PP Systems

Optical Sampling with UniSpec-SC/DC



Leaf/Ecosystem Optical Sampling

- Plant Physiology & Ecology
- Field Crop Monitoring
- Screening Plant Populations
- Ground Truthing
- Oceanography/Aquatic Plants

UniSpec-SC





Ecosystem ground remote sensing

- Remote Sensing (aircraft, balloons, flux towers)
- Ground Truthing
- Automated Optical Sampling
- Plant Ecophysiology

UniSpec-DC







Optical/RS Instruments

Plant Ecophysiology Pigments (color) Physiology ("health") Photosynthetic activity Water content

Remote Sensing as a scaling tool Field sampling/ground truthing Mobile platforms Tram/Cable/Balloon Aircraft UniSpec-SC

UniSpec-DC



Unispec-SC as a "reflectometer"





Leaf reflectance monitoring





Needle Leaf Mini Clip

Broad Leaf Standard Clip



Leaf reflectance equations





Leaf Reflectance (Healthy/Dead)



PRI (xanthophyll cycle pigment index) responds rapidly to sudden illumination, reflecting changes in energy dissipation linked to photosynthetic activity.



Gamon et al. 1997

Reflectance indices can be used to monitor changing pigment levels in developing leaves (*Quercus* sp. shown here).



Leaf reflectance indices can be calibrated against pigment content determined by wet chemical methods (HPLC and spectrophotometry).



Reflectance indices provide rapid, non-destructive pigment screening techniques (e.g. can be used to evaluate pigment expression in *Arabidopsis* sp.)



Gamon & Surfus 1999

Assessing vegetation water content with spectral reflectance





Sims & Gamon 2003

Assessing N_{leaf} content with spectral reflectance







UniSpec-DC: Ecosystem Optical Properties



For simultaneous measurement of incident and reflected light – allows sampling under all sky conditions (including clouds).



Calculating the reflectance





UniSpec-DC Application

- Remote Sensing (aircraft, UAVs, balloons, etc.) and spatial and temporal analyses.
- Ground Truthing (Multi-Scale analyses, integrated GPS)
- Automated optical sampling (tram systems, unattended operation (wireless))
- Link to ecophysiological properties (e.g., species composition, carbon and water fluxes)







UniSpec-DC Platforms







Components of Ecosystem CO₂ Flux

Photosynthesis = f (<u>absorbed radiation</u> x <u>efficiency</u>)

(NDVI & PAR) (PRI, fluorescence)

Respiration = f (temperature, moisture...)

Index:	Formula:	Application:
Normalized difference vegetation index	$NDVI = (R_{800} - R_{680}) / (R_{800} + R_{680})$	Green vegetation cover
Water band index	WBI=R ₉₀₀ /R ₉₇₀	Vegetation water content
Photochemical reflectance index	$PRI = (R_{531} - R_{570}) / (R_{531} + R_{570})$	Pigment content and photosynthetic light use efficiency
Red edge derivative	D ₇₂₀ /D ₇₀₀	Pigment content and photosynthetic light use efficiency



PP Systems

Multi-scale sampling

By comparing optical measurements at various scales, we can evaluate the accuracy of satellite data.

The UniSpec-SC and UniSpec DC have been used in a variety of ways to evaluate satellite data.















The MODIS satellite overestimates FPAR (relative to tram and aircraft)



Cheng et al., in press

The Enhanced Vegetation Index (EVI) agrees well across all sampling platforms



Cheng et al., in press











July, 2004





Spatial and temporal vegetation monitoring



Spatial optical property monitoring

Temporal optical property monitoring

Effects of species and drought on spectral reflectance



Af = Adenostema fasciculatum (chamise) Ap = Arctostaphylos pungens (manzanita) As = Adenostema sparsifolium (redshank)

Claudio et al. in press



Linking remote sensing to carbon fluxes





Vegetation index and carbon flux

