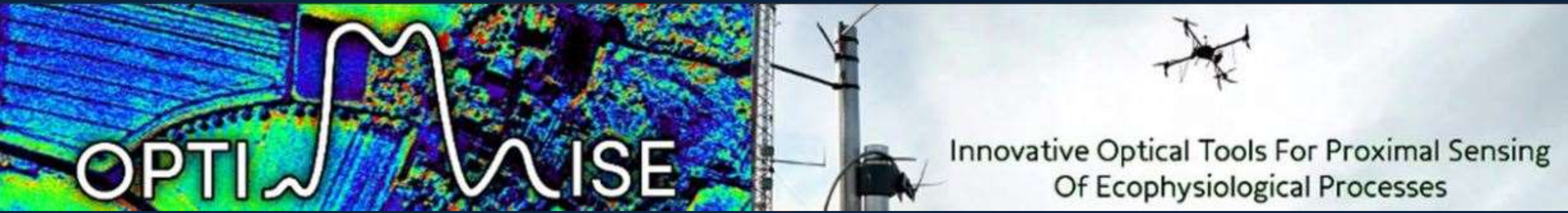


COST Action ES1309 OPTIMISE - Final Conference, 21-23 February 2018

Instruments, spectral data management, and protocols

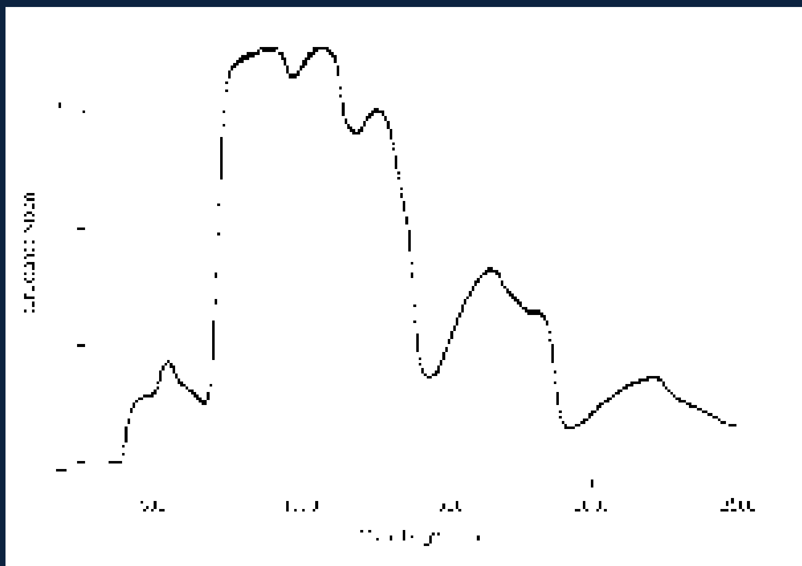
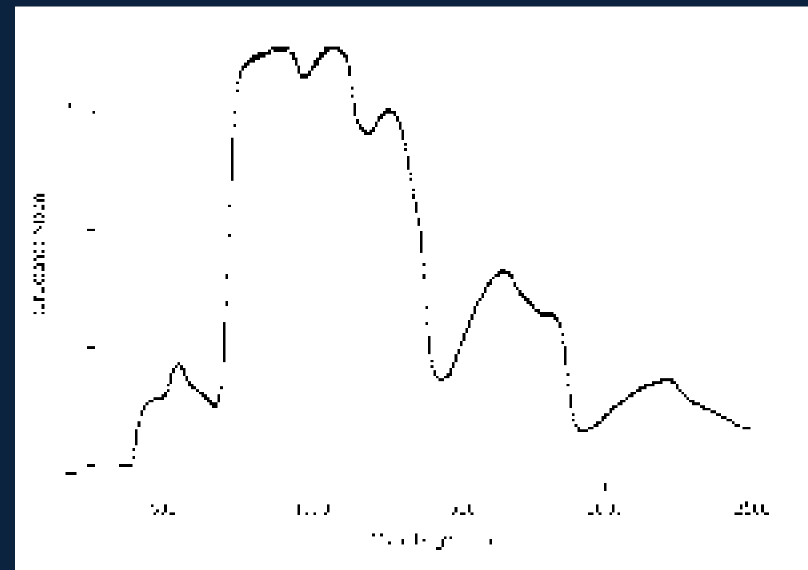
Laurie Chisholm

University of Wollongong

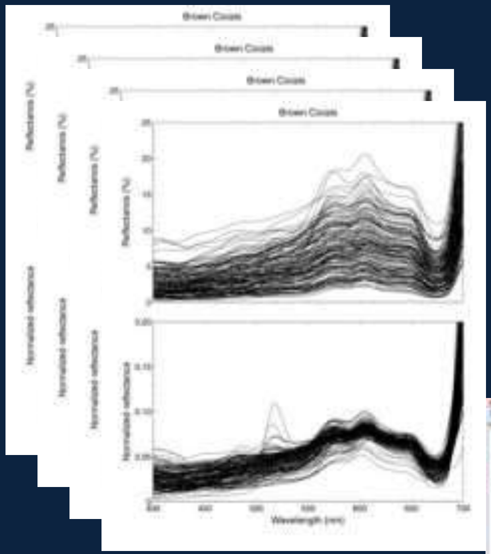
UNIVERSITY
OF WOLLONGONG
AUSTRALIA

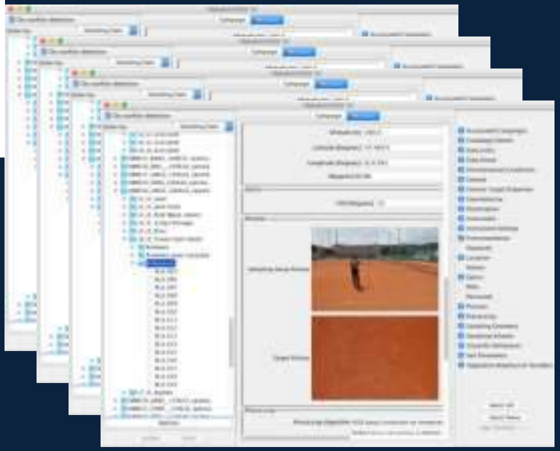
Common types of field spectroscopy Clockwise from left: vegetation, estuarine, snow, underwater coral, and geological. Source (Source: Rasaiah etal 2012)

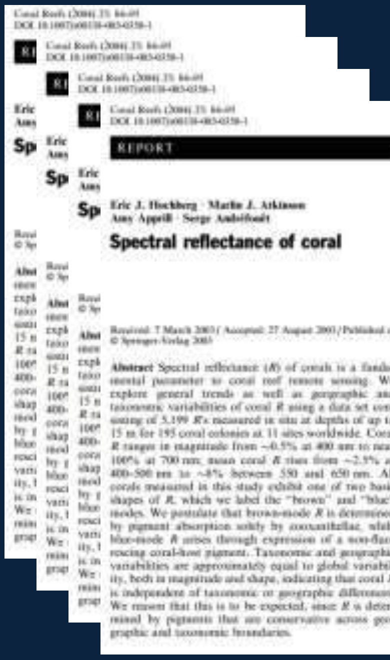
Does this change things for your project?

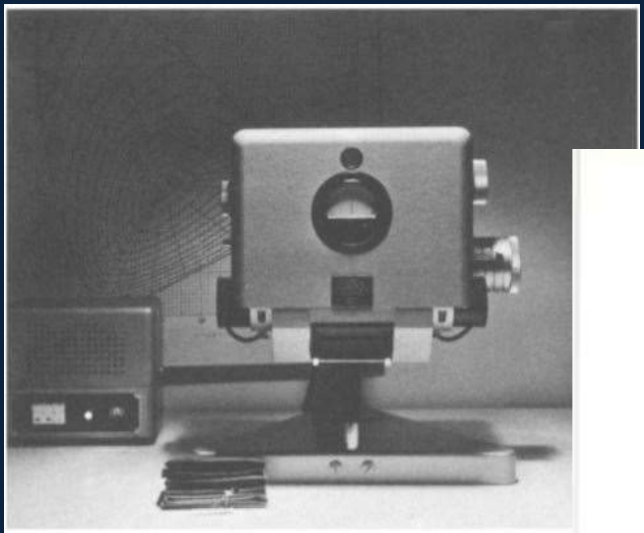
21^{st} Sept 2013	**Acquisition Date**	Unknown
8	**Fore optic degree**	Unknown
25	**Number of samples**	Unknown
25	**Dark current integrations**	Unknown
10	**White reference integrations**	Unknown

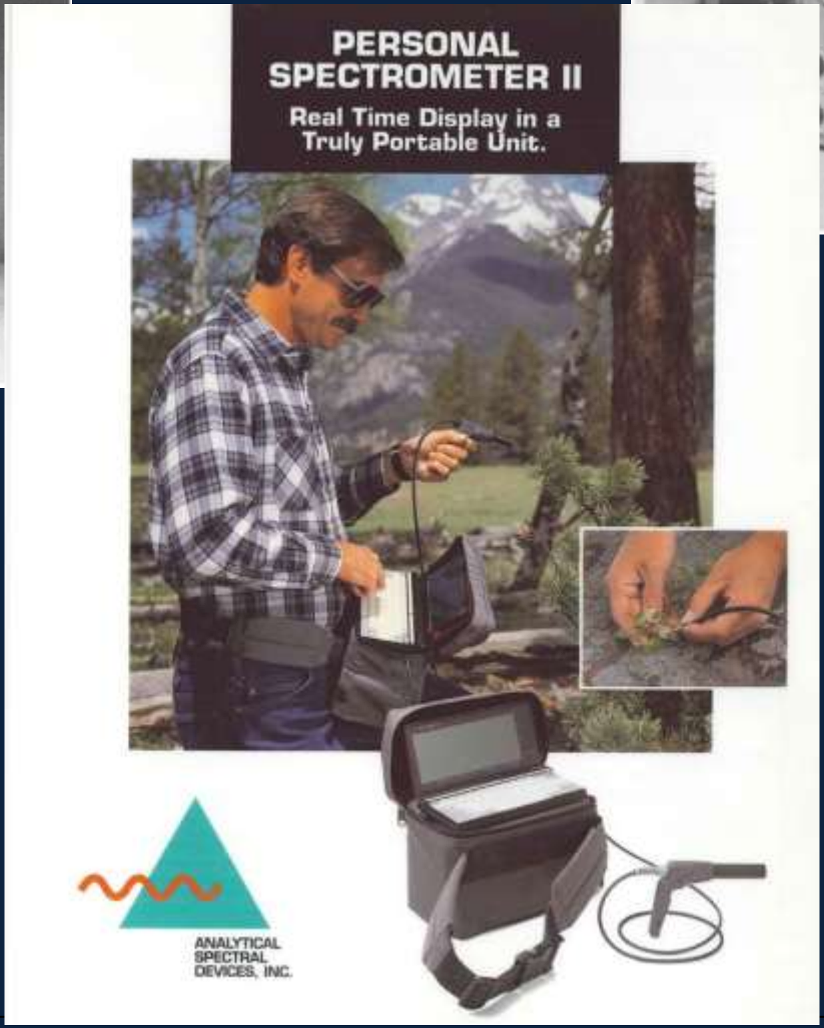

Brown Corals
Reflectance (%)
Normalized reflectance
Wavelength (nm)




REPORT
Spectral reflectance of coral

Instruments





Wendlandt 1968; ASD 1990

ASD FR 4 Hi Res

PolyPen RP 400

Spectral Data Management

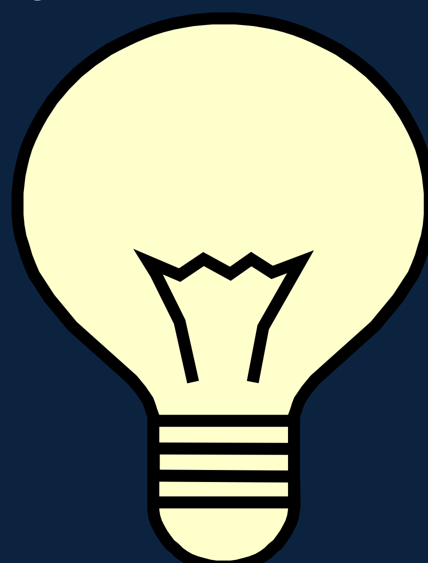
Giving thought to the story of your research data

Setting up your research design

collect

store

describe



share

What’s your data management plan?

- The Usual Stuff
  - My name, project title, project timing, project context, etc.
- The Field Stuff
  - Sites, permissions, documentation, etc...
- The Spectral Data Stuff
  - Instrument
  - Protocol
  - Generate data
  - How much data to generate
  - What do you expect to be able to **<u>do</u>** with it?

= RESEARCH OUTPUT

Why?

It saves time

Encourages re-use

Supports research integrity

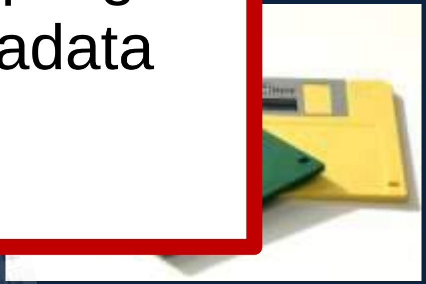
Adds value

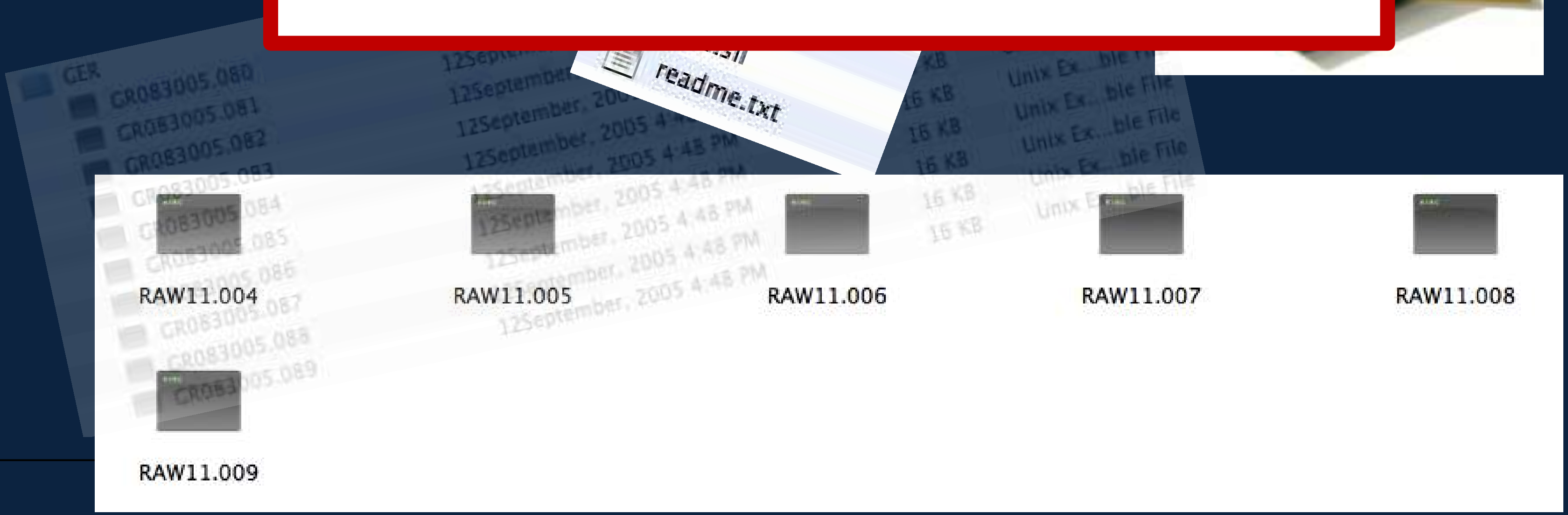
Nemesis of spectral data collections

Collections of spectral data held in any random, semi-structured or static way, such as files and folders stored on personal computers or servers:

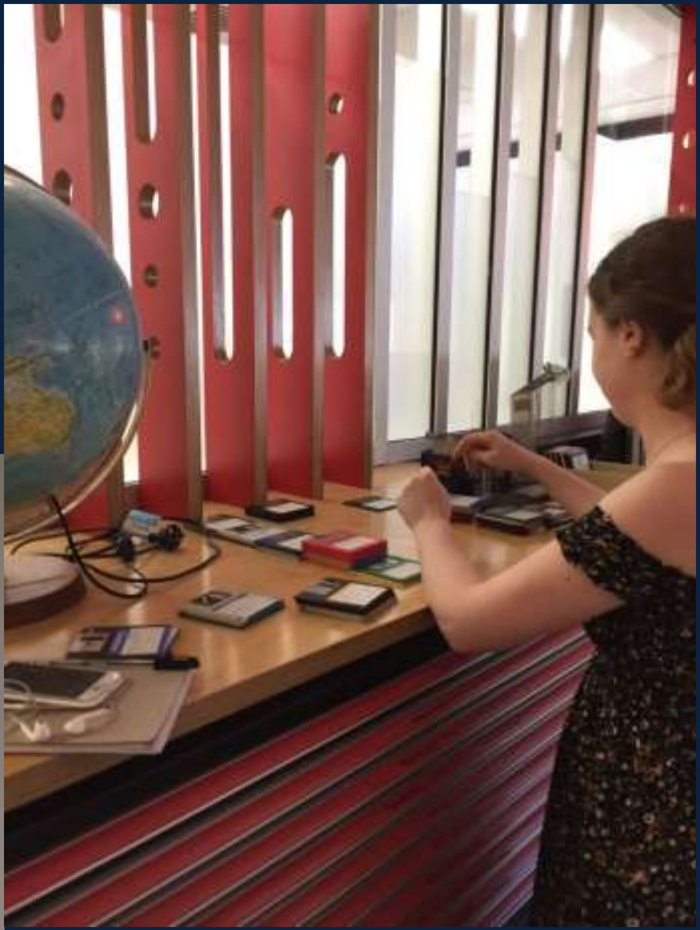
- Undiscov
- Non shar
- Void of c
- Rapid de

…… planning of sampling experiments, including the definition of sampling protocols, & adhering to a metadata standard





Program Manager
File
Options
Window
Help
Space-Time
1 2 3 4
Supermap - 1981 & 1986 Censuses
CDATA91 Release 2.1



Terrestrial Ecosystem Research Network

Australian Centre for Ecological Analysis & Synthesis

Bio-optical data: Best practice and legacy datasets workshop

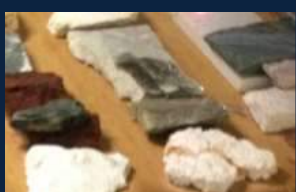
18 – 22 June 2012

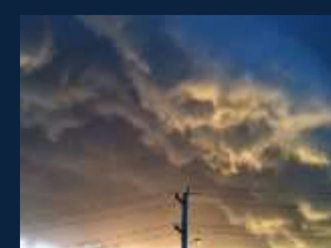
University of Queensland, Brisbane

Report: http://www.aceas.org.au

TERN is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative.

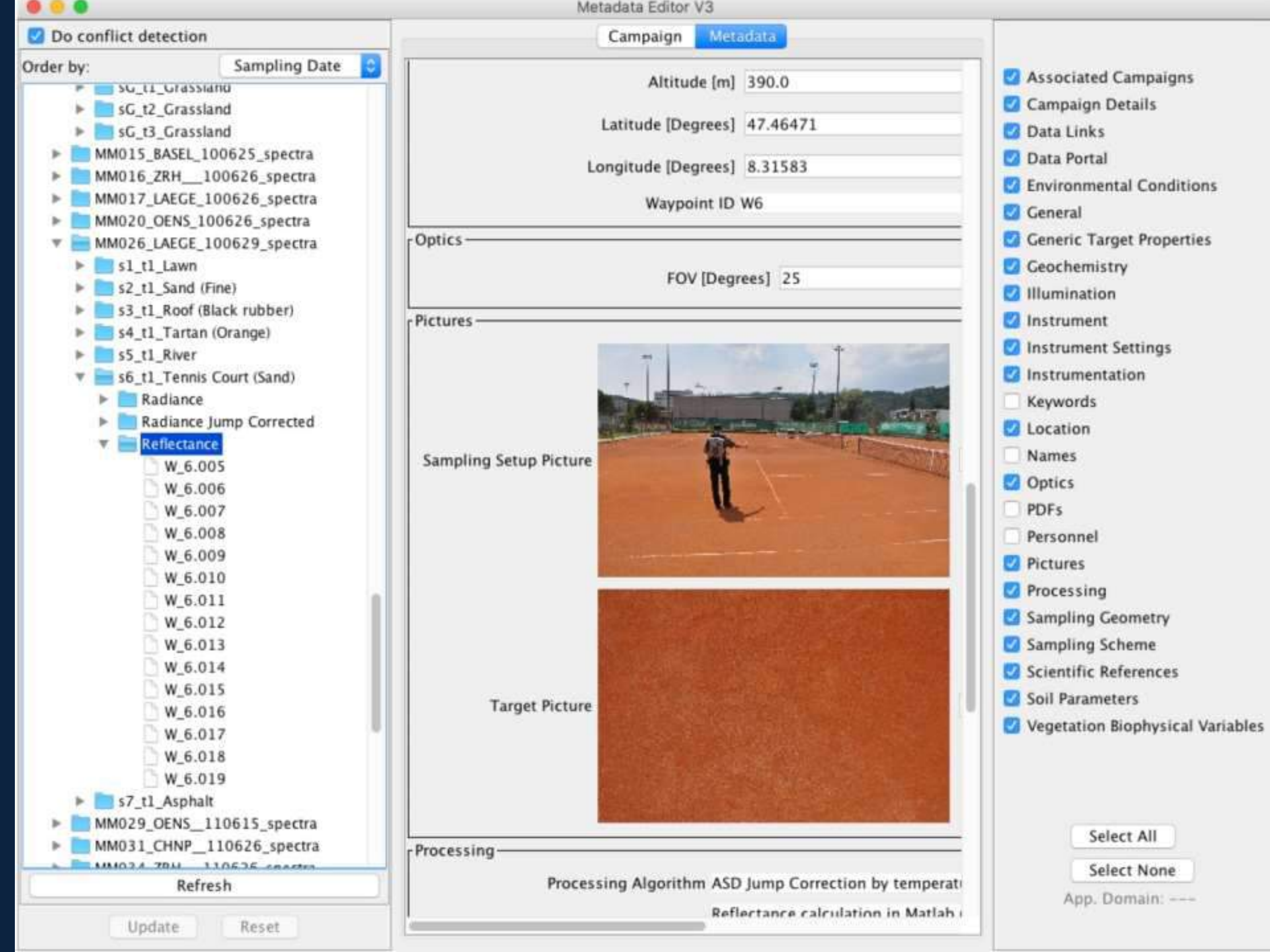
Spectroscopy User Info Sessions





- Identified **core metadata requirements** for a number of different applications.
- Considered a variety of methods to both **exchange** and store spectral data and tools to assist in summarising the **completeness and quality** of such datasets.
- Agreed that with modifications, the SPECCHIO (Hueni et al 2009) software could meet international objectives for **spectral data exchange and to** promote **best practice protocols**.

→ AUS-SPECCHIO


Metadata Editor V3
Do conflict detection
Order by:
Sampling Date
sG_t2_Grassland
sG_t3_Grassland
MM015_BASEL_100625_spectra
MM016_ZRH__100626_spectra
MM017_LAEGE_100626_spectra
MM020_OENS_100626_spectra
MM026_LAEGE_100629_spectra
s1_t1_Lawn
s2_t1_Sand (Fine)
s3_t1_Roof (Black rubber)
s4_t1_Tartan (Orange)
s5_t1_River
s6_t1_Tennis Court (Sand)
Radiance
Radiance Jump Corrected
Reflectance
W_6.005
W_6.006
W_6.007
W_6.008
W_6.009
W_6.010
W_6.011
W_6.012
W_6.013
W_6.014
W_6.015
W_6.016
W_6.017
W_6.018
W_6.019
s7_t1_Asphalt
MM029_OENS__110615_spectra
MM031_CHNP__110626_spectra
Refresh
Update
Reset
Campaign
Metadata
Altitude [m] 390.0
Latitude [Degrees] 47.46471
Longitude [Degrees] 8.31583
Waypoint ID W6
Optics
FOV [Degrees] 25
Pictures
Sampling Setup Picture
Target Picture
Processing
Processing Algorithm ASD Jump Correction by temperat
Associated Campaigns
Campaign Details
Data Links
Data Portal
Environmental Conditions
General
Generic Target Properties
Geochemistry
Illumination
Instrument
Instrument Settings
Instrumentation
Keywords
Location
Names
Optics
PDFs
Personnel
Pictures
Processing
Sampling Geometry
Sampling Scheme
Scientific References
Soil Parameters
Vegetation Biophysical Variables
Select All
Select None
App. Domain: ---

Protocols

- Various methods developed by many in the past
- Variability between different methods
- International organisations such as CEOS WGCV LPV do not currently have a standard protocol for the validation of surface reflectance data.

Digital Earth AUSTRALIA

Validating foundation products within Digital Earth Australia

Guy Byrne · Medhavy Thankappan

Goal: Working to develop and identify protocols and data sets to support the validation of both the historic and future epochs of Geoscience Australia' analysis ready Landsat archive.

Geoscience Australia has agreed to host a National Spectral Database (Aus-SPECCHIO) that will support data analysis and validation for Australia' Earth Observation community.

The database is currently managed by the University of Wollongong who have been active developing, documenting and promoting SPECCHIO within the Australian research community.

It is expected the national node for Aus-SPECCHIO will be launched in the first quarter of 2018.

https://www.researchgate.net/project/Validating-foundation-products-within-Digital-Earth-Australia?discoverMore=1

CSIRO EARTH OBSERVATION COORDINATION PROGRAM
www.csiro.au

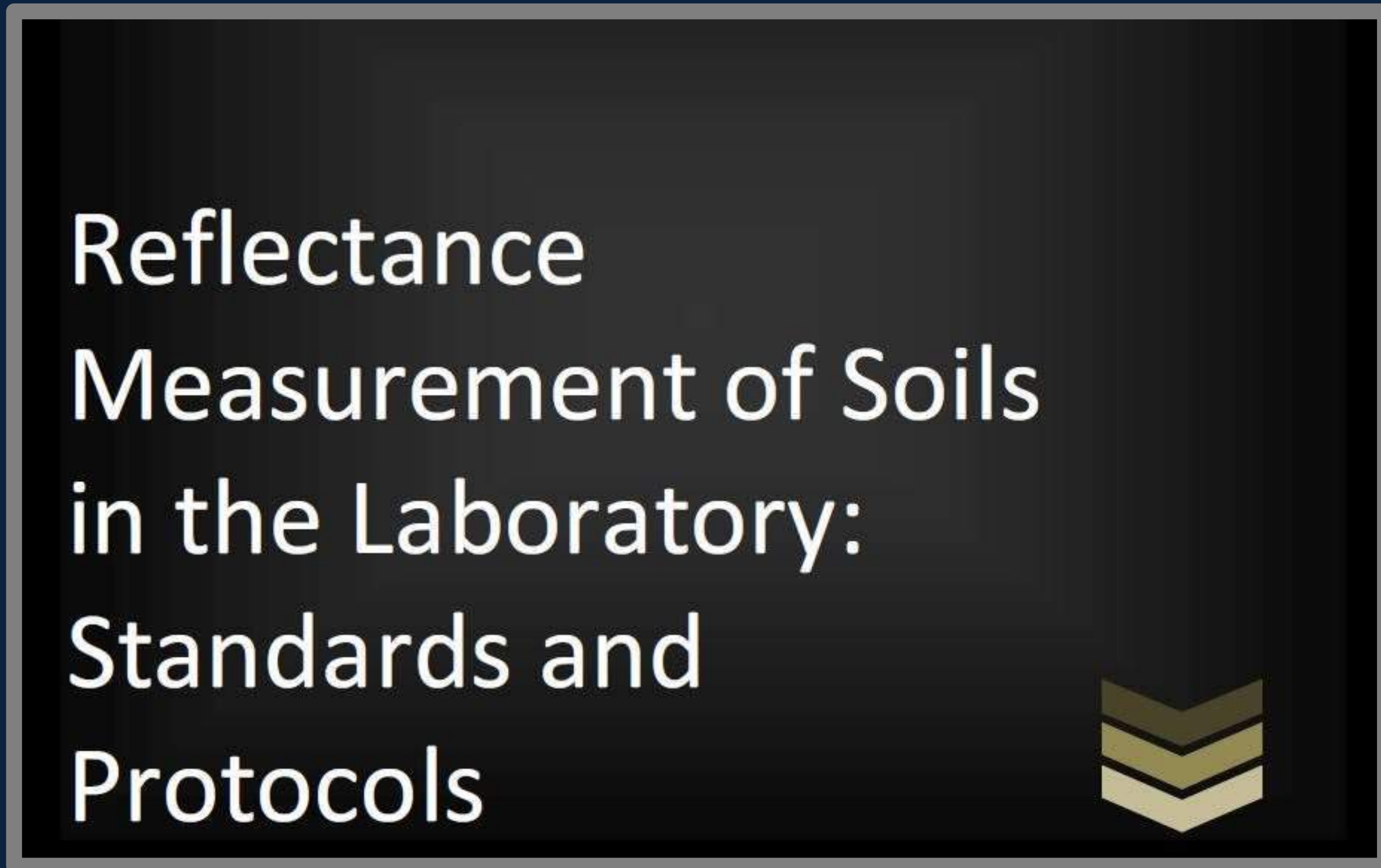
CSIRO

Digital Earth Australia reflectance validation - A community approach to the standa… ised validation of surface reflectance data

Tim Malthus, Cindy Ong, Ia…

Nov 2017

- nationally ag… …tegy
- establishmen… …guidelines for
  - site selection
  - sampling methodology including metadata and spectral reference standards collected in the field
  - training
  - traceable (to NIST) inter-calibration of optical equipment and reference panels
- review



- Detailed instructions/routines on how to measure laboratory soil reflectance systematically and accurately

- Reproducible data of high quality.

Ben Dor, Eyal; Ong, Cindy; Lau, Ian (2014): Soil Reflectance Measurement Protocol. v1. CSIRO. Data Collection. https://doi.org/10.4225/08/5492635CD1F26

A Standard Design for Collecting Vegetation Reference Spectra: Implementation and Implications for Data Sharing

K. Pfitzner
A. Bollhöfer
G. Carr

Spectral signatures repre... and biophysical rela... documentation... these si... meani... procedu... the trans... to anothe... implementa... collection o... metadata. A sp... assessment and... The concept of colle... d accurate spectral data whi... g the influence of potential extrane... ariation is relevant to field spectrometry in all environments and is particularly important for ecological applications.

...ne ...adiation ...roperties of ... the fundamental ...ation and analysis in ... (reflected sunlight) remote ... relationship between spectral ... and the biological, chemical, physical ...tomic structure of gases, water, vegetation and soils has been explored using remote sensing techniques in areas of atmospheric chemistry, plant physiology, geological sciences, soil sciences, and limnology and oceanography since the 1960s. Coupled with recent advances in remote sensing technology and expectations of future developments in satellite technology, has been the increasing need to measure field-

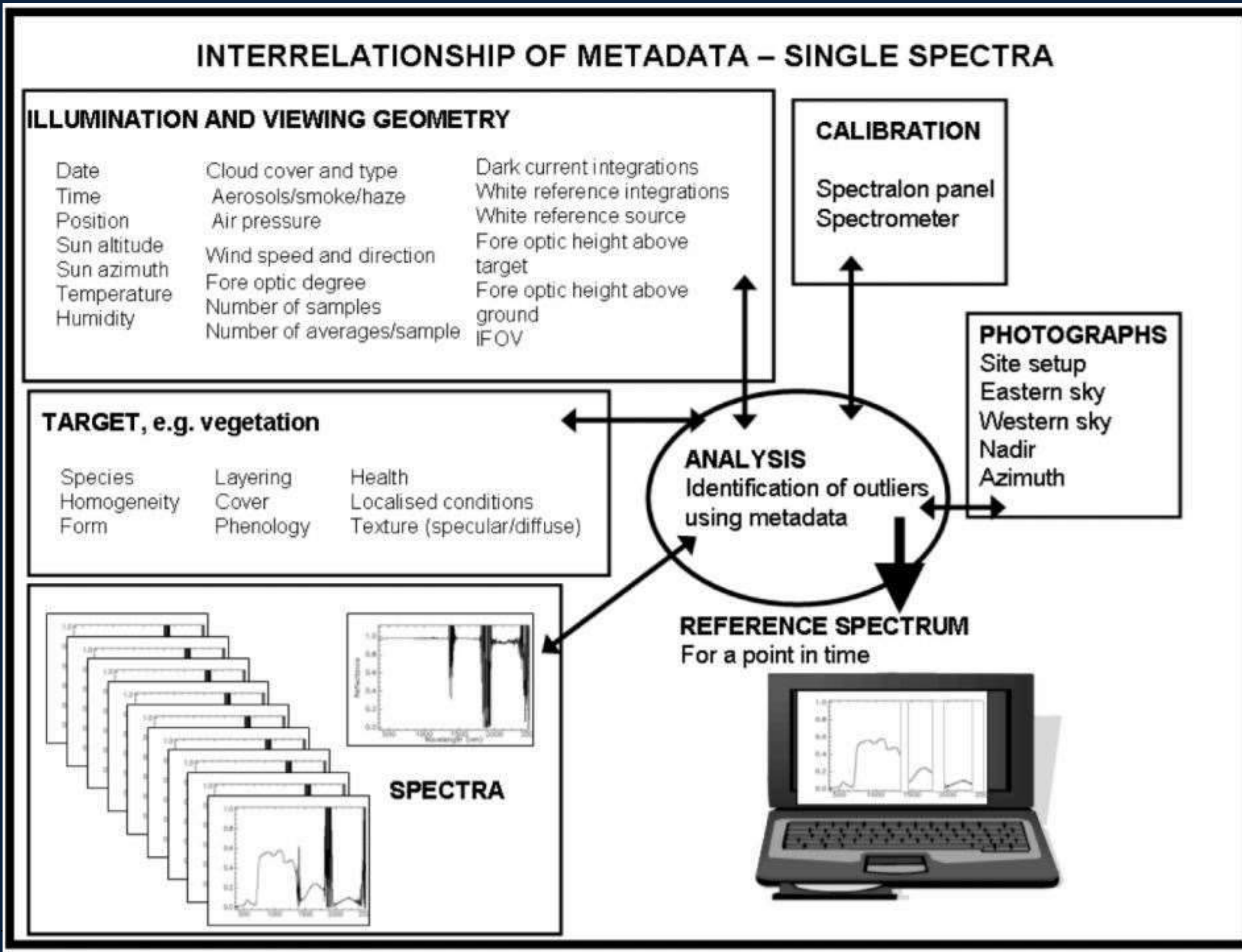
Standards for reflectance spectral measurement of temporal vegetation plots

Department of Sustainability, Environment, Water, Population and Communities, 2011

Supervising Scientist Report 195

Pfitzner K, Bartolo R, Carr G, Esparon A & Bollhöfer A

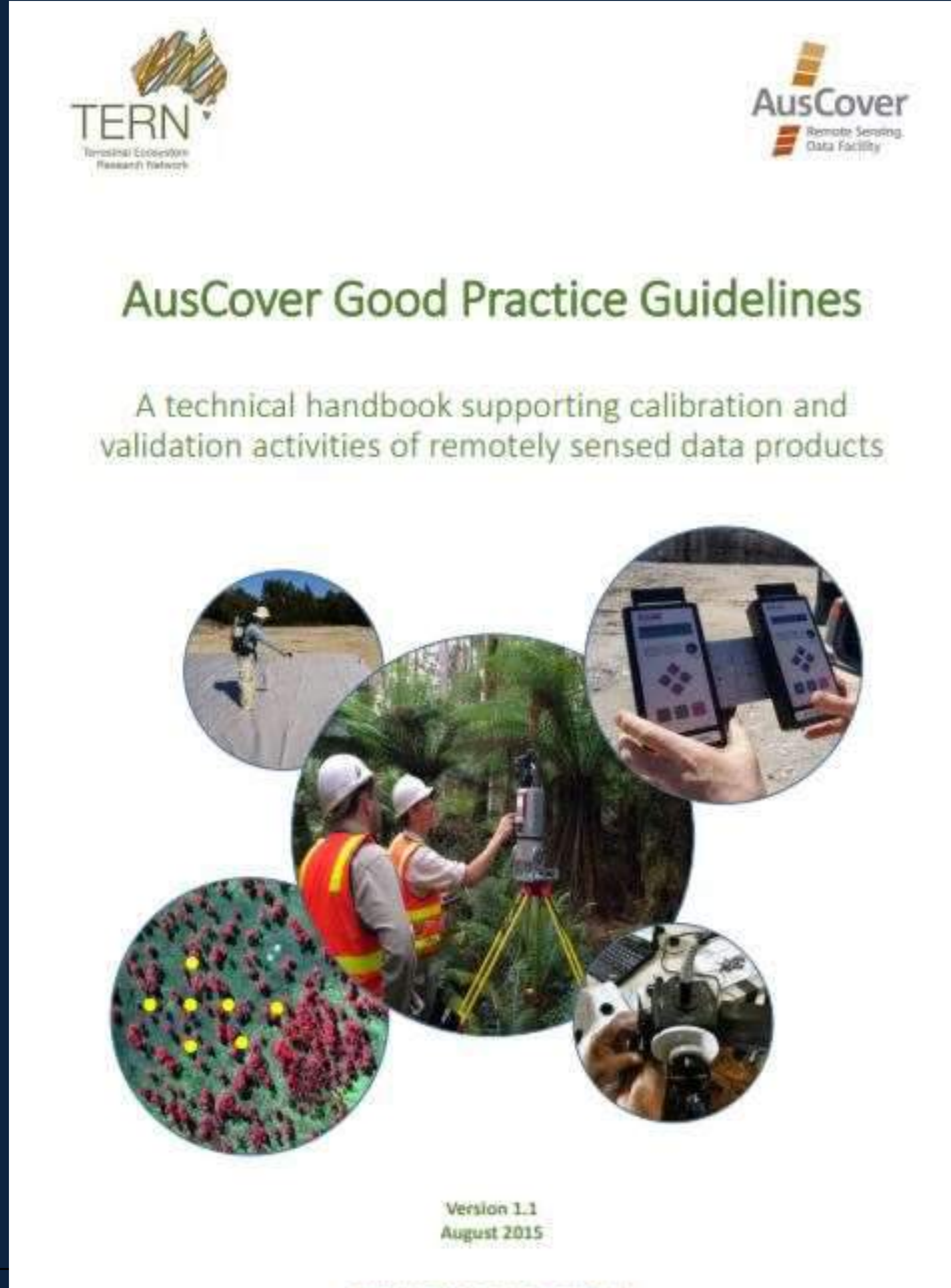
ISSN 1325-1554
ISBN: 978-1-921069-16-1


INTERRELATIONSHIP OF METADATA – SINGLE SPECTRA
ILLUMINATION AND VIEWING GEOMETRY
Date
Time
Position
Sun altitude
Sun azimuth
Temperature
Humidity
Cloud cover and type
Aerosols/smoke/haze
Air pressure
Wind speed and direction
Fore optic degree
Number of samples
Number of averages/sample
Dark current integrations
White reference integrations
White reference source
Fore optic height above target
Fore optic height above ground
IFOV
CALIBRATION
Spectralon panel
Spectrometer
PHOTOGRAPHS
Site setup
Eastern sky
Western sky
Nadir
Azimuth
TARGET, e.g. vegetation
Species
Homogeneity
Form
Layering
Cover
Phenology
Health
Localised conditions
Texture (specular/diffuse)
ANALYSIS
Identification of outliers using metadata
REFERENCE SPECTRUM
For a point in time
SPECTRA

Best Practice Guides (through 2013)

Name of document	Topics addressed					
	Application specific	Em theory	Instrument optimization	Recommended viewing geometry	Sampling strategy	Field data documentation protocol
NERC FSF instrument guides (ASD Field Spec Pro, GER1500, GER3700) (Mac Arthur, 2006, 2007*a*, 2007*b*)			X			
Australian Government Department of Sustainability, Environment, Water, Population and Communities: Standards for reflectance spectral measurement of temporal vegetation plots (Pfitzner *et al.*, 2011)	X	X	X	X	X	X
University of Queensland Field Spectrometer and Radiometer Guide (Phinn *et al.*, 2007)	X	X	X	X	X	X
Spectranomics Protocol: Leaf Spectroscopy (350-2500nm) (Carnegie Spectranomics, 2010)	X				X	
ASD instrument guides and FAQ (ASD 2012, 2013*b*)		X	X	X		

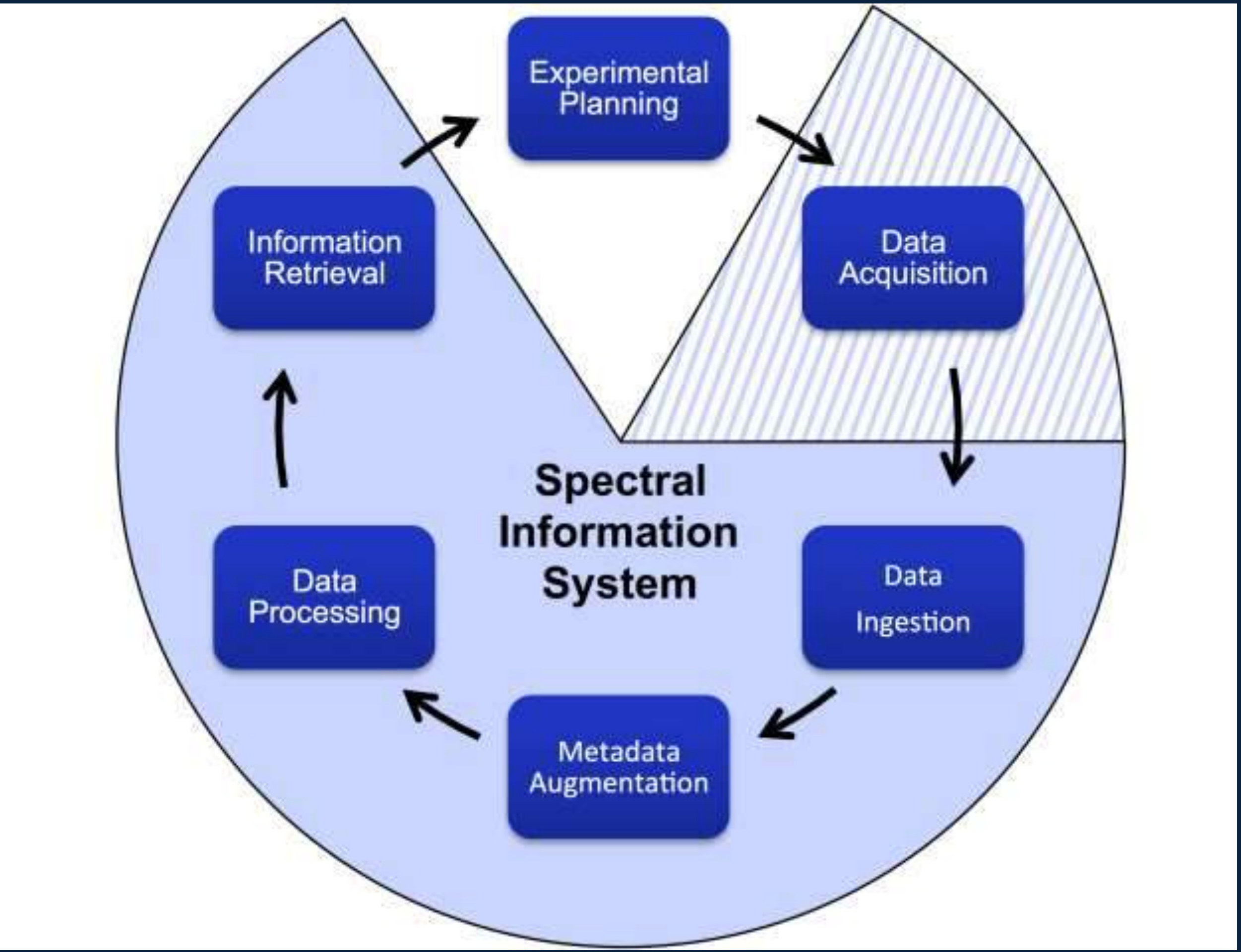
Rasaiah 2014



http://qld.auscover.org.au/public/html/AusCoverGoodPracticeGuidelines_2015_2.pdf

Table of Contents

Spectroscopy data life cycle



Chapter 14. **The Spectroscopy Dataset Lifecycle: Best Practice for Exchange and Dissemination**

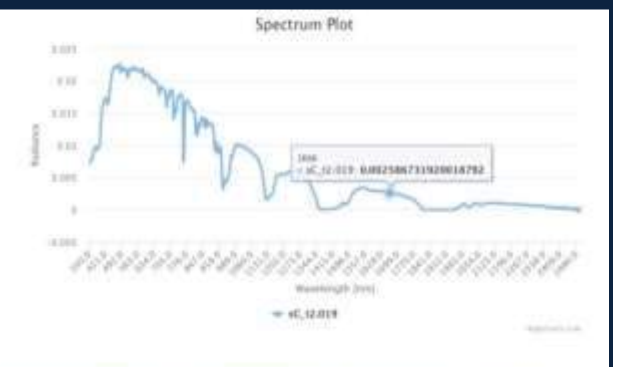
L.A. Chisholm[1], A. Hueni[2]

[1] School of Earth and Environmental Sciences, Centre for Sustainable Ecosystem Solutions, University of Wollongong, Wollongong, NSW, Australia
[2] Remote Sensing Laboratories, University of Zurich, Switzerland

*Corresponding author:

Chisholm & Hueni 2015 (in revision)

Why enter all that metadata?
➜ Quantitative and qualitative interpretation!
➜ Spectral in situ data without metadata is useless. (Hueni, all the time)



Generic Target Properties

Target/Reference Designator:	Target
Basic Target Type:	Roof (Black rubber)

Optics

FOV:	25

Sampling Geometry

Sensor Distance:	1.0
Illumination Azimuth:	105.00302797758435
Illumination Zenith:	45.06345046087947
Sensor Zenith:	0.0

General

File Comments:	
Spectrum Number:	19
File Name:	sC_t2.019
Acquisition Time:	2010-06-26 11:23:25
Loading Time:	2016-12-02 14:23:13

Show All

Instrumentation

Reference Panel Levelled:	true

Sampling Scheme

Spatial Sampling Scheme:	Sweep

Processing

UTC Time Computation:	UTC Acquisition Time computed by shifting 2 hours East using the SPECCHIO UTC function.

Location

Environmental Conditions

Cloud Cover:	0.0

Instrument Settings

Integration Time:	34
Number of Internal Scans:	10
Gain_SWIR1:	44
Gain_SWIR2:	16
Offset_SWIR1:	2072

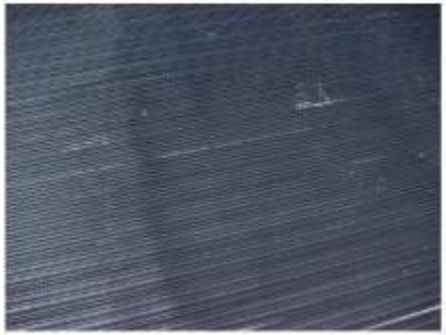
Show All

Campaign Details

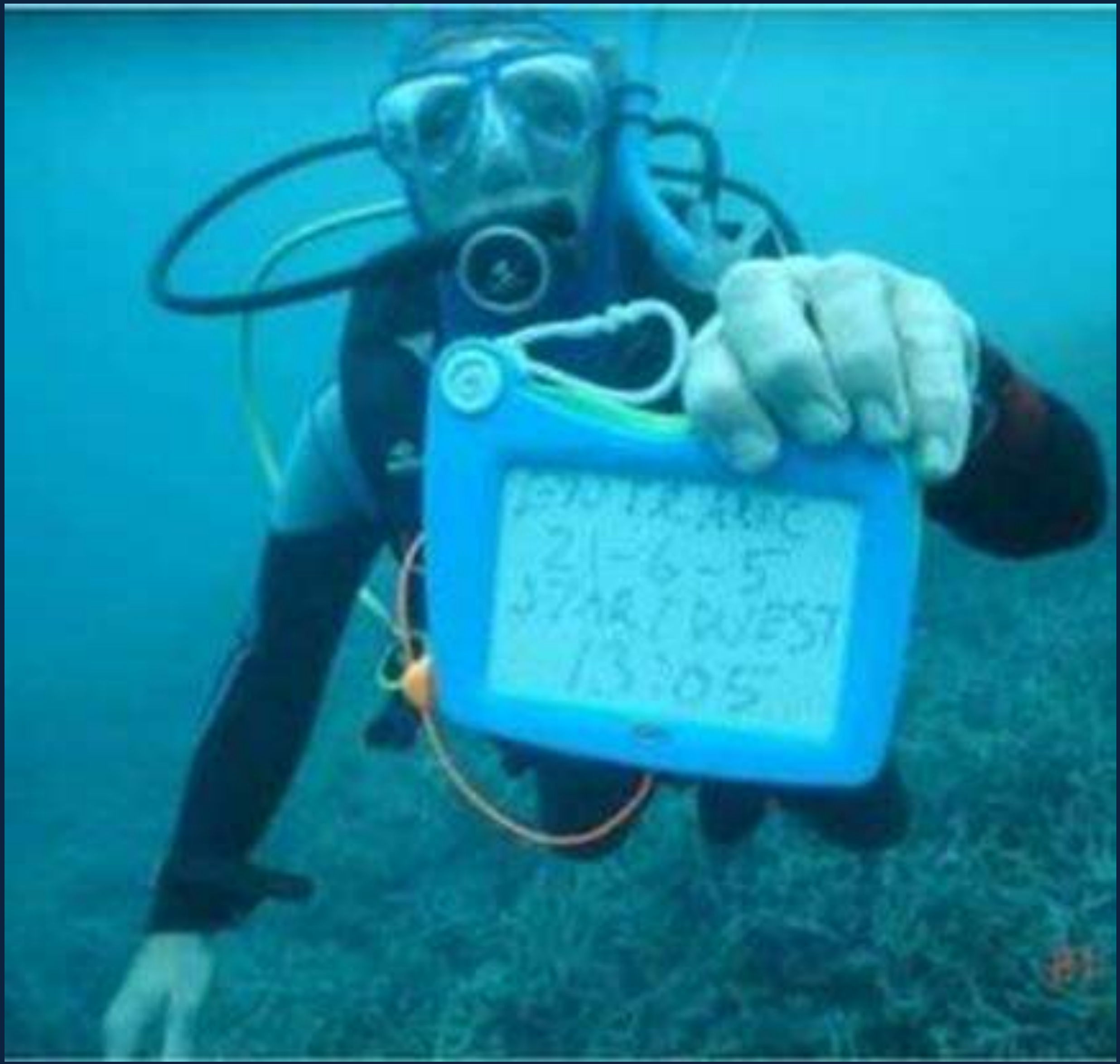
Campaign Name:	APEX SGCPs

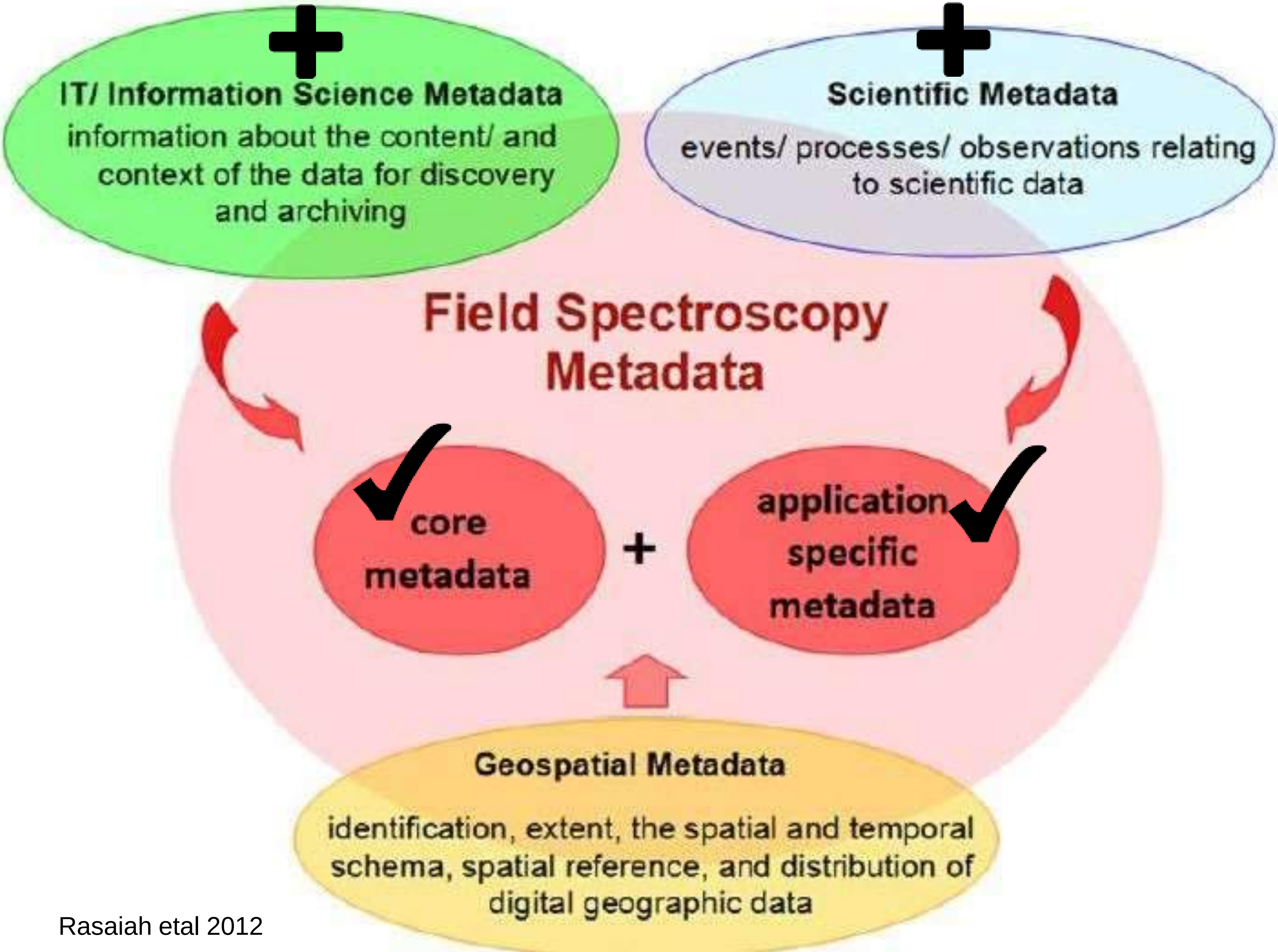
Pictures

Target Picture:



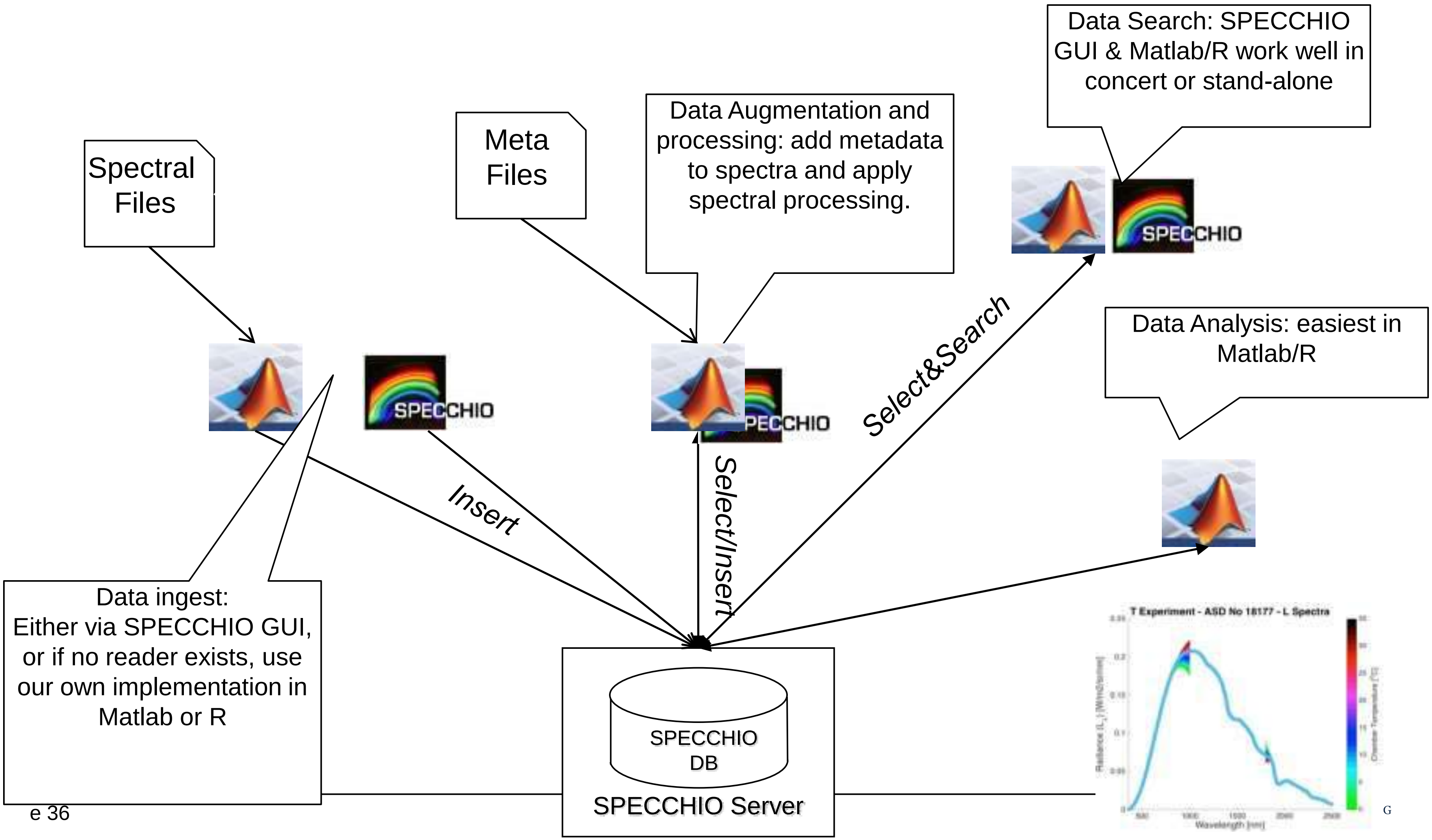
Sampling Setup Picture:


21-6-05
13:05



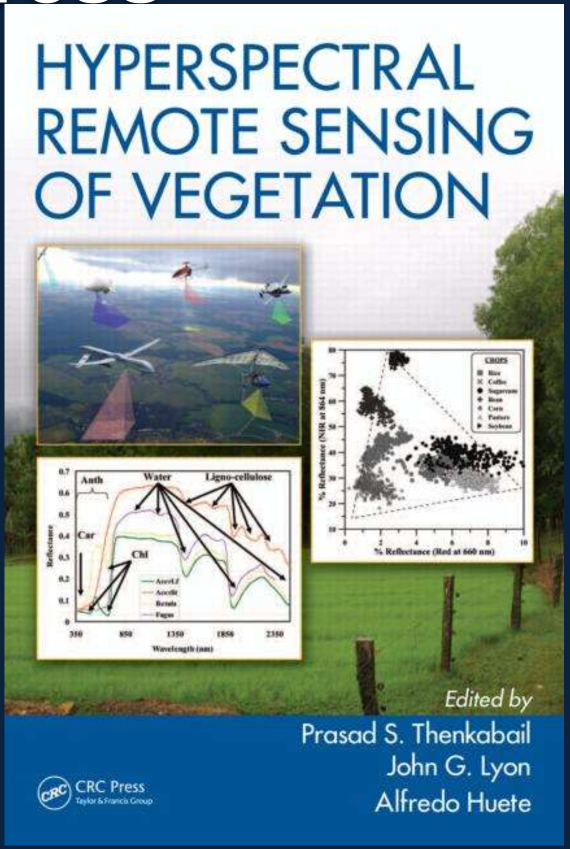
Rasaiah etal 2012

Spend your research time analysing data instead of trying to find it on your file system

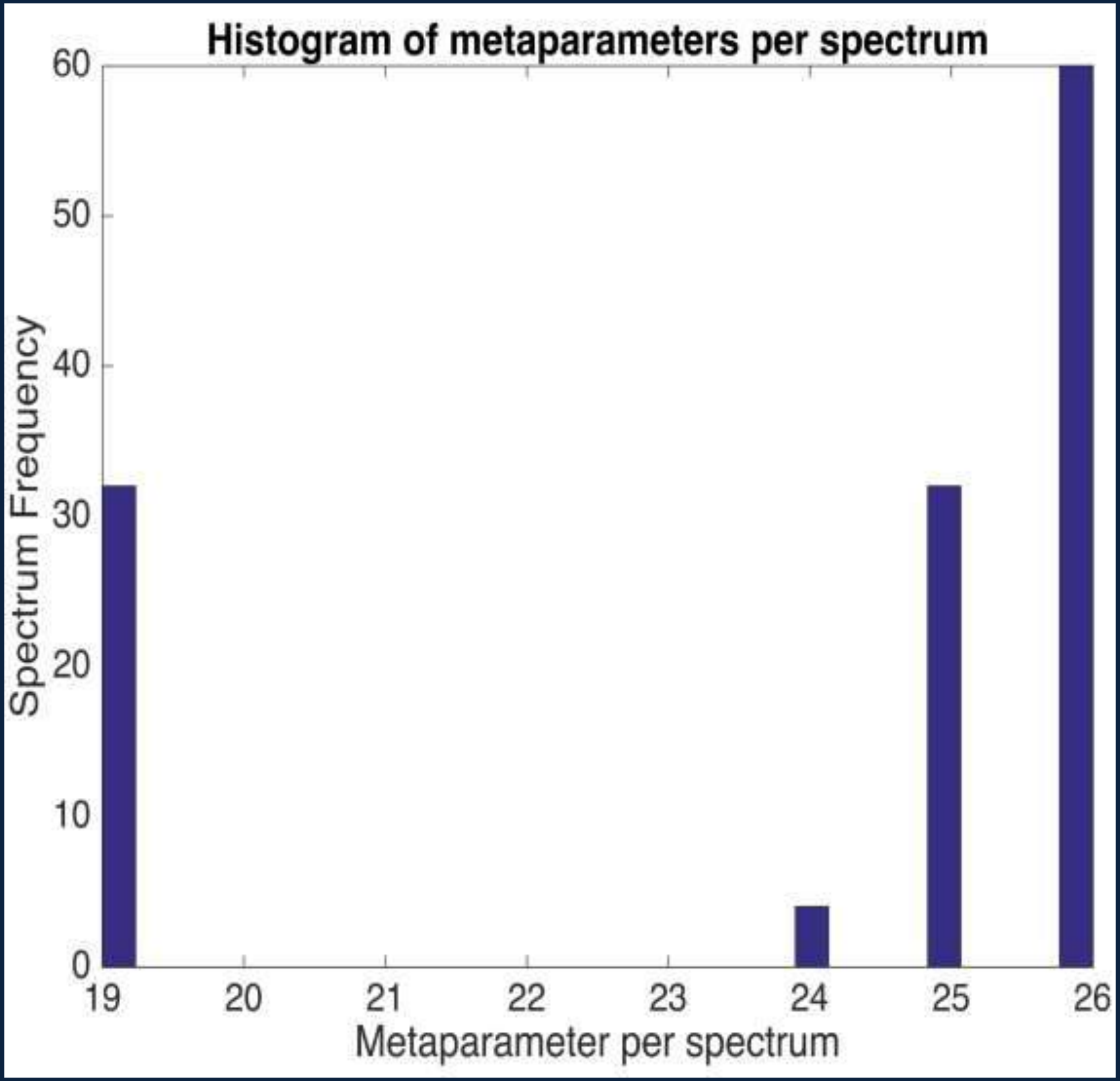


Case Study

Spectral Database Containing Pigment Content in A Water Stress Experiment



Hueni, A., Suarez, L., Chisholm, L.A., & Held, A. (2018) The use of spectral databases for remote sensing of agricultural crops, in Thenkabail, Lyon, Huete (eds), Hyperspectral Remote Sensing of Vegetation, second edition, Volume II: Advanced Approaches and Applications in Crops and Plants.

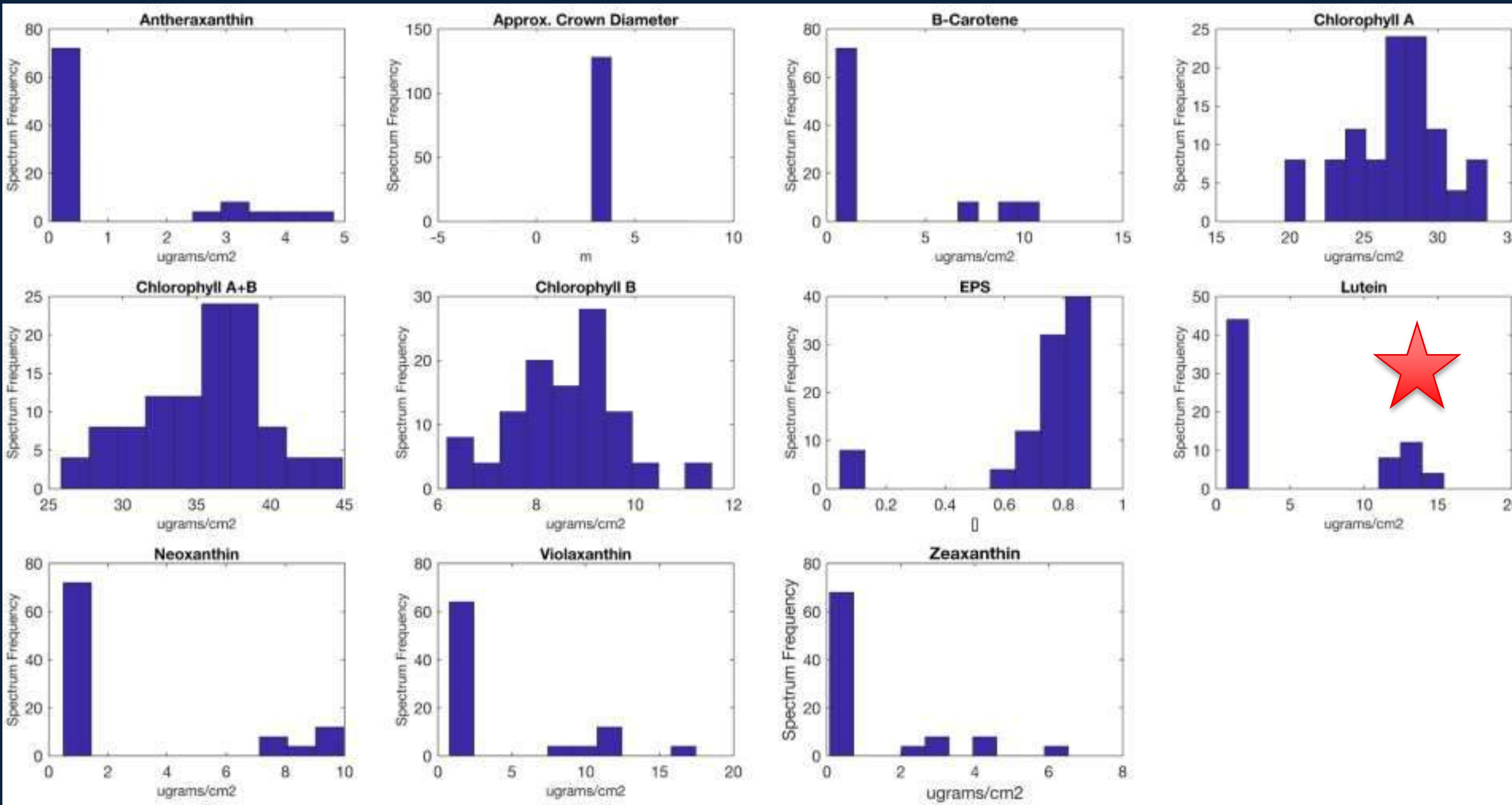


Ingestion of 12 metaparameters

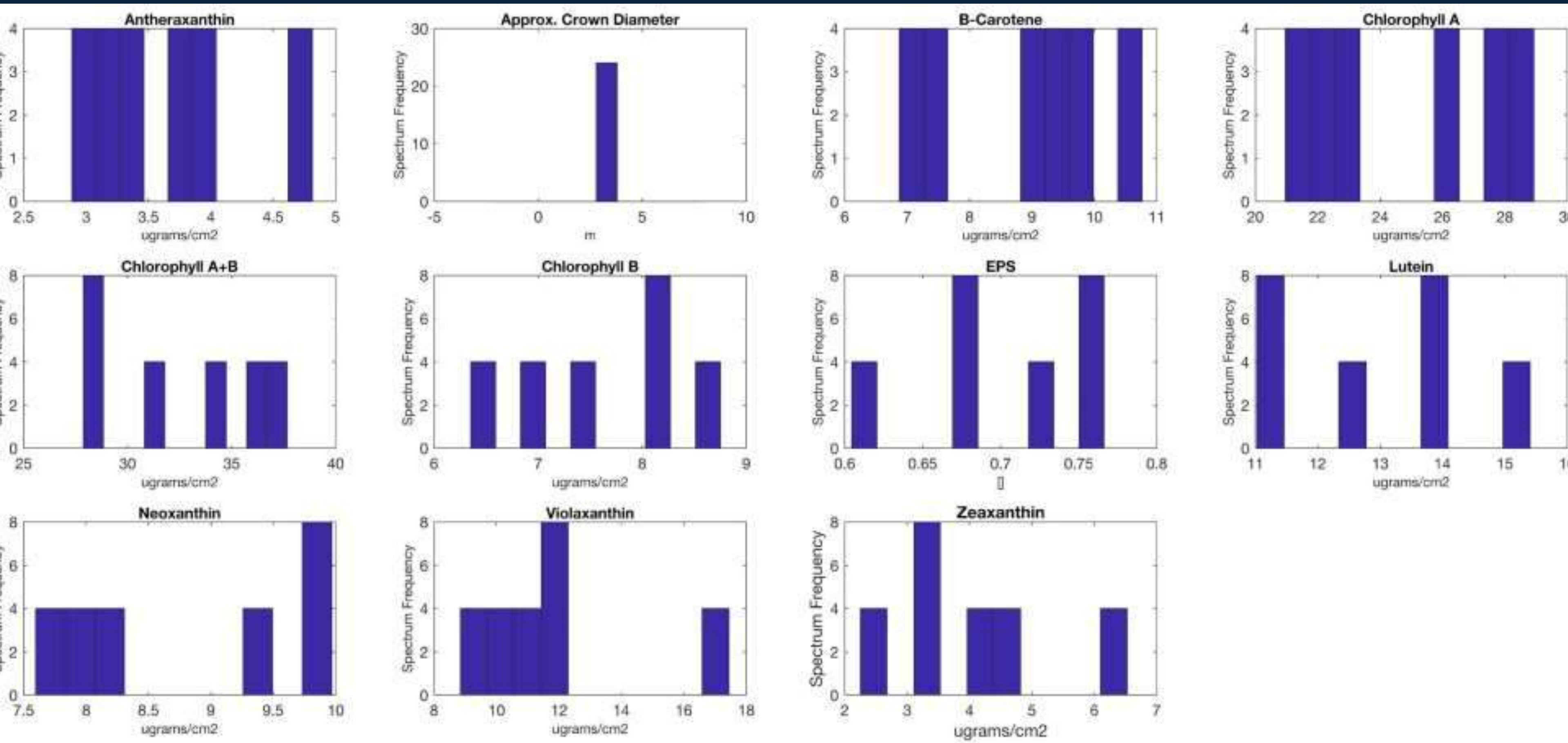
lab-based chemical leaf data included linked by tree identifier

Total of 24 metaparameters per spectrum

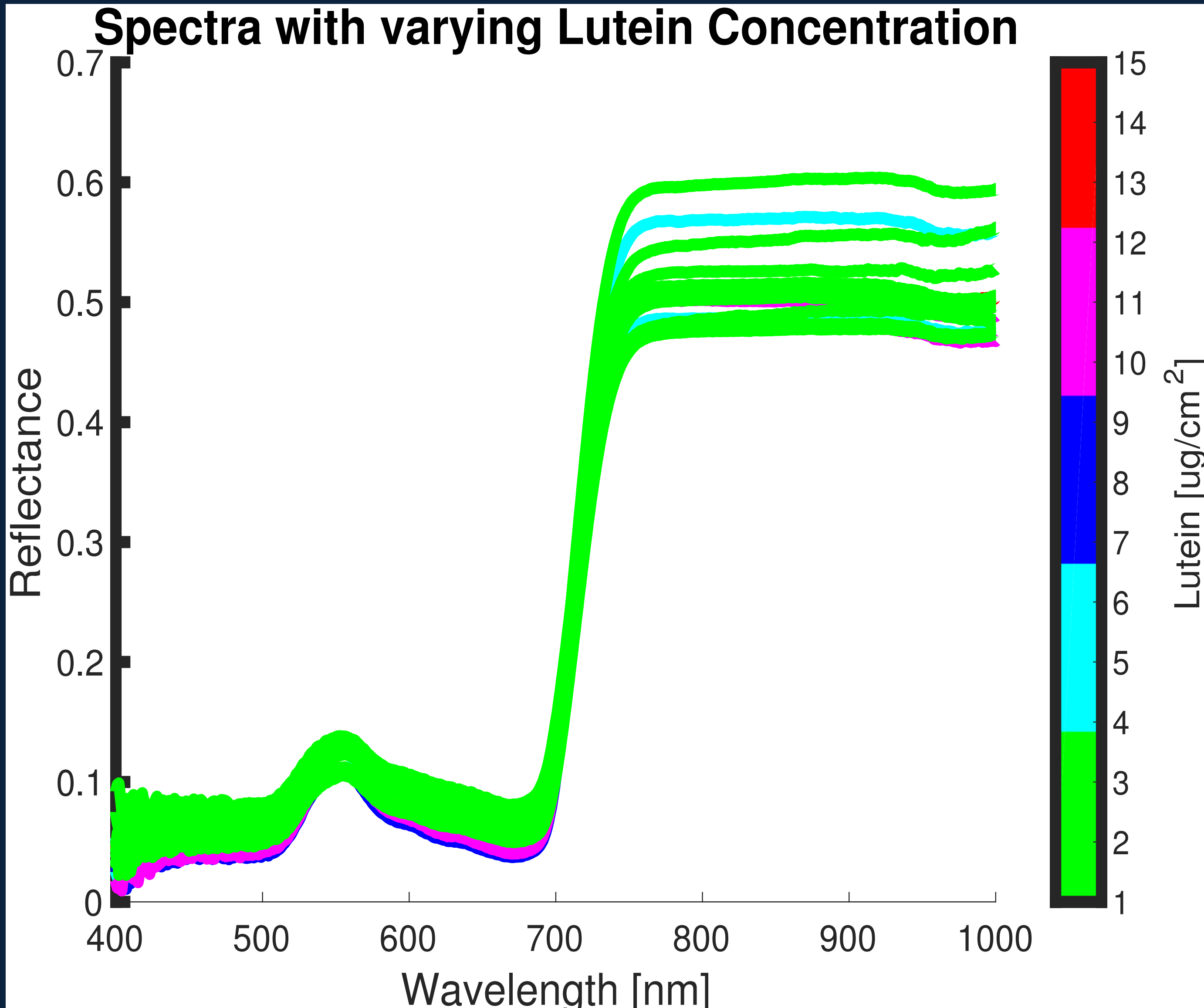
Histogram of the metadata space density after biophysical metadata augmentation.



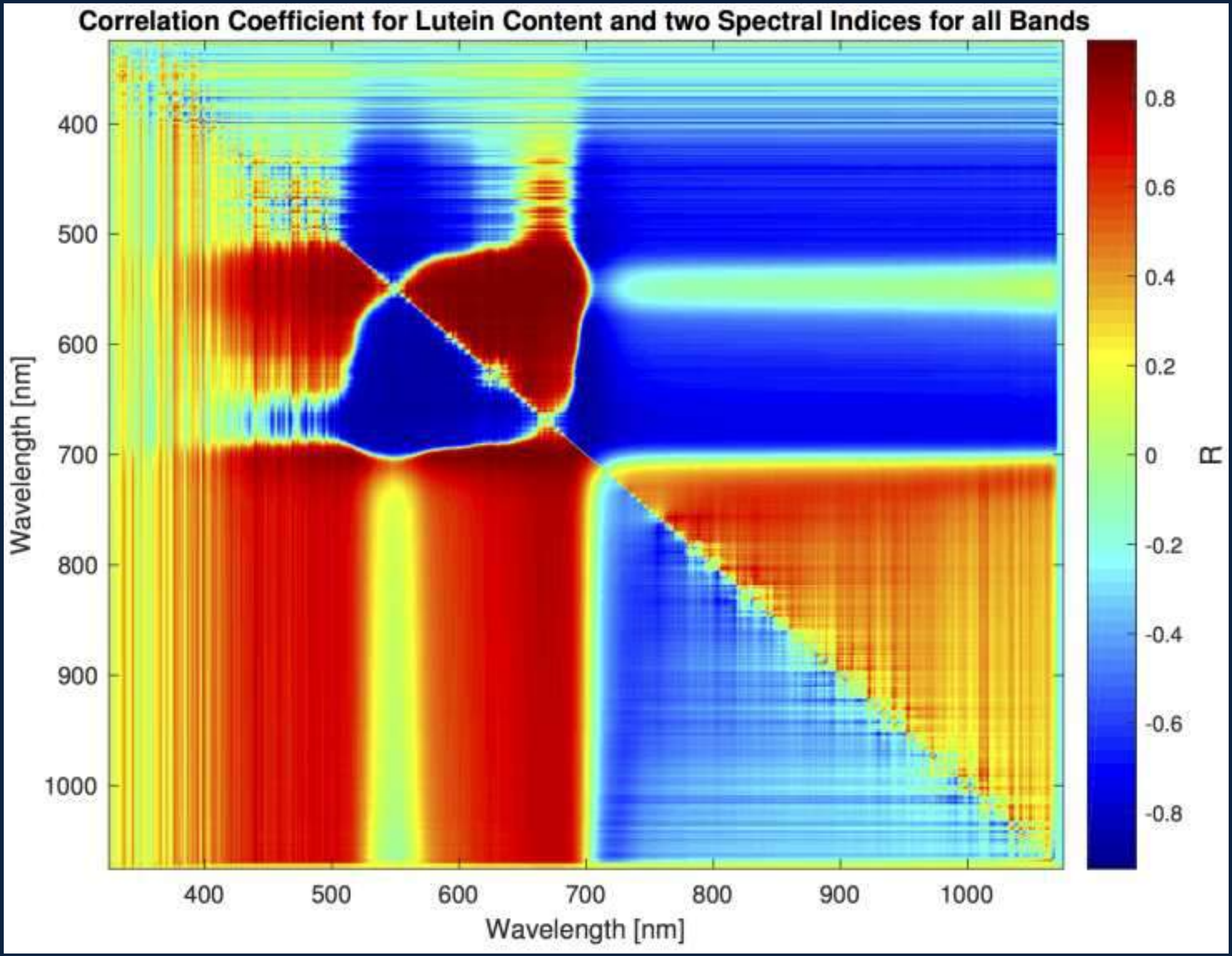
Histograms by biophysical parameter showing value ranges and number of spectra per value via Matlab / SPECCHIO Java API – including which spectra have a Lutein content above 10 µgrams/cm^2



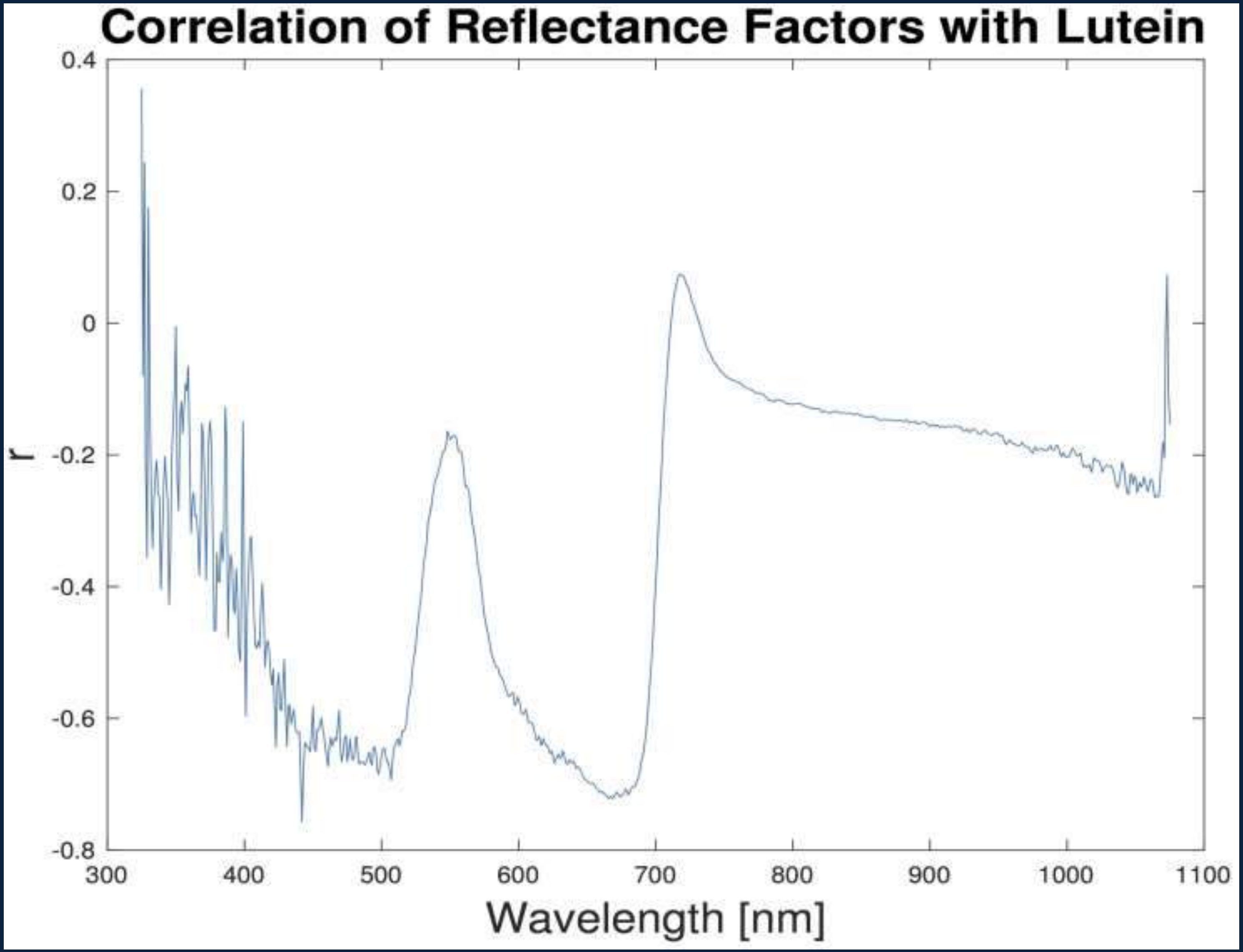
Histograms by biophysical parameter showing value ranges and number of spectra per value for spectra with high associated Lutein content - useful for comparison to entire dataset + visualising the variation of pigment content related to water stress.



Averaged spectra color coded by mean Lutein concentration, demonstrating a generally low reflectance in the 400 nm to 700 nm range for high Lutein contents, and absorption in the visible in at the lower end of the range.



Correlation analysis of Lutein concentration and two spectral indices calculated for all bands: upper triangle: simple band ratio (Rx / Ry), lower triangle: normalised difference index (Rx - Ry) / (Rx + Ry) – potential to estimate Lutein content from leaf spectra



Correlation between reflectance factors and Lutein content –if Lutein is the pigment of interest, it is useful to know which wavelengths are highly related to Lutein concentration

Summary

Instruments, spectral data management, and protocols comprise a package of considerations when acquiring spectral data directed by research goals.

- New instrumentation
- Research data planning for spectral data acquisition
- Evolving protocols

Trends towards intelligent searching for data, but is only possible with metadata-rich datasets

Need for streamlining protocols & improving scaleability to changing IT infrastructure

Challenge is applying science to the (large) volume of data.

Case study demonstrates the potential of a spectral database system to address specific needs for an application, e.g. agricultural management.

Such systems must be based upon data collection protocols and metadata descriptions that enhance data transferability within and among working groups.

If conducted over time and compiled for a wide range of agricultural-related measurements over varying conditions ….. could become a tool as a source of data for hypothesis testing and validation.

This approach opens the potential to apply machine learning techniques for prediction using large, quality-controlled datasets.

Thank you …

ands
AUSTRALIAN NATIONAL DATA SERVICE

Australian Government
Department of Industry
Innovation, Science, Research
and Tertiary Education

UNIVERSITY
OF WOLLONGONG
AUSTRALIA

University of
Zurich[UZH]

RSL
measurements | products | policy

CSIRO