

Measurements of Tree Canopy BRDF From a Crane Substituting an UAV as Carrying Platform

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1. Introduction & State of Knowledge

- Canopy Models Estimate Canopy Biophysical / Structural Variables for Applications in Different Disciplines
- Remote Sensing Can Play an Important Role in Providing Information to Canopy Models or Vice Versa (Inversion)
- Hyperspectral RS Contains Useful Information



1. Introduction & State of Knowledge

- Reflectance of Vegetation Varies Strongly With Sun-Sensor-Viewing Geometry
- Measuring Reflectance in Canopies is Challenging
- UAVs Have the Potential to Carry Measurement Devices



- 2. Research Gaps, Opportunities, Challenges
- Gain Experience in Hyperspectral RS, Data Processing and Analysis
- Heterogeneous Photosynthesis within Tree Canopy Depends on Sun Elevation
 > Derived from Fluorescence Measurements
- Time Constraints
- Focus on Reflectance and BRDF only



3. Our Methodology

- Two Trees at Las Majadas Research Site
 - Easily accessible
 - Quercus ilex (Holm Oak)
 - Different canopy shapes
- 2 Spectrometers
 - Ocean Optics USB2000
 (350 nm 1026 nm, Res ~ 0.4 nm)
 - Ocean Optics HR Maya (650 nm – 834 nm, Res 0.1 nm)
 - Both measure upwelling and downwelling light alternatingly
- 1 NIR camera
- 1 Truck Crane





3. Our Methodology



















3. Our Methodology: Calculation of VIs

Vegetation Index	Formula
PRI	$\frac{R531 - R570}{R531 + R570}$
NDVI	$\frac{R750 - R680}{R750 + R680}$
MTCI	$\frac{R754 - R709}{R709 + R681}$



3. Our Methodology: NIR Camera Images











Idea: Calculation of Image Position over Canopy



Didn't work! 😕



4. Our Findings: Reflectance





4. Our Findings: VIs















5. Conclusions

- BRDF effects are evident in our measurements
- BRDF effects are stronger in visual domain than in NIR
- BRDF effects are stronger in symmetrical canopy than in asymmetrical canopy
- Variation of PRI most likely due to BRDF effects instead of physiological changes
- NDVI most stable vegetation index
- UAVs could be used to measure BRDF effects over canopies 14



Connection Points to Other Projects

- 1. Calculate View Angles with 3D Model Increase Accuracy
- Combine with leaf-level reflectance see effects of vegetation variability
- 3. ...



Thanks for Your Attention!!