Field Spectroscopy, and its role in Earth Observation

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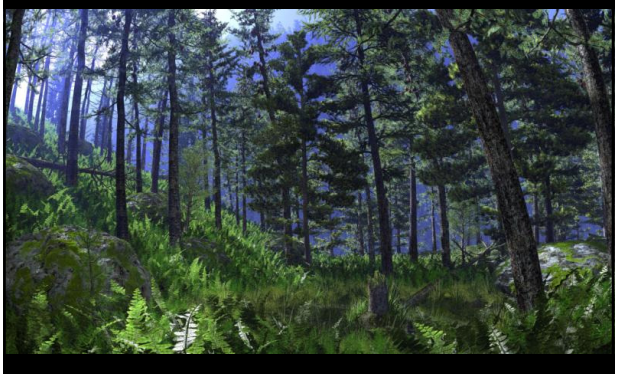
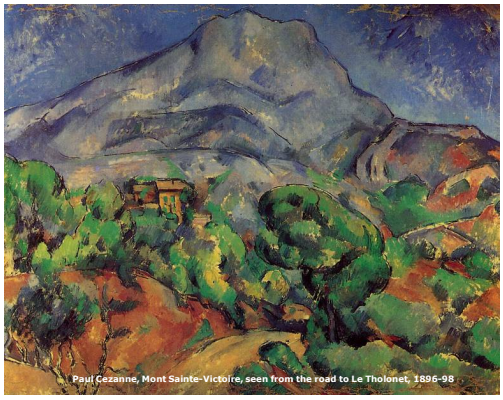
Making Sense of the Scene



Making Sense of the Scene



Paul Cezanne, Mont Sainte-Victoire, seen from the road to Le Tholonet, 1896-98

Making Sense of the Scene

Vincent van Gogh, Long Grass with Butterflies

Making Sense of the Scene

'Boreal' created using the 'Persistence of Vision' Ray Tracer
by Norbert Kern (2004)

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.

Boucher, Madame de Pompadour, Wallace Collection

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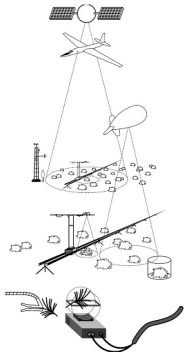
Role of Field Spectroscopy in 'scaling-up'

- 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

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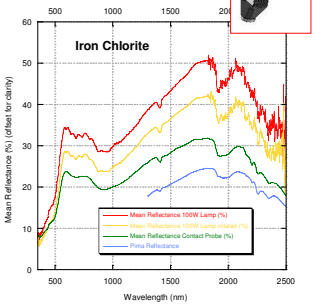
Proximate Field Spectroscopy



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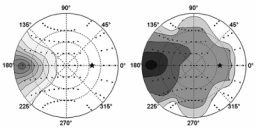
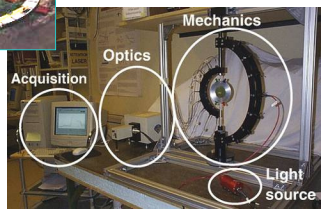
Relocating samples to the lab

Peltoniemi et al., 2005

Beech leaves



Combes et al. (2007)



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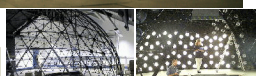
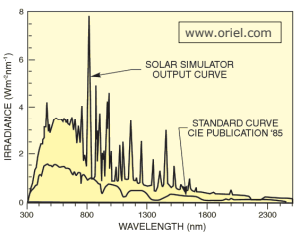
Recreating Sun and skylight indoors

http://www.cardiff.ac.uk/archi/skydome.php





Peltoniemi et al., 2005

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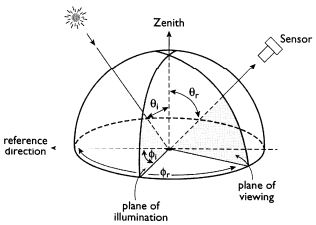
Measuring the BRDF

(Bidirectional Reflectance Distribution Function)



BRDF is

- an inherent property of the surface.
- conceptual, not measurable.
- a mathematical function, not a single value.

... 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)

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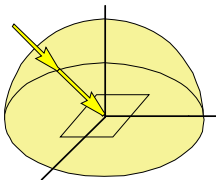
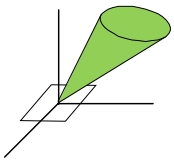
BRDF vs 'reflectance factor'

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

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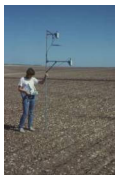
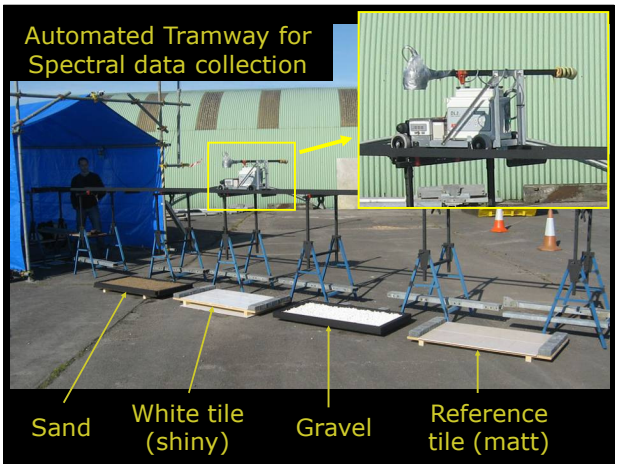
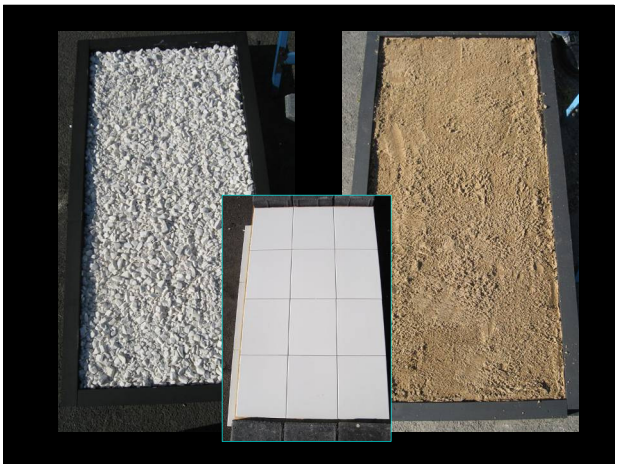
Measurement of reflectance factors



- 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.





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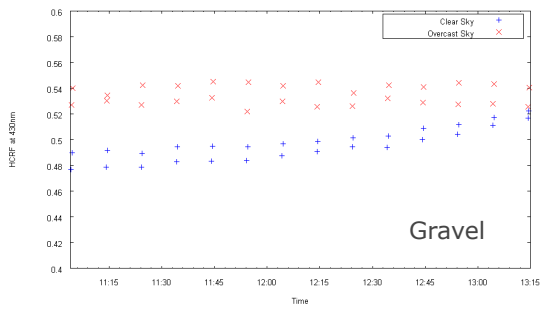
Reflectance Factor: Clear vs. Overcast sky



Vincent Odongo (2010)

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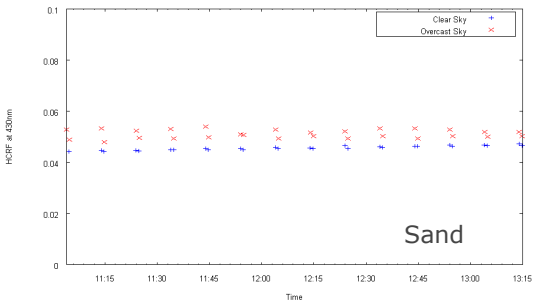
Reflectance Factor: Clear vs. Overcast sky



Vincent Odongo (2010)

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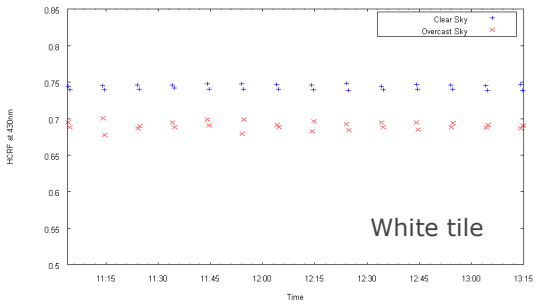
Reflectance Factor: Clear vs. Overcast sky



Vincent Odongo (2010)

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The importance of metadata

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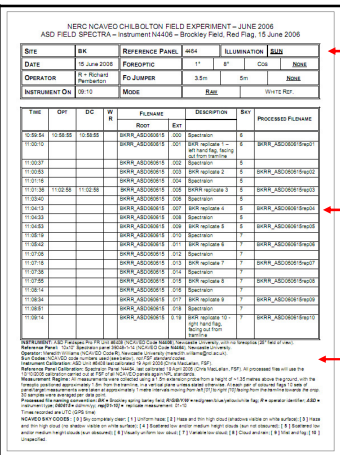

- Site information
- Reference panel
- Foreoptics etc.

Sequence of spectral data, with times and notes.

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

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Development of Field Spectroscopy 1970 - 2010

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ISCO Field Spectroradiometer (1969)

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Portable Multiband Radiometers

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Role of FS in Education and Training

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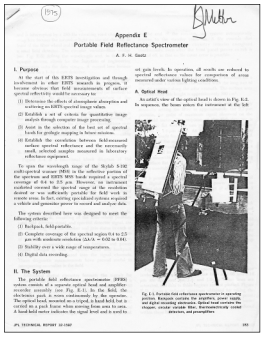
JPL Portable Field Reflectance Spectrometer (1975)



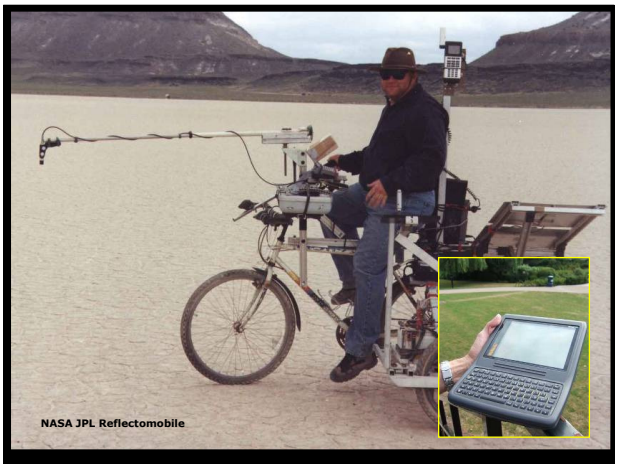
Appendix E

Portable Field Reflectance Spectrometer

A. F. H. Goetz

I. Purpose

II. The System



NASA JPL Reflectomobile

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Fixed Geometry, Single Beam Instruments

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Solutions to the problem of tall canopies

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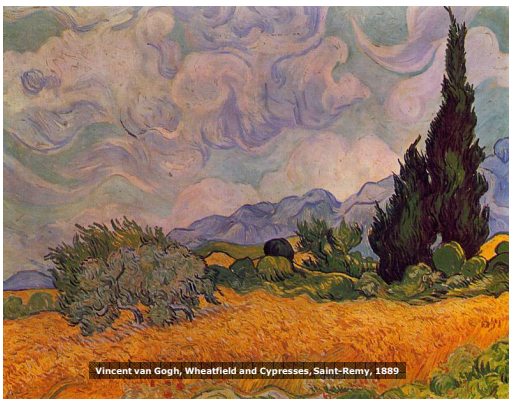
The problem of sub-visual clouds



Vincent van Gogh, Wheatfield and Cypresses, Saint-Remy, 1889

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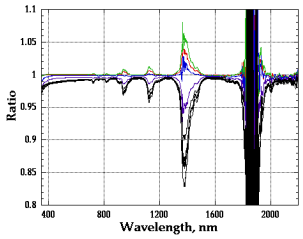
Demonstration of SAMS Spectral Analysis and Management System



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

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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

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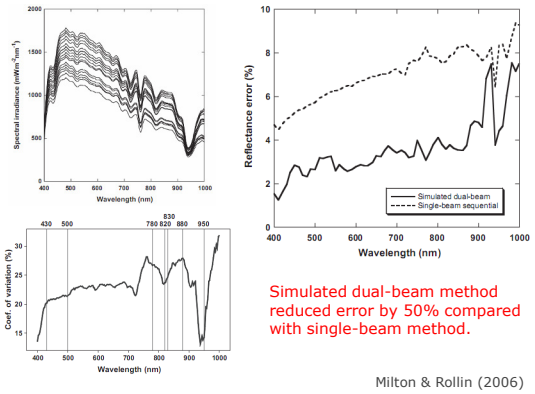
Simulated dual-beam method



Simulated dual-beam method reduced error by 50% compared with single-beam method.

Milton & Rollin (2006)

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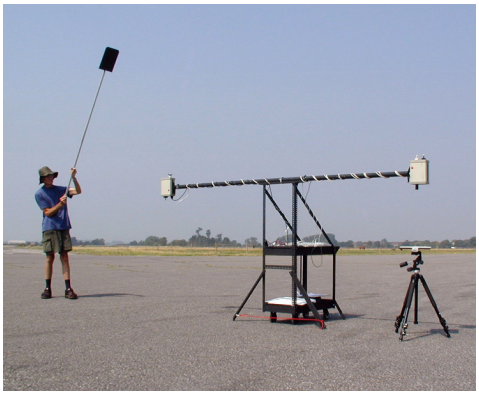
Dual-beam HCRF and D:G ratio (parasol method)



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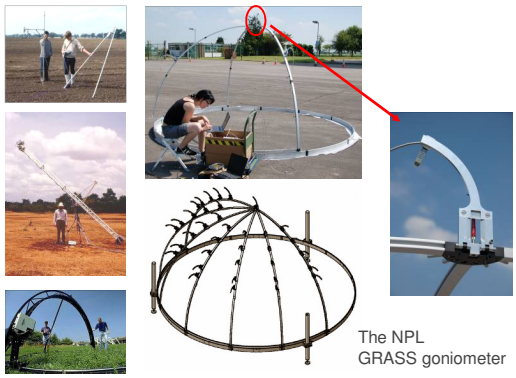
Variable Geometry Instruments



The NPL GRASS goniometer

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University of Zurich RSL dual-beam goniometer

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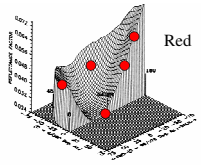
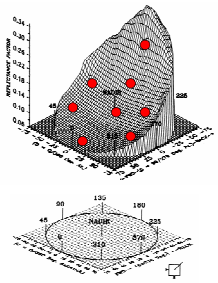
Estimating the BRDF

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

Dense grass canopy



Bare soil (red wavelengths)



Co-ordinate system (Sun at 180°)

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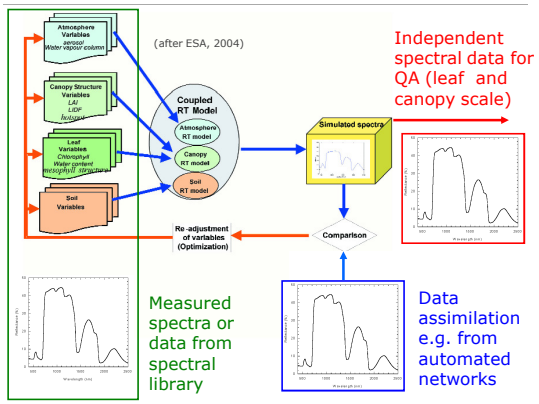
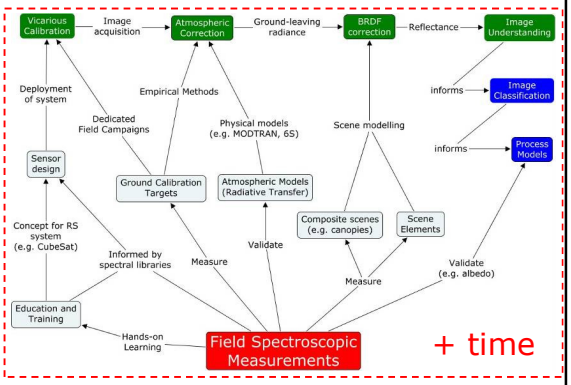
Role of Field Spectroscopy in Modelling



Field Spectroscopy in Earth Observation

Field Spectroscopy in Earth Observation



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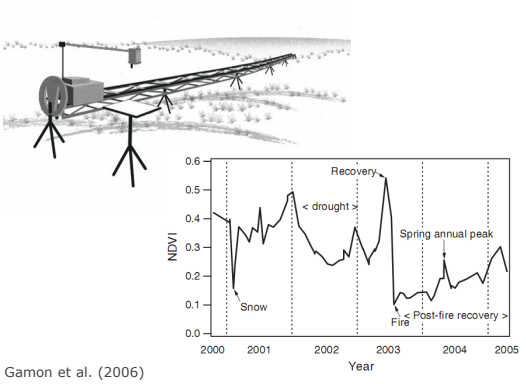
Field Spectroscopy and vegetation canopy dynamics



Gamon et al. (2006)

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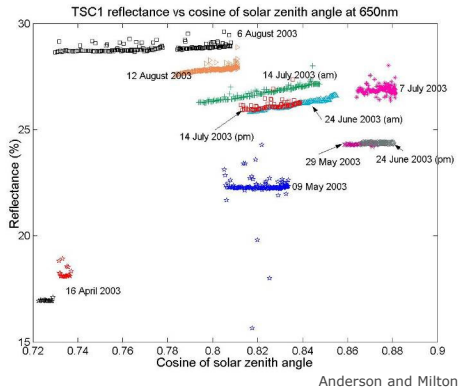
Seasonal change in the HCRF of weathered concrete



Anderson and Milton (2006)

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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 anaysis
  - 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.

NCAVEO
Field Campaign