Field Spectroscopy, and its role in Earth Observation

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Making Sense of the Scene

• First we see, then we measure.
• “Nature is too green and badly lit”
  (François Boucher, 1703-1770)
• What we see is not the complete picture.

• ‘Boreal’ created using the ‘Persistence of Vision’ Ray Tracer

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Role of Field Spectroscopy in 'scaling-up'

- Scaling-up from individual elements of the scene to areas the size of a pixel.
- Based on physical units: radiance, irradiance and reflectance.
- Traceability of measurements is important – need to standardise methods and materials.

Principles of Field Spectroscopy

Proximate Field Spectroscopy

Recreating Sun and skylight indoors

Relocating samples to the lab

Measuring the BRDF

(Bidirectional Reflectance Distribution Function)

... a mathematical function “relating the irradiance incident from one given direction to its contribution to the reflected radiance in another direction” (Nicodemus et al., 1977)
Madrid Workshop 3-4 Dec 2009

BRDF vs ‘reflectance factor’

What we actually measure is the ‘Hemispherical-Conical Reflectance Factor’ (HCRF)

Incident light from the Sun and the sky

Reflected light from the surface contained within a 3D cone

Measurement of reflectance factors

- Reference panels need calibrating (spectral and angular).
- Reference panels deteriorate over time.
- Reflectance factors are not an inherent property of the target.

... need to pay more attention to the spectral irradiance distribution.

Automated Tramway for Spectral data collection

Sand White tile (shiny) Gravel Reference tile (matt)

Reflectance Factor: Clear vs. Overcast sky

Vincent Odongo (2010)

Gravel

Reflectance Factor: Clear vs. Overcast sky

Vincent Odongo (2010)

Sand
Reflectance Factor: Clear vs. Overcast sky

White tile

The importance of metadata

- Site information
- Reference panel
- Foreoptics etc.

- Sequence of spectral data, with times and notes.

- Ancillary data
- Calib. history
- Sky codes
- Contact details

isco Field Spectroradiometer (1969)

Portable Multiband Radiometers
Demonstration of SAMS Spectral Analysis and Management System

http://sams.casil.ucdavis.edu/

The problem of sub-visual clouds

- Cause the amount of irradiance to change rapidly.
- Cause the angular distribution of irradiance to vary.

**Significant source of error**

Possible solutions:
- dual-beam methodology
- monitor or model the irradiance

Simulated dual-beam method

- Reduced error by 50% compared with single-beam method.


Dual-beam HCRF and D:G ratio (parasol method)

Variable Geometry Instruments

- The NPL GRASS goniometer

University of Zurich RSL dual-beam goniometer
Role of Field Spectroscopy in Modelling

Independent spectral data for QA (leaf and canopy scale)

Data assimilation e.g. from automated networks

Field Spectroscopy in Earth Observation

Field Spectroscopic Measurements

+ time

Field Spectroscopy and vegetation canopy dynamics

Seasonal change in the HCRF of weathered concrete

Estimating the BRDF

- Measure the HCRF
- Use this in a mathematical model to estimate the BRDF

Co-ordinate system (Sun at 180°)

Field Spectroscopy in Earth Observation

Gamon et al. (2006)

Anderson and Milton (2006)
Roles for Field Spectroscopy in EO

- An effective tool for teaching the physical principles of remote sensing.
- Scaling-up from individual elements of the scene to areas the size of a pixel. Using those pixel-scale data to:
  - validate numerical models & perform sensitivity analysis
  - validate sensor calibration post-launch
  - correct remotely sensed data for the effect of the atmosphere.
- Complementary to imaging spectrometry – FS can give access to the dynamics of the scene. Link with processes and change.