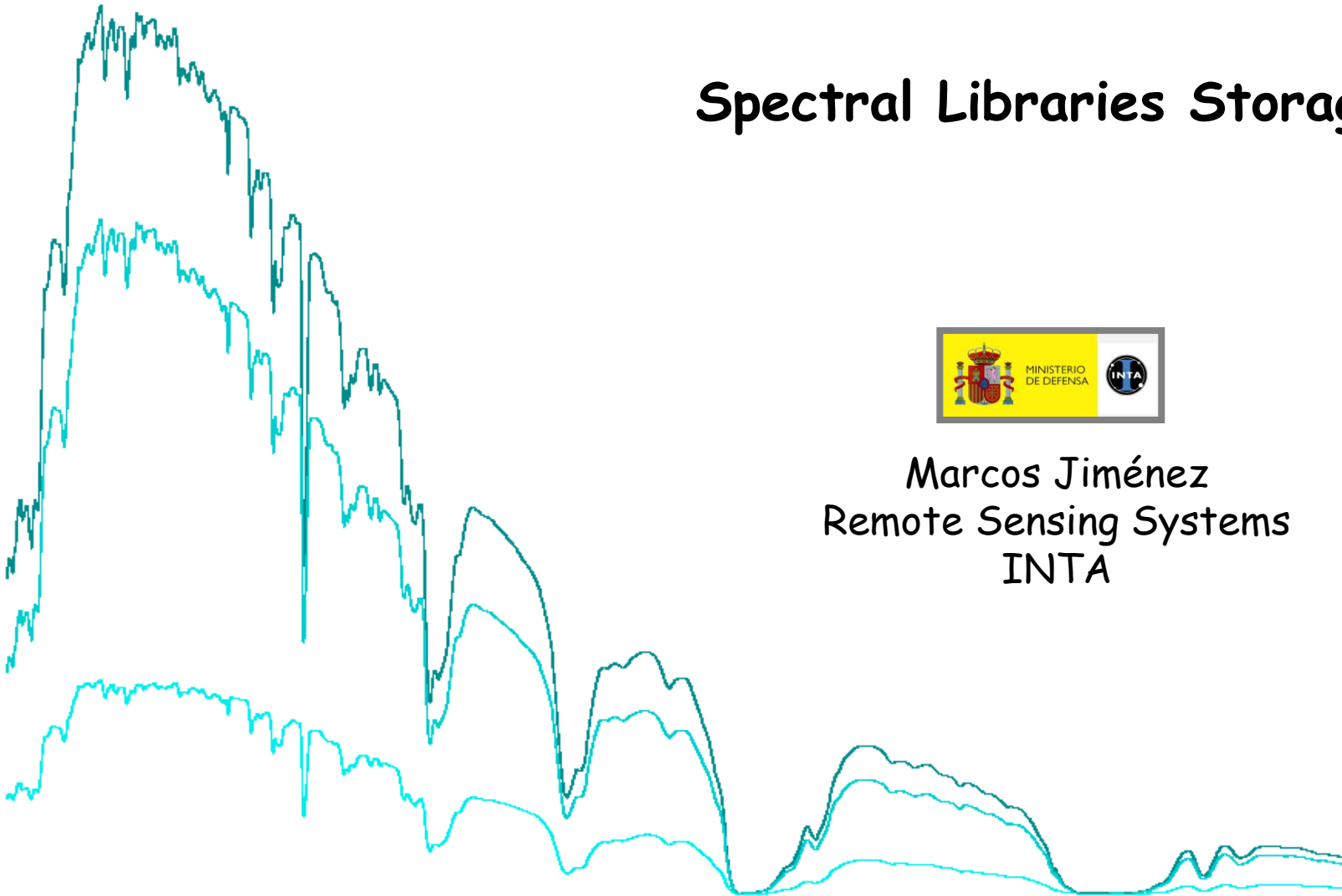
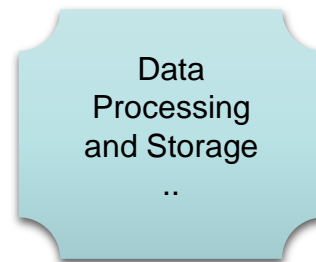
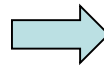
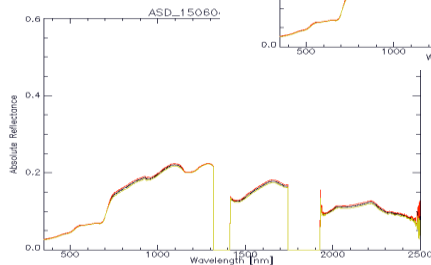
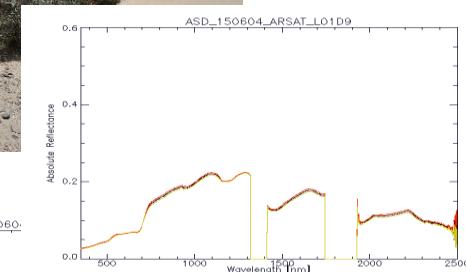
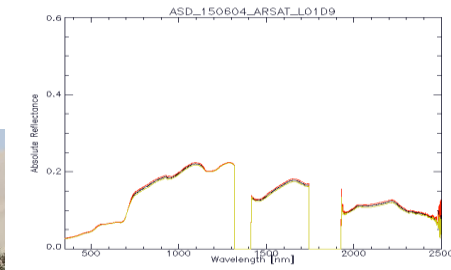


Spectral Libraries Storage



Marcos Jiménez
Remote Sensing Systems
INTA

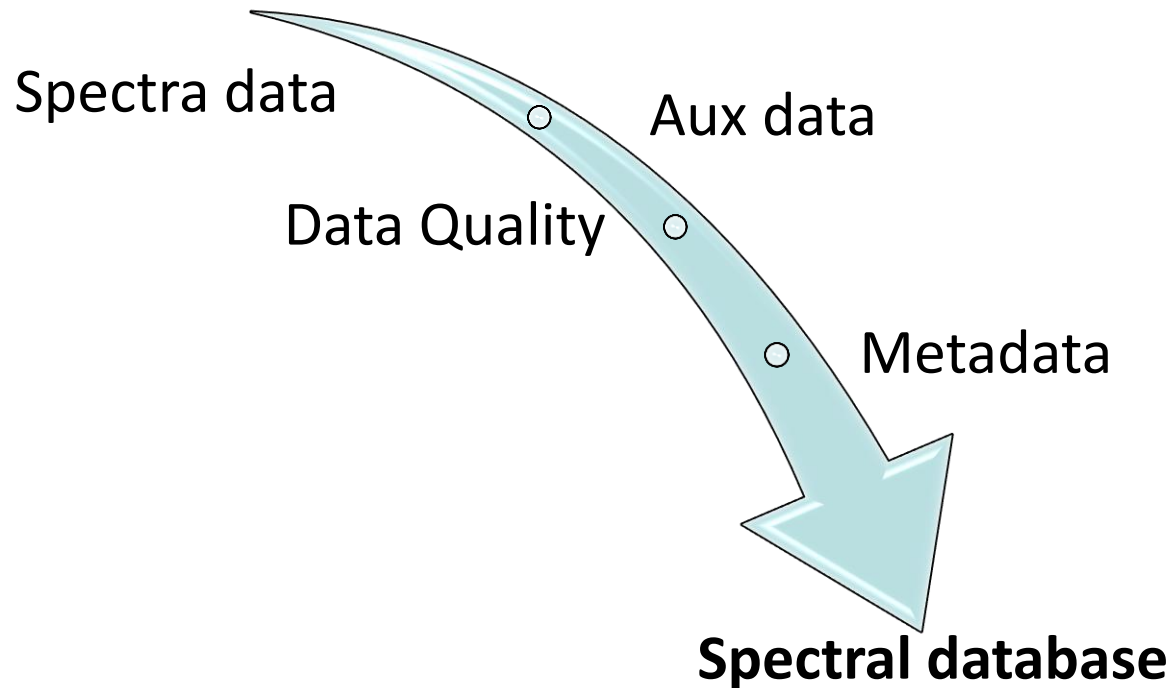
- ✓ Acquire our spectra as we are data providers
- ✓ Archive the data to always have it available and easily shared
- ✓ Standardization is very difficult but we have to try



- Easily Find the spectra
- Identify spectra characteristics
- data interchange

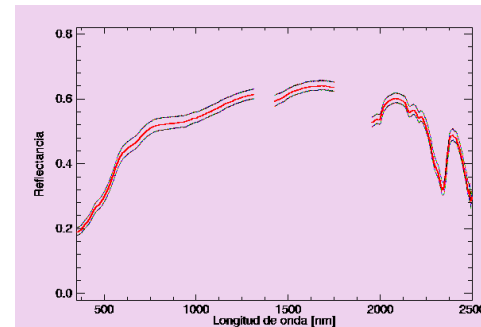
Spectral libraries are collections of spectra that characterize the reflectance or emissivity spectral response of Earth's surfaces and materials

Spectral library

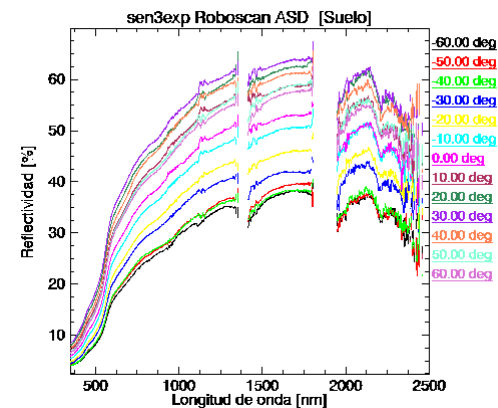
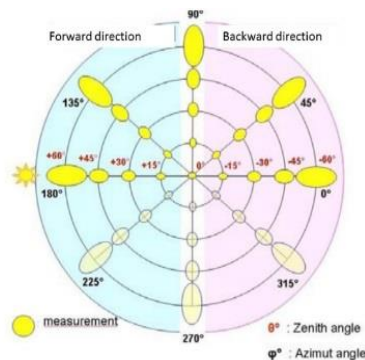


Spectral databases are systems for the organised storage of spectral signatures accompanied by associated metadata (Hueny, 2009)

I) Simple case: characterize spectral response



II) Complex case: characterize spectral spatial, temporal, angular response



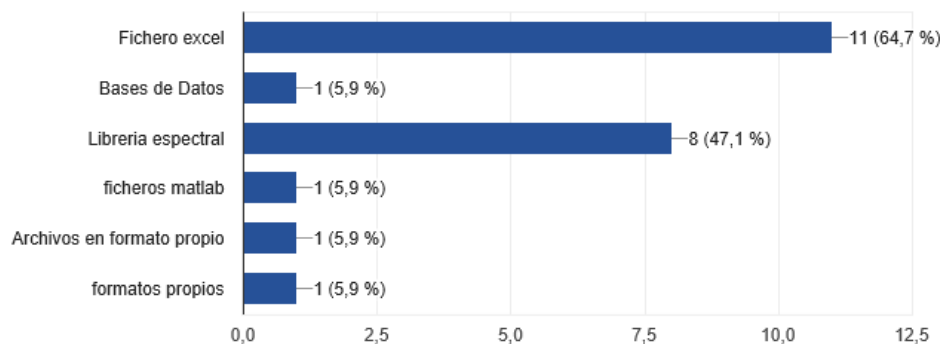
Excel (.xls)
Ascii (.txt)

Envi (.sli)

Wvl	bfern1	bfern2	bfern3	bfern4	bfern5	bfern6	bfern7	bfern8
350	0.0251693	0.02180227	0.02168852	0.02083316	0.0251693	0.0272244	0.0228867	0.01638
351	0.02609237	0.02205677	0.02120608	0.02185116	0.02609237	0.02736029	0.02311907	0.01675
352	0.02670406	0.02304296	0.02252308	0.022515				
353	0.02667814	0.02355111	0.02333972	0.022720				
354	0.02536824	0.02222287	0.02127706	0.022120				
355	0.02532748	0.02279621	0.02237556	0.022161				
356	68.1	0.02306737	0.02242806	0.022323				
357	0.02465166	0.02250804	0.02036442	0.022508				
358	0.02545843	0.02255876	0.02116152	0.022558				
359	0.02576228	0.022542	0.02189644	0.0225				
360	0.02550994	0.02234399	0.02223933	0.022343				
361	0.02452836	0.02135697	0.02051422	0.021356				
362	0.02585315	0.02275078	0.02171665	0.022323				
363	0.02699409	0.02397205	0.0229647	0.022766				
364	0.02560426	0.022661	0.02167992	0.020794				
365	0.0261002	0.02264477	0.02168531	0.021302				
366	0.02609165	0.02289031	0.0216651	0.02166				
367	0.02506964	0.02312163	0.02135562	0.021355				
368	0.02430984	0.02181487	0.02125899	0.021258				
369	0.02444283	0.02092695	0.02092695	0.021296				
370	0.0251672	0.02068911	0.02050666	0.021438				
371	0.0253656	0.02216616	0.02066827	0.021607				
372	0.02585498	0.02256722	0.02115348	0.022093				

¿Cómo organiza sus datos de espectro-radiometría?

17 respuestas



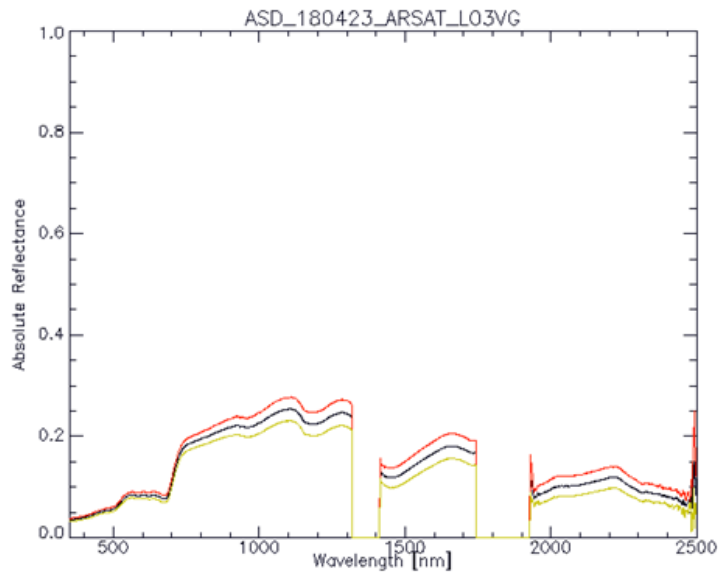
wvl
350.000
351.000
352.000
353.000
354.000
355.000
356.000
357.000
358.000
359.000
360.000
361.000

0.0250736 0.0232273
0.0249883 0.0233005
0.0249174 0.0233962
0.0250481 0.0234734
0.0252141 0.0235376
0.0253346 0.0236057
0.0253806 0.0236832

Este equipo > Toshiba HDD (E) > entregas > ARSAT18 > ASD_180423 > L2

Nombre	Fecha de modifica...	Tipo	Tam
ASD_180423_ARSAT_L01VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L01VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L01VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L02VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L02VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L02VG_L2R	16/05/2018 13:46	Archivo SLI	
	16/05/2018 13:46	Archivo BMP	
	16/05/2018 13:46	Archivo HDR	
	16/05/2018 13:46	Archivo SLI	
	16/05/2018 13:46	Archivo BMP	
	16/05/2018 13:46	Archivo HDR	
	16/05/2018 13:46	Archivo SLI	
	16/05/2018 13:46	Archivo BMP	
	16/05/2018 13:46	Archivo HDR	
	16/05/2018 13:46	Archivo SLI	
	16/05/2018 13:46	Archivo BMP	
	16/05/2018 13:46	Archivo HDR	
	16/05/2018 13:46	Archivo SLI	
	16/05/2018 13:46	Archivo BMP	

```
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mean, +sd, -sd, reflectance 1, reflectance 2, reflectance 3}
wavelength = {
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355.000000,
356.000000, 357.000000, 358.000000, 359.000000, 360.000000,
361.000000,
362.000000, 363.000000, 364.000000, 365.000000, 366.000000,
367.000000,
368.000000, 369.000000, 370.000000, 371.000000, 372.000000,
373.000000,
374.000000, 375.000000, 376.000000, 377.000000, 378.000000,
379.000000,
380.000000, 381.000000, 382.000000, 383.000000, 384.000000,
385.000000,
```



GPS



Pictures



Environment
(sun position
AOT)

Remote Sens. **2014**, *6*, 3662-3680; doi:10.3390/rs6053662

OPEN ACCESS

remote sensing

ISSN 2072-4292

www.mdpi.com/journal/remotesensing

Article

Critical Metadata for Spectroscopy Field Campaigns

Barbara A. Rasaiah ^{1,*}, Simon. D. Jones ¹, Chris Bellman ¹ and Tim J. Malthus ²

Remote Sens. **2015**, *7*, 15668-15701; doi:10.3390/rs71115668

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remote sensing

ISSN 2072-4292

www.mdpi.com/journal/remotesensing

Article

Towards an Interoperable Field Spectroscopy Metadata Standard with Extended Support for Marine Specific Applications

Barbara A. Rasaiah ^{1,*}, Chris Bellman ¹, Simon. D. Jones ¹, Tim J. Malthus ² and Chris Roelfsema ³

Table 2.1 Categories of metadata fields in the survey

Generic campaign metadata

- ◆ instrument
- ◆ reference standards
- ◆ calibration
- ◆ hyperspectral signal properties
- ◆ illumination information
- ◆ viewing geometry
- ◆ environment information
- ◆ atmospheric conditions
- ◆ general project information
- ◆ location information
- ◆ general target and sampling information

Campaign-specific metadata

- ◆ vegetation
- ◆ woodland and forest
- ◆ agriculture
- ◆ soil
- ◆ mineral exploration
- ◆ snow
- ◆ urban environments
- ◆ marine and estuarine
- ◆ underwater substratum targets

A field spectroscopy metadata standard is defined as those data elements that explicitly document the spectroscopy dataset and field protocols, sampling strategies, instrument properties and environmental and logistical variables

Text ascii
files
Standard
XML

SPECCHIO Universidad de Zurich

EcologicalML de la Ecological Society of America

SpectroML de National Institute of Standards and Technology (NIST)

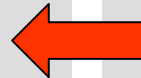
Malthus et al., 2009 CSIRO



- 19115:2003 *“Geographic Information - Metadata”*
- 19115-2:2009 *“Geographic Information-Metadata for imagery and gridded data”*
- 19130:2010 *“Geographic Information-Sensor data model for imagery and gridded data”*
- 19156:2011 *Geographic Information-Observations and Measurements”*



- Sensor Web Enablement (SWE 2.0)
- SensorML 1.0 (**en progreso 2.0**)
- Observations and Measurements 2.0





QA4EO Principle

Data and derived products shall have associated with them a fully traceable indicator of their quality

Quality Indicator

A Quality Indicator (QI) shall provide sufficient information to allow all users to readily evaluate the “fitness for purpose” of the data or derived product

Traceability

A QI shall be based on a documented and quantifiable assessment of evidence demonstrating the level of traceability to internationally agreed (where possible SI) reference standards

What is the meaning of a result without an uncertainty/confidence statement

JCGM 100:2008

GUM 1995 with minor corrections

Evaluation of measurement data — Guide to the expression of uncertainty in measurement

Uncertainty Type A and Type B

ISO 19157:2013

Geographic Information – Data quality

Thematic, Positional, temporal



Measurement uncertainties arise from a combination of several sources because the measurements are influenced by metrological agents, such as: measurement method, operator, environmental conditions, equipment and the sample itself (Mendes & Rosario, 2005)

- Repeatability
 - Same measurand, same conditions
 - Laboratory conditions
 - Usually only applies to single instrument measuring a single source multiple times
 - Indicator of theoretical measurement PRECISION
- Reproducibility
 - Closeness of agreement between measurements of the same physical parameter, under different conditions
 - Indicator of operational measurement precision
 - Quantification = critical to application of field spectroscopy across user groups with different instruments, and to MULTI-TEMPORAL studies
- Calibrations and trazability reports for spectroradiometer and panel



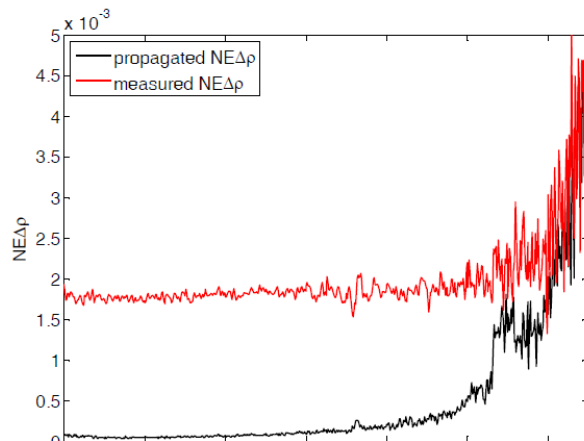
On the reproducibility of reflectance factors:
implications for EO science

Karen Anderson
School of Geography,
University of Exeter, UK
karen.anderson@exeter.ac.uk

E. J. Milton, Vincent Odongo
School of Geography,
University of Southampton, UK
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Jennifer L. Dungan
NASA Ames Research Center,
Moffett Field, CA, USA
Jennifer.L.Dungan@nasa.gov

$$NE\Delta\rho = \rho \sqrt{\left(\frac{NE\Delta L_{tar}}{L}\right)^2 + \left(\frac{NE\Delta L_{ref}}{E}\right)^2}$$

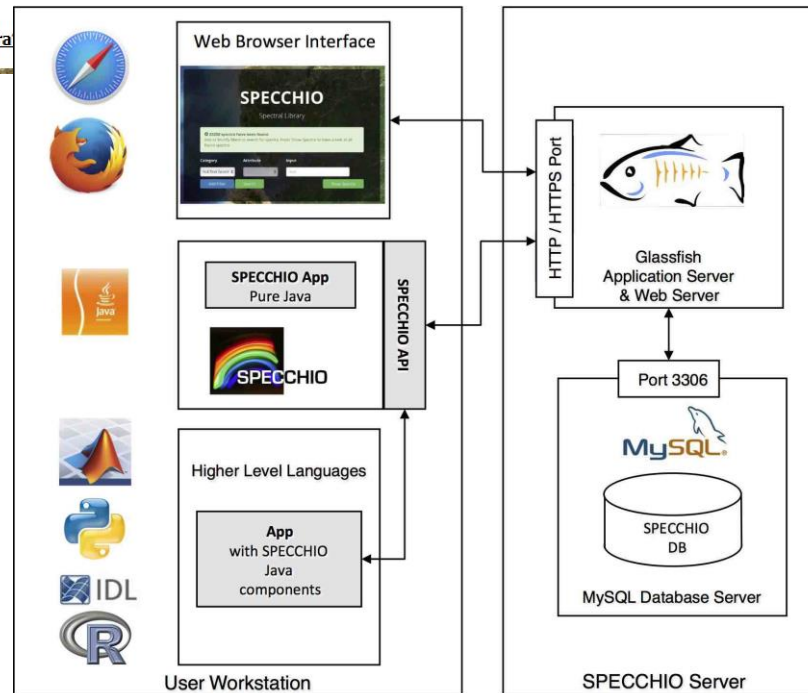
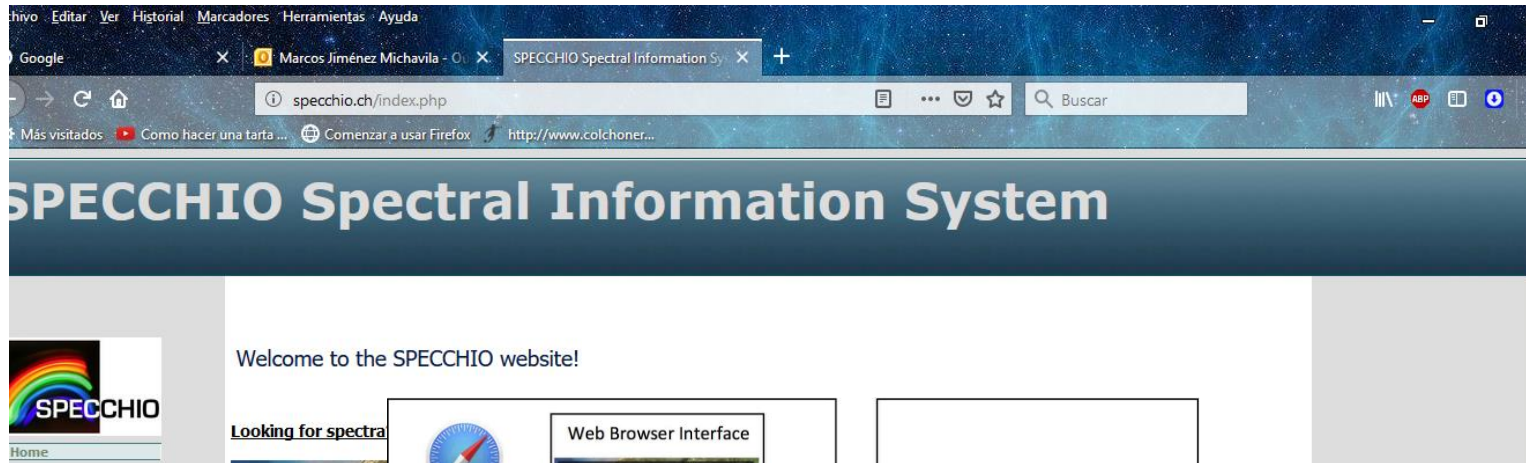


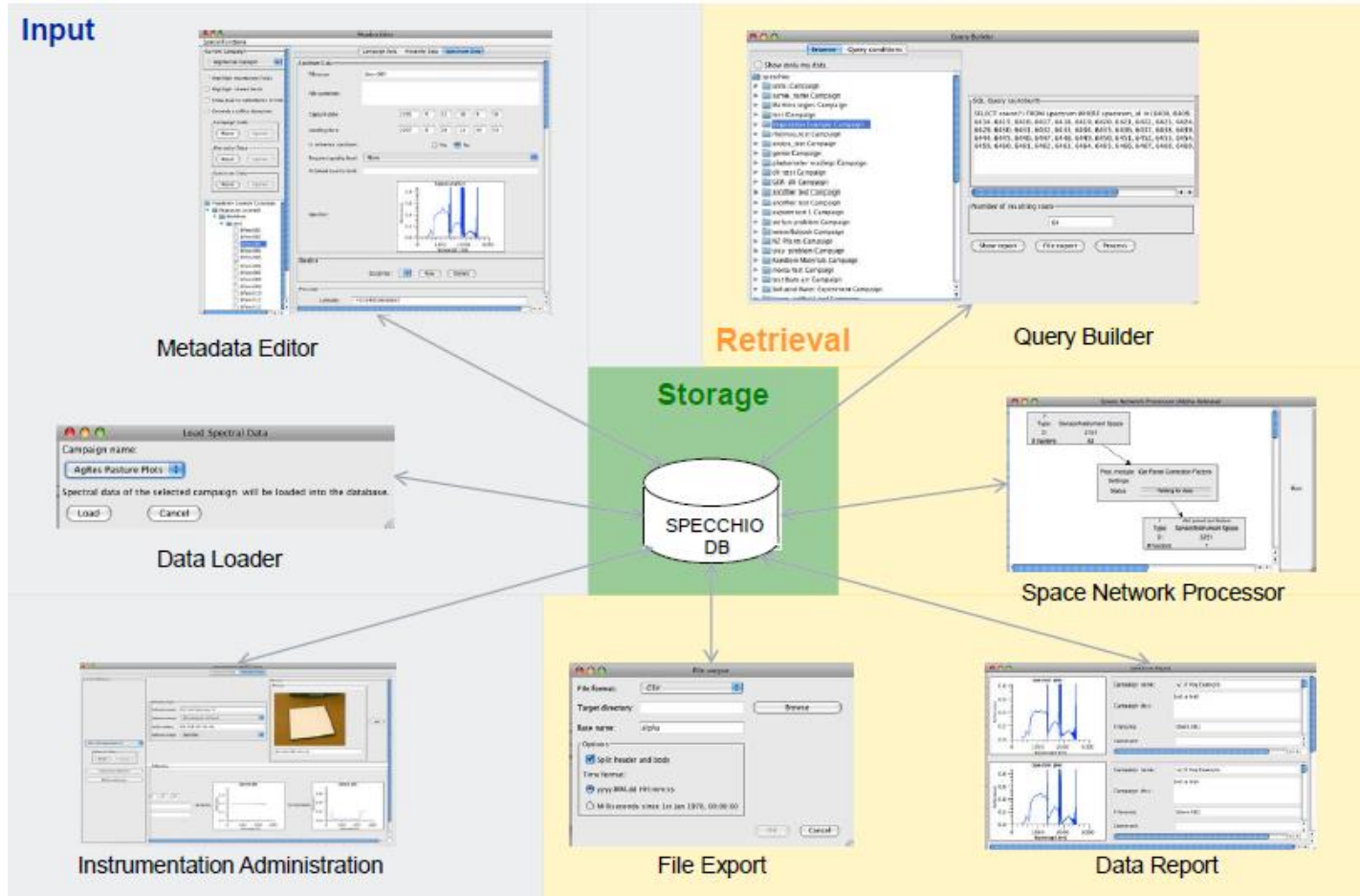
**SPECTRAL UNIFORMITY EVALUATION OF REFERENCE SURFACES
FOR AIRBORNE AND ORBITAL SENSORS ABSOLUTE CALIBRATION**

Cibele Teixeira Pinto^{1,2}, Flávio Jorge Ponzoni¹, Ruy Morgado de Castro^{2,3}
and Derek John Griffith⁴

$$\sigma_{final} = \sqrt{\sum (\sigma_A)^2 + \sum (\sigma_B)^2}$$

$$\sigma_A = \sqrt{(\sigma_{repetitividade})^2 + (\sigma_{reproduzibilidade})^2}$$





ISO 19115-1:2014 Geographic Information - Metadata- Part 1 Fundamentals

ISPRS Int. J. Geo-Inf. **2014**, *3*, 1003-1022; doi:10.3390/ijgi3031003

OPEN ACCESS

ISPRS International Journal of
Geo-Information

ISSN 2220-9964

www.mdpi.com/journal/ijgi/

Article

Field Spectroscopy Metadata System Based on ISO and OGC Standards

Marcos Jiménez ^{1*}, Magdalena González ¹, Alberto Amaro ² and Alix Fernández-Renau ¹

SensorML

ISO 19156
O&M

ISO 19115
MD-
Metadata

SPECTRO-RADIOMETER

Model → D
 Serial number → D
 Calibration date → D
 ForeOptic applied → D
 FOV used → D
 VNIR (FWHM) → D
 SWIR₁ (FWHM) → D
 SWIR₂ (FWHM) → D

CONTACT

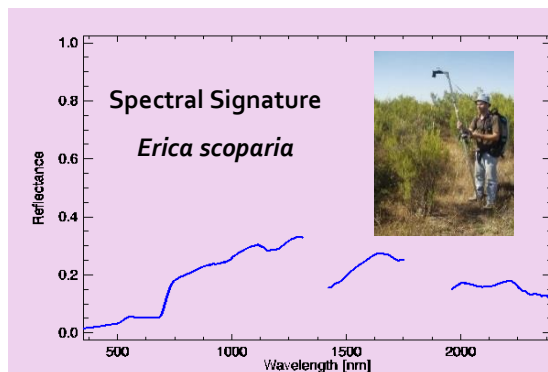
Organization responsible → D
 Person responsible of the data → D

QUALITY

Radiometric (NEDL) → D
 Geometric (RMSE_{x y}) → D
 Measurement
 Uncertainty → C
 Surface
 Heterogeneity → C

METHODOLOGY

Acquisition date → D
 Acquisition time → D
 Observation angle → M
 Sensor height → M
 Quantity measured → D
 Reference Panel → M
 Measurement method → M



Incorporation mode to XML metadata files

D: read Directly M: Manually C: Calculated

LOCALIZATION

Reference system → M
 Projection → M
 X coordinate → C
 Y coordinate → C
 Altitude → C

TARGET/SURFACE

Identification → D
 Description → M

CAMPAIGN

Name → D
 Date → D
 Objective → M
 Purpose → M
 Locality → M
 User (Organization) → M
 Operator → M

ENVIRONMENT

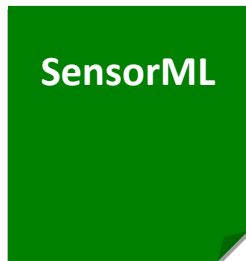
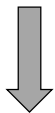
illumination source → M
 Solar zenith angle → C
 Solar azimuth angle → C
 Cloud cover → M
 Aerosol Optical depth → M

FILE

Name → D
 Format → D
 Creation date → D
 Number of samples → M
 Number of spectra → C
 Process level → M

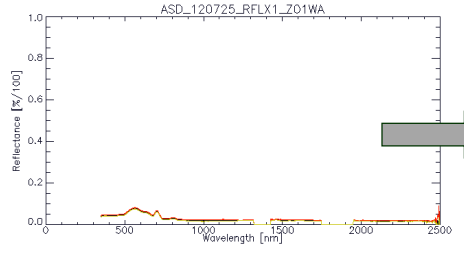
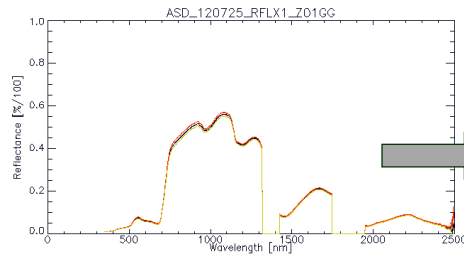
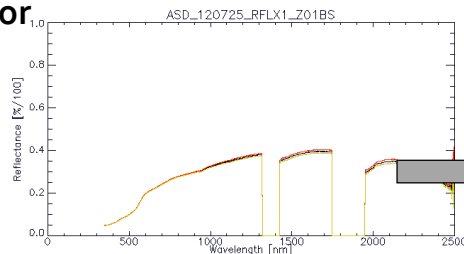
Field spectrometer

One SensorML XML file for each instrument used



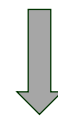
Spectral curves

One ISO 19156 XML file for each surface/material measured



Field campaign

One ISO 19115 XML file for each date



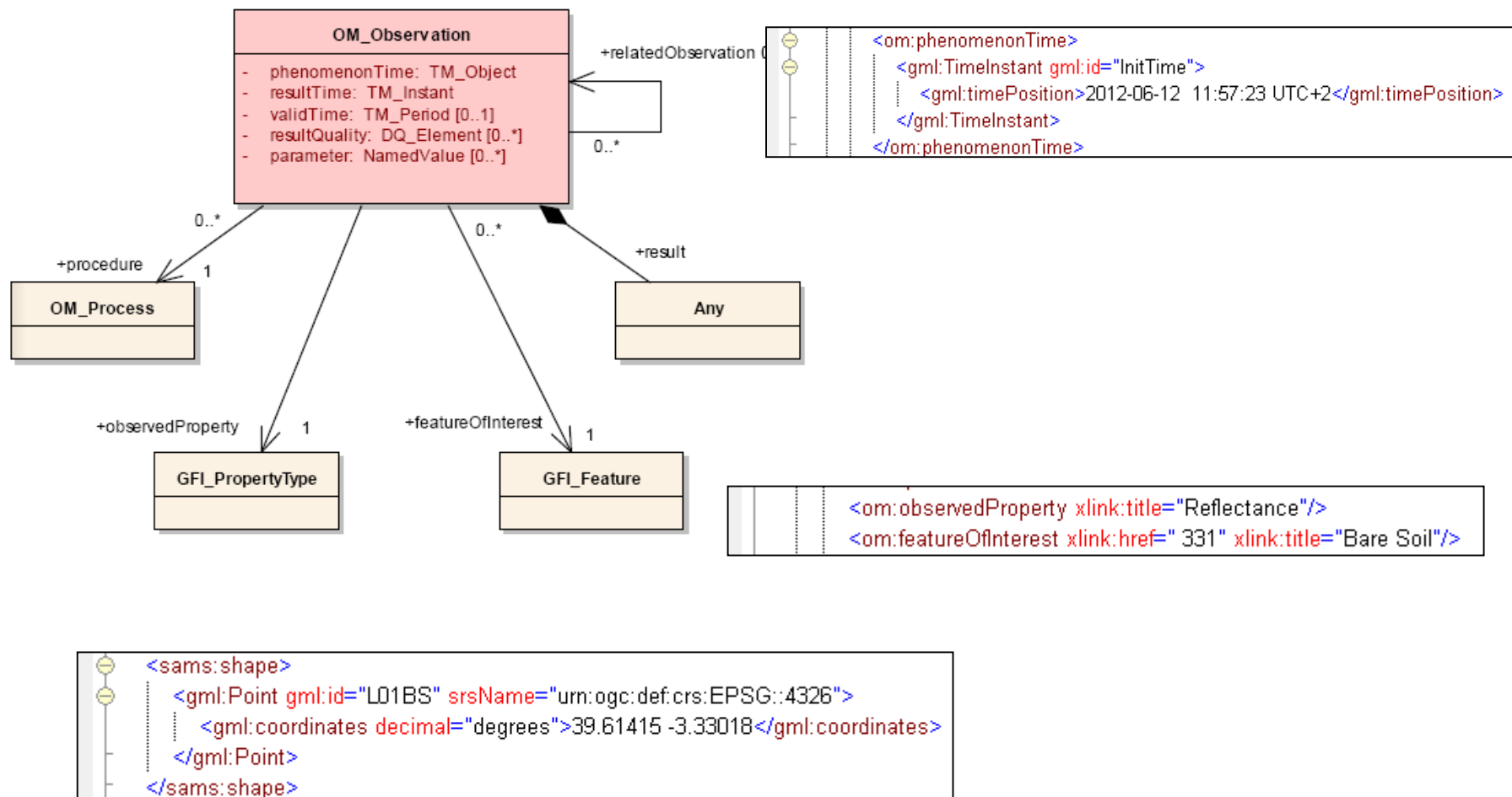
Xlink

Xlink

Xlink

Xlink

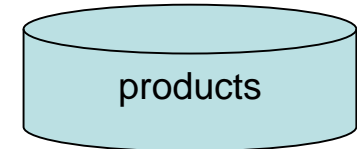
ISO 19156 Field Spectroscopy namespaces



- Excel read all metadata files (as spectral database) and visual basic interface

Este equipo > Toshiba HDD (E) > entregas > ARSAT18 > ASD_180423 > L2

Nombre	Fecha de modifica...	Tipo	Tam
ASD_180423_ARSAT_L01VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L01VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L01VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L02VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L02VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L02VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L03VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L03VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L03VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L04VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L04VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L04VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L05VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L05VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L05VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L06VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L06VG_L2R	16/05/2018 13:46	Archivo HDR	
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ASD_180423_ARSAT_L07VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L08VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L08VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L08VG_L2R.sli	16/05/2018 13:46	Archivo SLI	
ASD_180423_ARSAT_L09VG_L2R	16/05/2018 13:46	Archivo BMP	
ASD_180423_ARSAT_L09VG_L2R	16/05/2018 13:46	Archivo HDR	
ASD_180423_ARSAT_L09VG_L2R.sli	16/05/2018 13:46	Archivo SLI	



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creation="CI_DateTypeCode"
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      </dateType>
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    </Citation>
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```

Data

Proyecto: DESHY16 Registro: ASD_160503 DESHY L04AS L1RT.sli

Organismo: Universidad de las Palmas de Gran Canaria, Javier Marcelo

Identificador: ARSAT Lugar: Mascalomas, Gran Canaria Fecha: 10/05/2016 13:03

Operador: Marcos Jimenez Fecha/Hora: 2015-06-04 11:53:34 UTC+2

Registro	ASD_160503 DESHY L04AS L1RT.sli	RML	L06D3	Índice	DESHY 16
Objetivo	Calibración v analisis de imaciones Worldwid	H_VNIR	17.00%	C_VNIR	30.42%
Superficie	Not available	H_SWIR1	35.90%	C_SWIR1	30.52%
Nubes	2 - 2/8 cloud cover	H_SWIR2	86.76%	C_SWIR2	30.61%
Proyección	urn:oaed:ref:crs:EPSG:4326	Longitud	-15.60212	Latitud	27.78229
Medida	Reflectance	Tipo	Radiance	Altura (mtrs)	1
Óptica	8000	Centr Solar	16.03	Acimut solar	105.91
				Nº medidas	3

Report: Esp, Ing, MD, OM, Proceso, OM, MD



LABORATORIO DE PALEONTOLOGIA PARA LAS CIENCIAS DE LA TIERRA

Instrumento: Espectro radiómetro de campo ASD FieldSpec 3

Superficie: Identificador: L01VG Descripción: Asfalta

Fecha: Nombre: ASAT (datos ARSAT) ARSAT_160503_126 N° de medidas: 3 Hora inicio (hora local): 2016-04-23 13:29:28 UTC+1

GPS: Proyección: Coordenadas Geográficas L: Latitud (dd): 27.78074 Datum: WGS84 E: Longitud (dd): -15.58992 Altura (m):

Comentarios:

Configuración equipo: Distancia [m]: 0.5 Óptica: Filtro Tipo: Radiance

Datos meteorológicos: Cobertura nubosa: 4/8 AOT (560 nm): 0.12500 Vapor de agua: [cm]: 1.7 O3 (ppm): Solar Acumulado: 153.17

Calidad de Medida: VNIR: 1.19% | 1.06% | 0.90% SWIR: SWIR: Confianza de variación de los mediciones del punto de Referencia: VNIR: SWIR: Confianza de variación de los mediciones de la superficie: 7.23% | 14.55% | 19.21%

Foto panorámica del punto de medida Foto detalle de la superficie o material