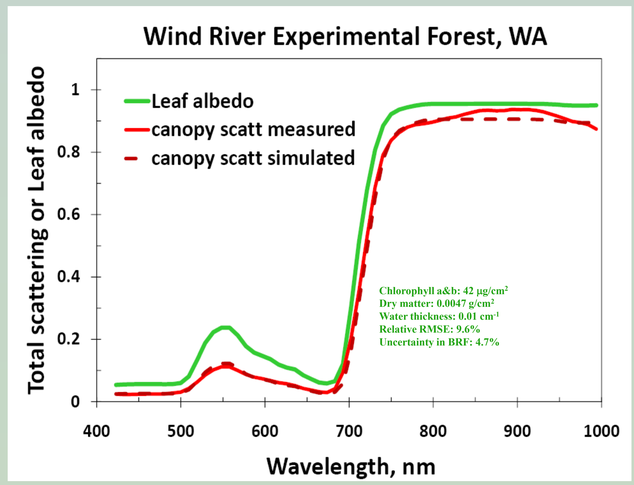
The effect of canopy structure on canopy reflectance is very strong. If its effect is removed, scattering is negatively correlated with nitrogen: the more N, the more leaf absorbs and the darker it is.







RETRIEVING LEAF BIOCHEMICAL CONSTITUENTS



Specular component of leaf scattering should be accounted in order to retrieve concentrations of leaf biochemical constituents. Since surface scattered light is partially polarized, polarization measurements of plant canopy provide the required information which can be used to reduce uncertainties in monitoring canopy nitrogen.

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ACKNOWLEDGEMENTS

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