TEMPORAL AND SPATIAL DYNAMICS OF SPECTRAL BIO-INDICATORS AND PHOTOSYNTHETIC ACTIVITIES IN A CORNFIELD

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INTRODUCTION

Canopy-level and leaf-level Spectral Bio-indicators indices derived from hyperspectral field data were examined for temporal dynamics in conjunction with carbon and energy fluxes and meteorological observations made from an instrumented tower. This was accomplished through intensive field-based campaigns conducted in an experimental cornfield at the USDA/Agricultural Research Service (ARS) in Beltsville, MD. During one day per week, diurnal measurements were made over a six week period in 2007 (see Hummerich \textit{et al}., 2008) and over a 14 week period in 2008 along a transect within the tower footprint. In 2009, daily spectrometer measurements were acquired over a five week period in the adjacent nitrogen treatment plots (supplemental N at 0%, 50%, 100% and 150% of the optimal N).

Define Terms: PRI = Photochemical Reflectance Index; SIF = Solar Induced Fluorescence; Fyield = Fluorescence Yield=SIF/PAR; FLR = Fraunhofer Line Depth; NEP = Net Ecosystem Production; PAR = Photosynthetically Active Radiation; LUE = Light Use Efficiency

METHODS

- High resolution (~1 nm) canopy-level spectral measurements (USB4000 Miniature Fiber Optic Spectrometer, Ocean Optics Inc., Dunedin, Florida, USA) used to determine SIF and PRI.
- PRI = (\rho_{531} - \rho_{750}) / (\rho_{531} + \rho_{750}).
- SIF was derived using FLR retrieval approach centered on the two atmospheric oxygen bands at 688 (O\textsubscript{2}-B; F\textsubscript{0}/F\textsubscript{Red}) and 760 nm (O\textsubscript{2}-A; F\textsubscript{0}/F\textsubscript{FarRed}).
- NEP and PAR were tower-derived; LUE was calculated as NEP/PAR.

RESULTS

- Considerable within-day as well as day to day variation was observed for NEP, PAR, and LUE, and all declined over the 2008 growing season (Fig. 1).
- The PRI was determined from average transect reflectance measured with the Ocean Optics (1 nm resolution) versus Fluorescent (mol C/mol Qa) from observations at the USDA/ARS cornfield in 2008. Colored lines/symbols connect observations collected over the same day. Regression line (r\textsuperscript{2} = 0.61, n = 81).

CONCLUSIONS

We found that canopy-level SIF, Fyields, and the PRI varied significantly throughout each field day, with the available PAR exerting a significant control on responses. The PRI and fluorescence parameter values tracked daily as well as seasonal changes in canopy level physiological stress. PRI successfully described seasonal declines in LUE for the cornfield.

SIF showed a clear difference among different nitrogen treatment plots separating non-stressed and stressed plots. Our studies advocate the use of hyperspectral data with various bio-indicators to monitor, estimate and model vegetation physiological status and carbon-related activities.

REFERENCES


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