

Estimating spectral irradiance from a limited number of discrete bands in the visible / near infrared

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Field spectra are needed for ...

- Vicarious calibration
- Atmospheric correction
- Modelling



The common method



Single-beam, sequential measurements of target and calibrated panel.

Advanced single-beam methods



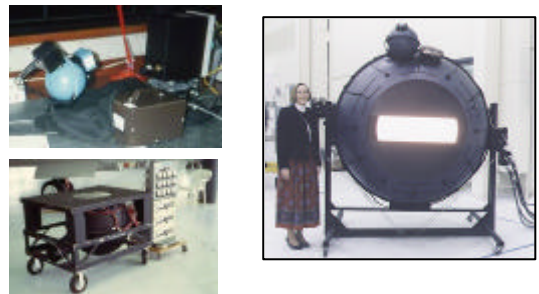
Sources:
1. FIGOS - Univ. Zurich
2. www-mistr.jpl.nasa.gov
3. Reflectomobile - JPL

The 'quality' of field spectra...

- **Traceability** implies ... unbroken chain of comparisons, all having stated uncertainties (aka 'accuracy').
- **Repeatability** relates to the difference between successive measurements ... under the same conditions of measurement (aka 'precision').
- **Reproducibility** relates to the difference between successive measurements ... under changed conditions of measurement.

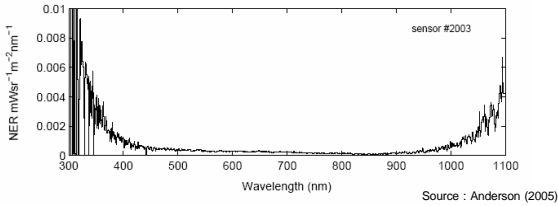
Based on CEOS WGCV definitions (Fox, 2001).

Traceability



Repeatability

- Modern field spectroradiometers have excellent repeatability. Example below shows the noise-equivalent spectral radiance of a GER 1500 spectroradiometer.



Reproducibility

- Relatively poor due to the methodology commonly adopted in the field.
- Under realistic field conditions, typical values for the coefficient of variation, expressed as (s.d. / mean * 100) are around a few percent.
- Reason : single-beam methodology.

The dual-beam methodology



Problems with dual-beam methodology

- Cost.
- Matching the two sensor heads (derivation of the intercalibration function - ICF).
- Sensitivity of the ICF to environmental factors.
- Anderson *et al.* (IJRS in press). ICF best derived in the field, and repeated several times during a set of measurements.

Aim of the experiment

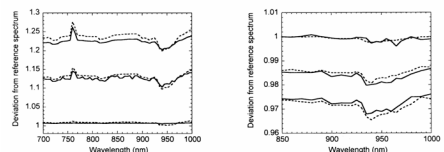
To simulate dual-beam spectral measurements using :

- Conventional spectroradiometer measuring the target radiance;
- Bandpass radiometer measuring the irradiance in a small number of discrete bands;
- Model relating fine bandwidth measurements to contiguous regions of the solar spectrum.

Phase 1 : Proof-of-concept

Milton and Goetz, 1997

- ASD FR spectroradiometer.
- 100 spectra from Spain, 92 from Colorado.
- Artificial neural network.
- Seven predictor wavelengths : 425, 500, 780, 820, 830, 880 and 950nm. FWHM = 10nm.



Phase 2 : a more flexible approach

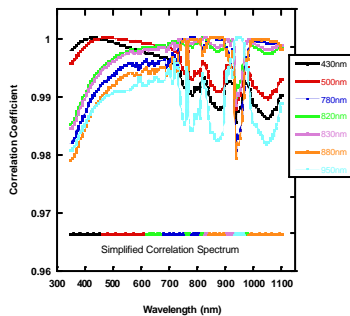
- ANN needed to be re-trained for different instruments.
- Computational limit on number of output nodes.
- Towards a physically-based method : spectroradiometer calibrated to radiance.
- Regression model to relate radiance at each of the seven input λ to radiance at adjacent λ .

Phase 2 : the data set

- Data from three different spectroradiometers.
- Over 550 spectra, from seven dates 1999– 2003.
- Southern and eastern England
- Diffuse-to-Global ratios between 0.15 and 0.48 (@ 550nm)
- Linear regression model.
- Seven reference wavelengths : 425, 500, 780, 820, 830, 880 and 950nm. FWHM = 10nm.

Date	Instrument	Bandwidth/ Sampling Interval
21May99	Spectron SE590	10nm/3nm
24July01	ASDFieldSpec Pro	1.5nm
18June 02	GER1500	1.5nm
28June 02	GER1500	1.5nm
16April03	Spectron SE590	10nm/3nm
29May03	Spectron SE590	10nm/3nm
16June03	Spectron SE590	10nm/3nm

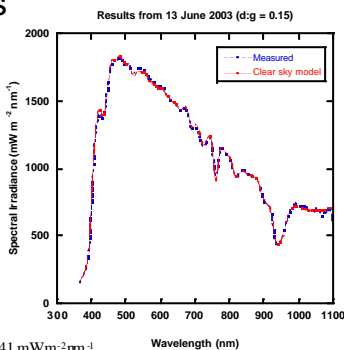
Correlation between reference λ and adjacent λ



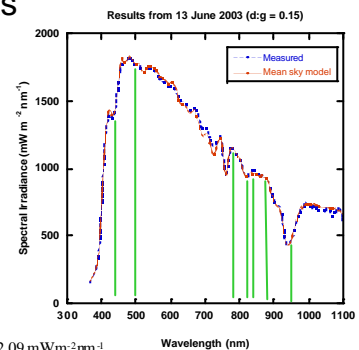
Phase 3 : the INSPIRE instrument

- Independent Spectral Irradiance Estimator.
- Seven band instrument.
- 10nm bandwidth interference filters.
- Measures the spectral radiance of a calibrated Spectralon panel.
- Spectral irradiance estimated using the regression models derived in Phase 2.

Results



Results



Conclusion

- The dual-beam methodology is highly desirable, but very difficult (and costly) to implement in practice.
- An empirical, model-based approach is a good substitute and can produce excellent results.
- Further validation of this new method is required under a range of conditions.