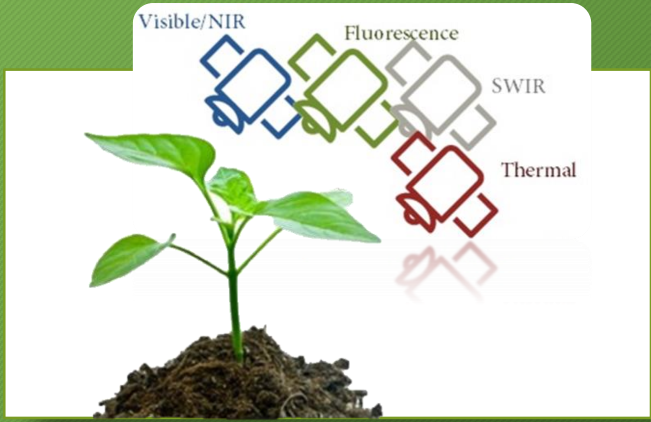
Overview on existing protocols for vegetation monitoring



Dr. Laura Mihai

Photonic Investigations Lab. - Center for Advanced Laser Technologies,
National Institute for Laser, Plasma and Radiation Physics, Romania

SHORT OVERVIEW

WG3 Objective 3.1 To provide homogenized protocols and methods for synergistic use of multi-sensor approaches.

SENSECO

ABOUT SENSECO WORKING GROUPS NETWORKING JOIN US NEWS

Announcement Kick-off meeting WG3 SENSECO - Sensor synergies

Date: Tuesday February 05, 2019

Time: 09:00 -13:00

Location: Brno, Czech Republic, hotel BWP Premier (https://www.hotelinternational.cz/en/)

Meeting description

Multi-sensor or synergistic sensor use will provide a deeper insight into the relations between spectral features and associated plant conditions. Working Group 3 aims to help realize synergies between passive optical EO domains.

- Introduction into the topic
- Overview on the expertise and sensors used from the WG3 participants
- On which concrete topics do we like to work on? Plant stresses with different sensors? Which kind of stresses?
- Will we use or even acquire (as part of a training for example) a common data set from different sensors?
- What will be the next event?

First aims and deliverables for WG3 are best practice protocols and guidelines for synergistic use of multi-sensor approaches.

From the SENSECO MC, a budget has been foreseen for 8 persons for which travelling can be reimbursed. The selection of these persons will be based on order of registration by sending an email to miriam.machwitz@list.lu stating name and organization.

Minutes of the meeting can be downloaded here.

Today →State of the art for:

(i) sensor calibration and characterization

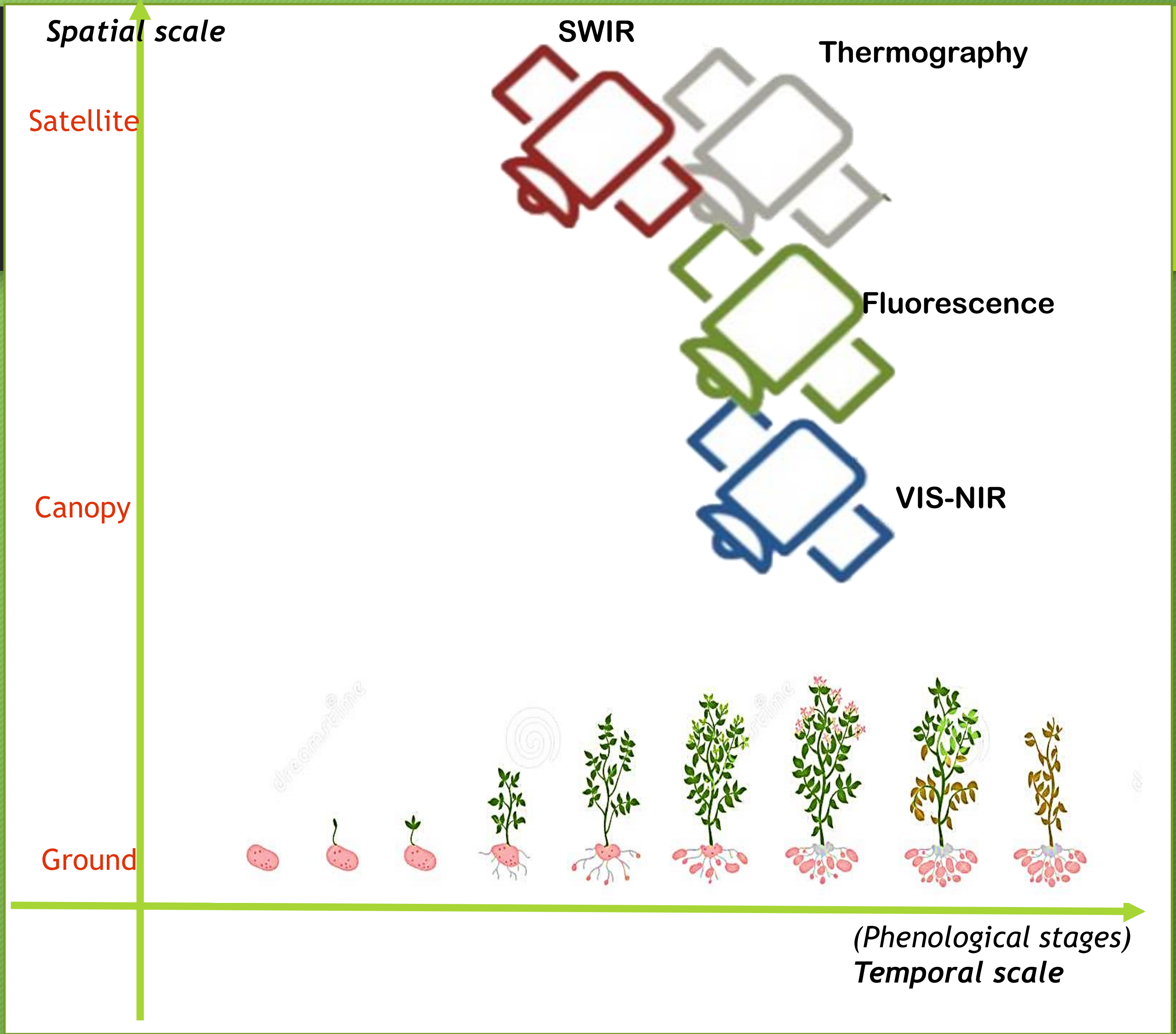
(ii) sensor employment

(iii) data fusion

VEGETATION MONITORING

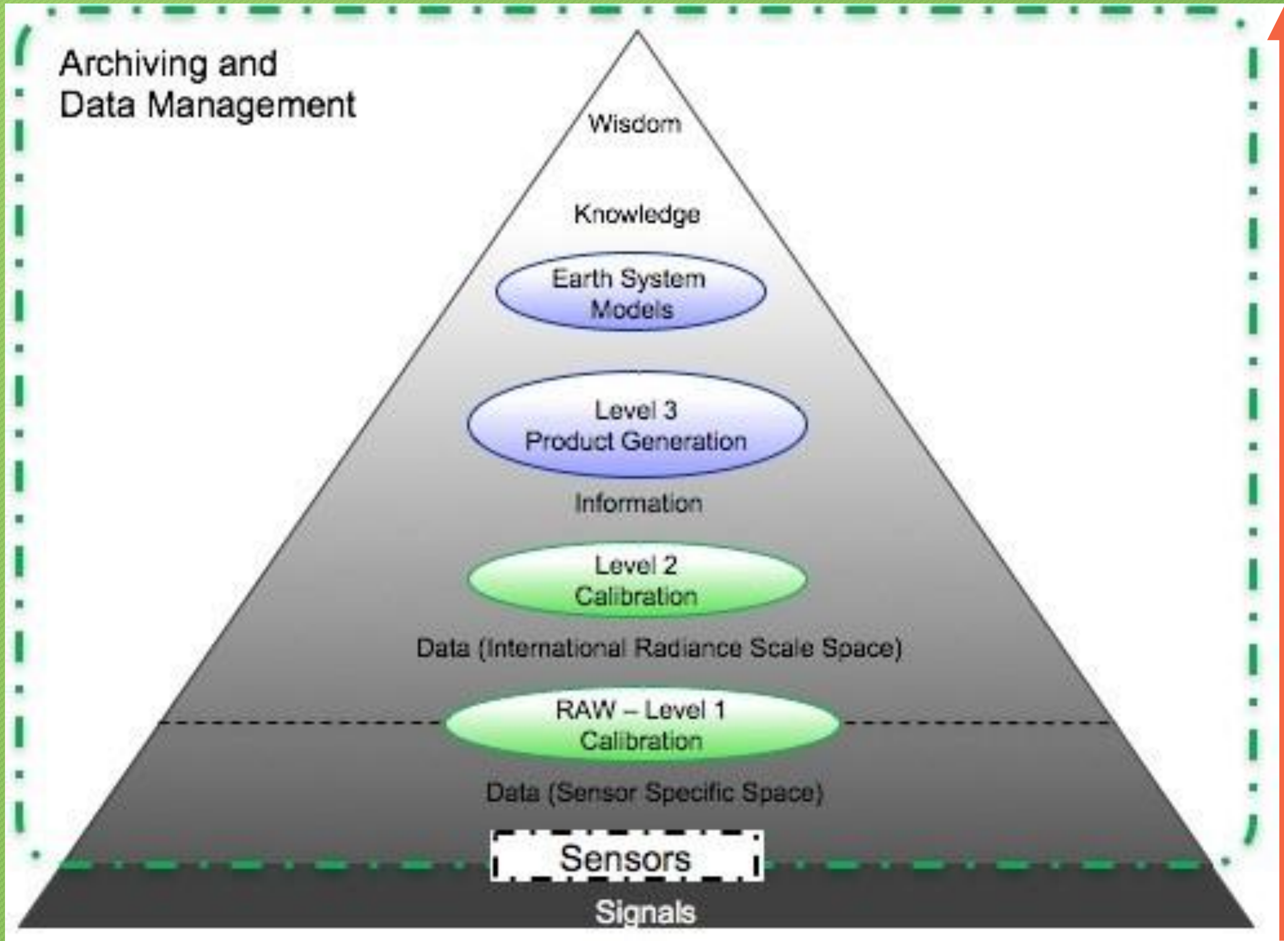
Water stress
Radiation stress
Chemical stress
Abiotic stress
Temperature stress
Mechanical stress

Fungal foliar infection
Insects attack
Biotic stress
Vascular wilt diseases
Bacterial infection
Herbivores



!!!! NEED TO KNOW UNCERTAINTIES FROM EACH INPUT DATA →DETERMINE THE RELATIVE BIASES BETWEEN SENSORS RESPONSE

MEASUREMENTS TRACEABILITY



- Final Results
- Models
- SIF/ vegetation indices
- Reflectance/Emittance units
- Calibrated Physical Units (Radiance/ Irradiance units)
- Raw data (DN)

SENSOR CALIBRATION AND CHARACTERIZATION

CAL/VAL

Spatial performances

Temporal performances

Radiometric Performances
-Signal to noise ratio
-Absolute radiometric accuracy
-Polarization sensitivity
-Stray light sensitivity

Spectral performances
- Spectral sampling interval (SSI)
- Spectral resolution (SR)
- Spectral coregistration (smile)

Geometric Performances
- Spatial sampling

Establishing metrological traceability for radiometric calibration of earth observation sensor in Malaysia. Available from: https://www.researchgate.net/publication/309593558_Establishing_metrological_traceability_for_radiometric_calibration_of_earth_observation_sensor_in_Malaysia

SENSOR CALIBRATION AND CHARACTERIZATION

remote sensing MDPI

Article

Optimized Spectrometers Characterization Procedure for Near Ground Support of ESA FLEX Observations: Part 1 Spectral Calibration and Characterisation

Laura Mihai [1,*], Alasdair Mac Arthur [2], Andreas Hueni [3], Iain Robinson [4] and Dan Sporea [1]

1 CETAL, Photonic Investigations Laboratory, National Institute for Laser, Plasma and Radiation Physics, Măgurele 77125, Romania; dan.sporea@inflpr.ro
2 School of Geosciences, University of Edinburgh, Edinburgh EH9 3FF, UK; alasdair.macarthur@ed.ac.uk
3 Remote Sensing Laboratories, Department of Geography, University of Zurich, 8057 Zurich, Switzerland; andreas.hueni@geo.uzh.ch
4 Rutherford Appleton Laboratory Space Science and Technology Department, Harwell Campus, Didcot, Oxfordshire OX11 0QX, UK; sdfkl239874@googlemail.com
* Correspondence: laura.mihai@inflpr.ro

Received: 31 December 2017; Accepted: 10 February 2

Abstract: The paper presents two procedures fo absorption spectral bands (O2-A, λ_c = 687 nn spectrometers used for reflectance and Sun-induc and Ar pen-type spectral lamps were employed monochromator setup. The double monochroma errors associated with different operating config

Calibration of a Field Spectroradiometer

Calibration and Characterization of a Non–Imaging Field Spectroradiometer Supporting Imaging Spectrometer Validation and Hyperspectral Sensor Modelling

Dissertation

zur

ng der naturwissenschaftlichen Doktorwürde

(Dr. sc. nat.)

vorgelegt der

ematisch–naturwissenschaftlichen Fakultät

der

Universität Zürich

von

Michael Ellert Schaepman

von

Zürich / ZH

ISO Search ISO/TS 19159-3:2018(en) ×

ISO/TS 19159-3:2018(en) Geographic information — Calibration and validation of remote sensing imagery sensors and data — Part 3: SAR/InSAR

Table of contents

Foreword
Introduction
1 Scope
2 Normative references
3 Terms and definitions
4 Symbols, abbreviated terms and
4.1 Symbols
4.2 Abbreviated terms

1 Scope

This document defines the calibration of SAR/InSAR sensors and validation of SAR/InSAR calibration information.

This document addresses earth based remote sensing. The specified sensors include airborne and spaceborne SAR/InSAR sensors.

This document also addresses the metadata related to calibration and validation.

Improving the Calibration of Airborne Hyperspectral Sensors for Earth Observation

Dissertation

zur

Erlangung der naturwissenschaftlichen Doktorwürde
(Dr. sc. nat.)

vorgelegt der

Mathematisch-naturwissenschaftlichen Fakultät

der

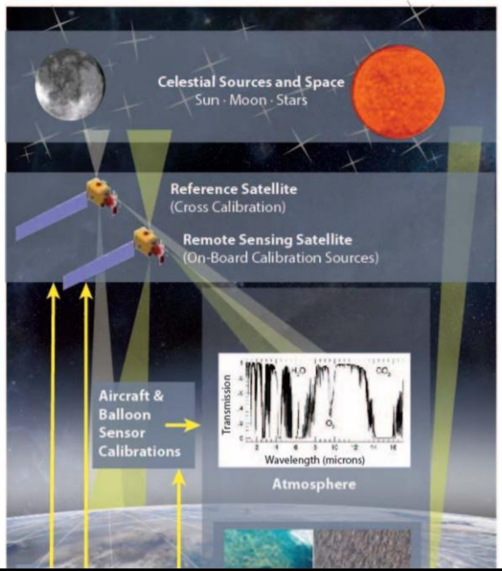
Universität Zürich

von

Karim Lenhard

aus

Deutschland



NISTHB 157

Guidelines for Radiometric Calibration of Electro-Optical Instruments for Remote Sensing

Joe Tansock, Daniel Bancroft, Jim Butler, Changyong Cao, Raju Datla, Scott Hansen, Dennis Helder, Raghu Kacker, Harri Latvakoski, Martin Mlynczak, Tom Murdock, James Peterson, David Pollock, Ray Russell, Deron Scott, John Seamons, Tom Stone,

Open access peer-reviewed chapter

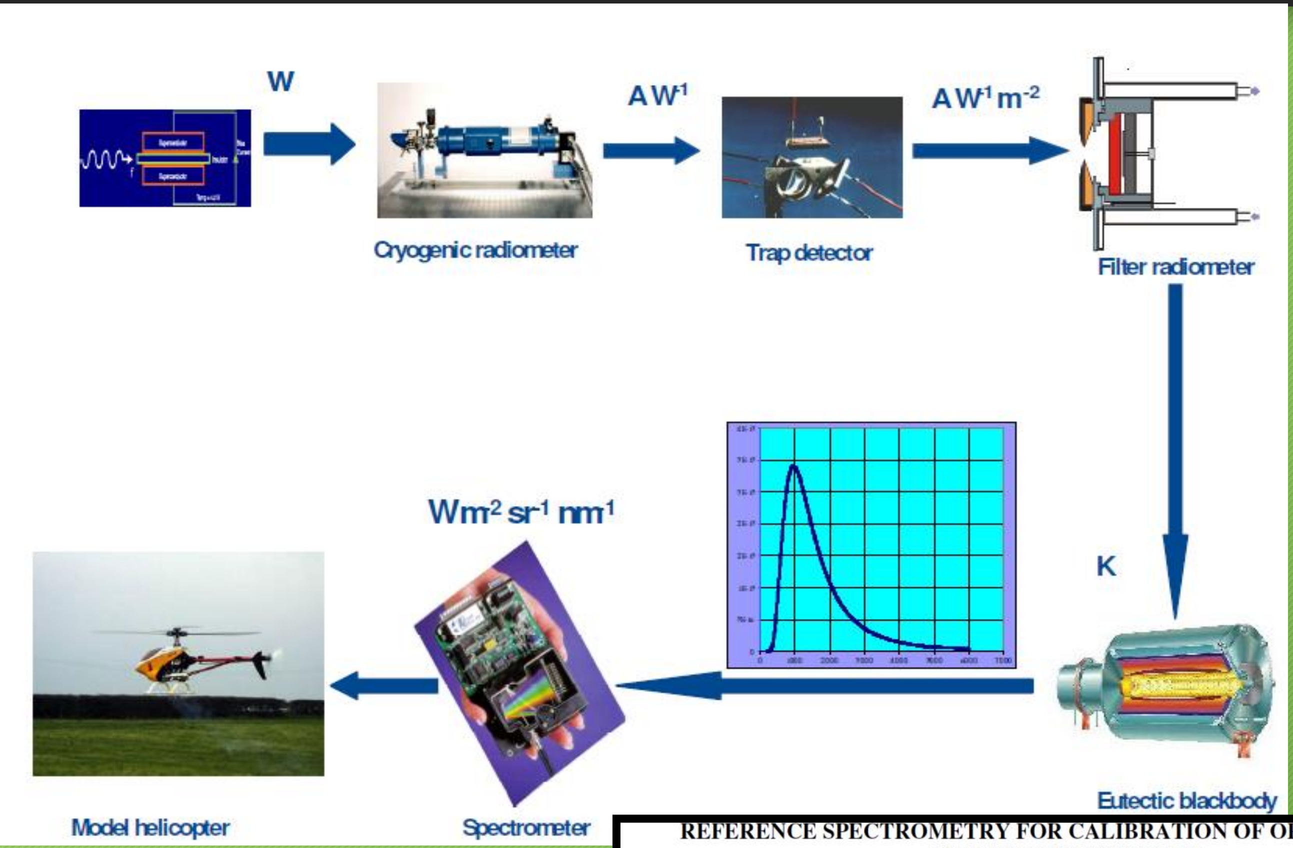
Optical Radiation Metrology and Uncertainty

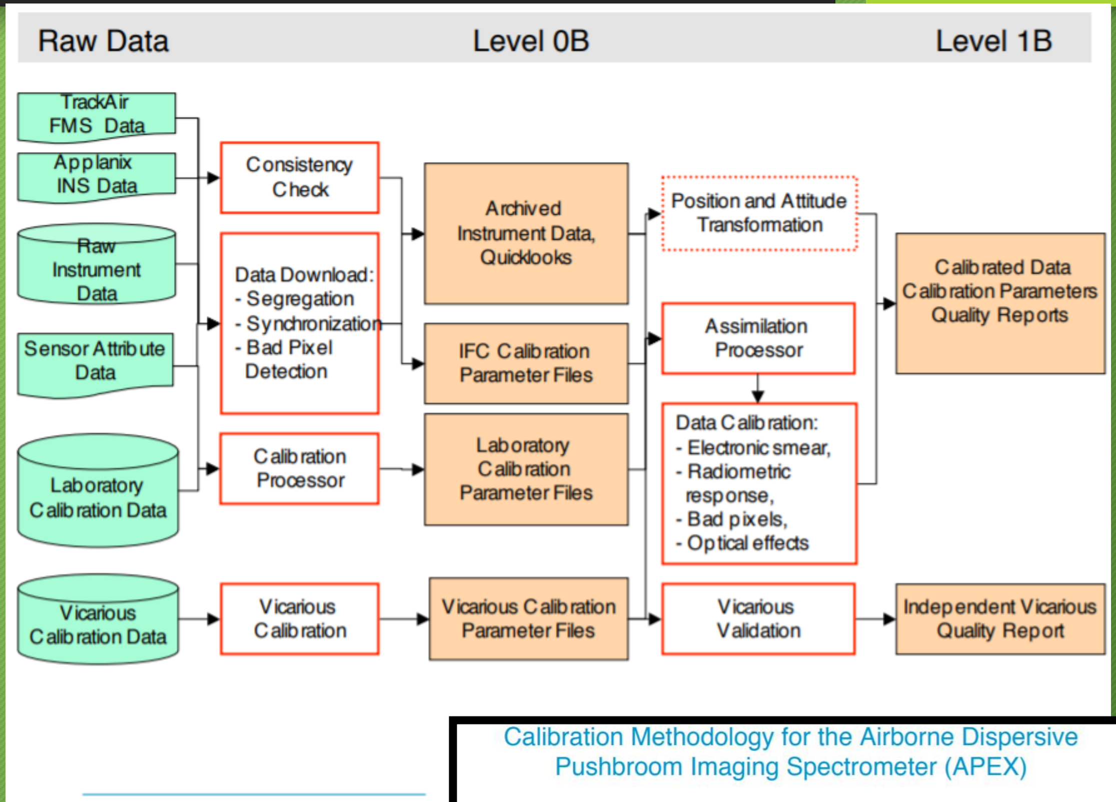
By Manal A. Haridy and Affia Aslam

Submitted: September 26th 2017 Reviewed: February 12th 2018 Published: March 14th 2018
DOI: 10.5772/intechopen.75205

SENSOR CALIBRATION AND CHARACTERIZATION

Radiometric
Spectral
Geometric





REFERENCE SPECTROMETRY FOR CALIBRATION OF OPTICAL EARTH OBSERVATION SYSTEMS

S. G. R. Salim [a, *], N. P. Fox [a], E. R. Woolliams [a], R. Winkler [a], H. M. Pegrum [a], T. Sun [b], K. T. V. Grattan [b]

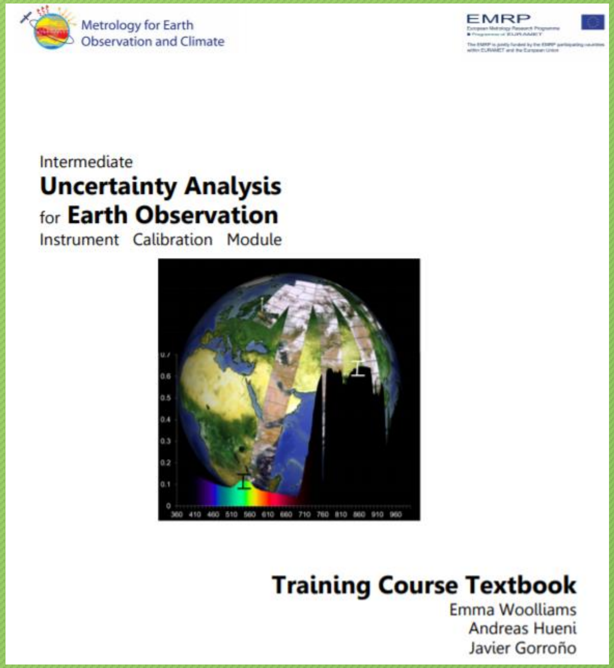
[a] National Physical Laboratory, Hampton road, Teddington, Middlesex, TW11 0LW, UK – (saber.salim, nigel.fox, emma.woolliams, rainer.winkler, heather.pegrum)@npl.co.uk
[b] City University, North Hampton Square, London, EC1V 0HB, UK – (T.Sun, K.T.V.Grattan)@city.ac.uk

Calibration Methodology for the Airborne Dispersive Pushbroom Imaging Spectrometer (APEX)

Jens Nieke, Johannes W. Kaiser, Daniel Schläpfer, Jason Brazile, Klaus I. Itten (RSL),
Horst Schwarzer, Peter Strobl (DLR),
Michael E. Schaepman (WUR),
Gerd Ulbrich (ESA)

and the APEX team

UNCERTAINTIES ANALYSIS GUIDELINES



The steps to an uncertainty budget:

- **Understanding the problem**

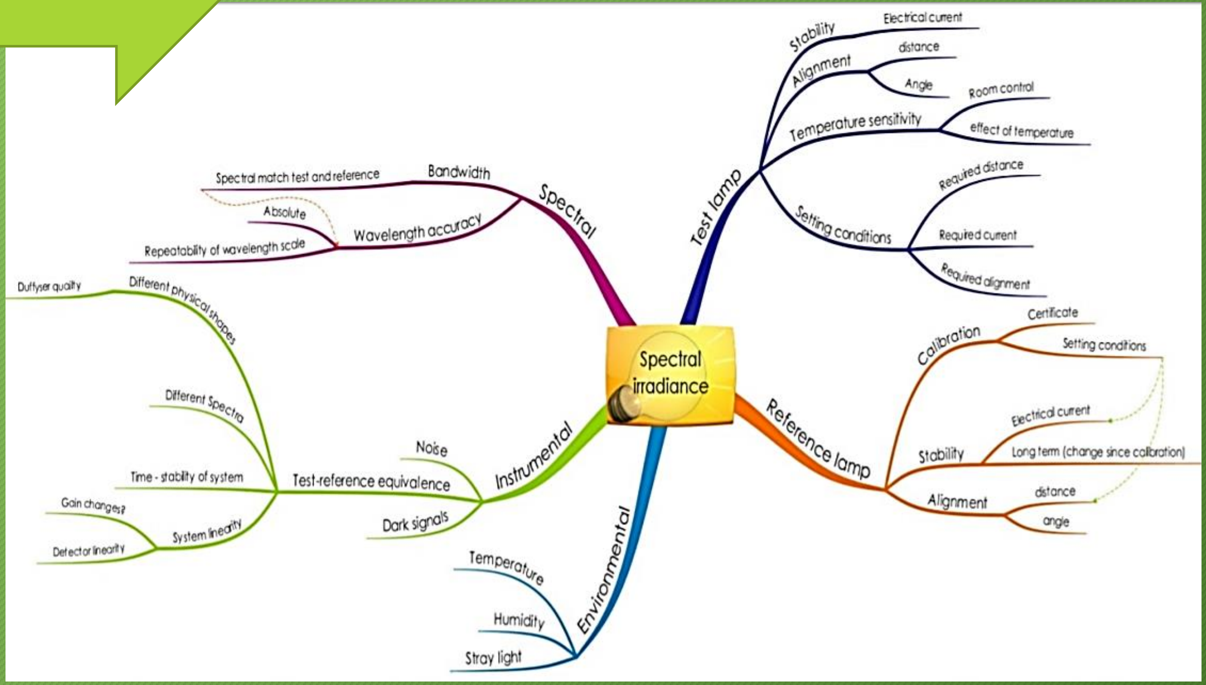
Step 1: Describing the traceability chain
Step 2: Writing down the calculation equations
Step 3: Considering the sources of uncertainty

- **Determining the formal relationships**

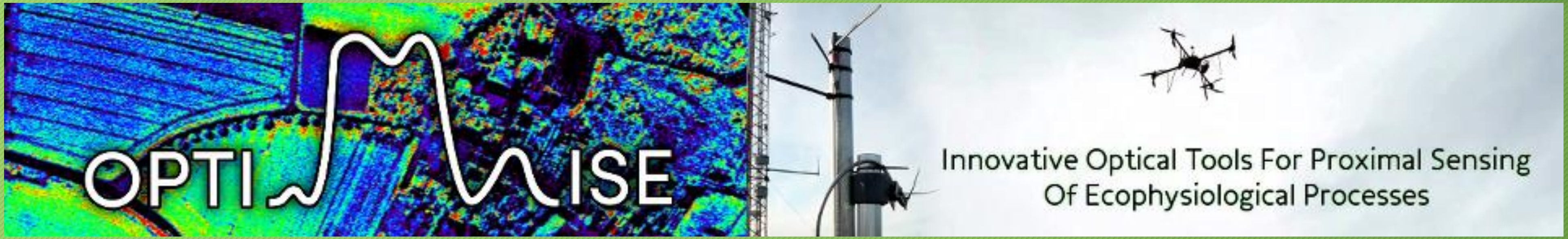
Step 4: Creating the measurement equation
Step 5: Determining the sensitivity coefficients
Step 6: Assigning uncertainties

- **Propagating the uncertainties**

Step 7: Combining and propagating uncertainties
Step 8: Expanding uncertainties



PROTOCOLS FOR SIF MEASUREMENTS



Optimise papers → protocols for SIF measurements

- Paper 1: Sun-induced chlorophyll fluorescence I: Instrumental considerations for proximal spectroradiometers

- Paper 2: Sun-induced chlorophyll fluorescence II: Review of passive measurement setups, protocols and their application at leaf to canopy level

- Paper 3: Sun-induced chlorophyll fluorescence III: benchmarking retrieval methods and sensor characteristics for proximal sensing

PROTOCOLS FOR SIF MEASUREMENTS

Paper 1
→instrument characterization

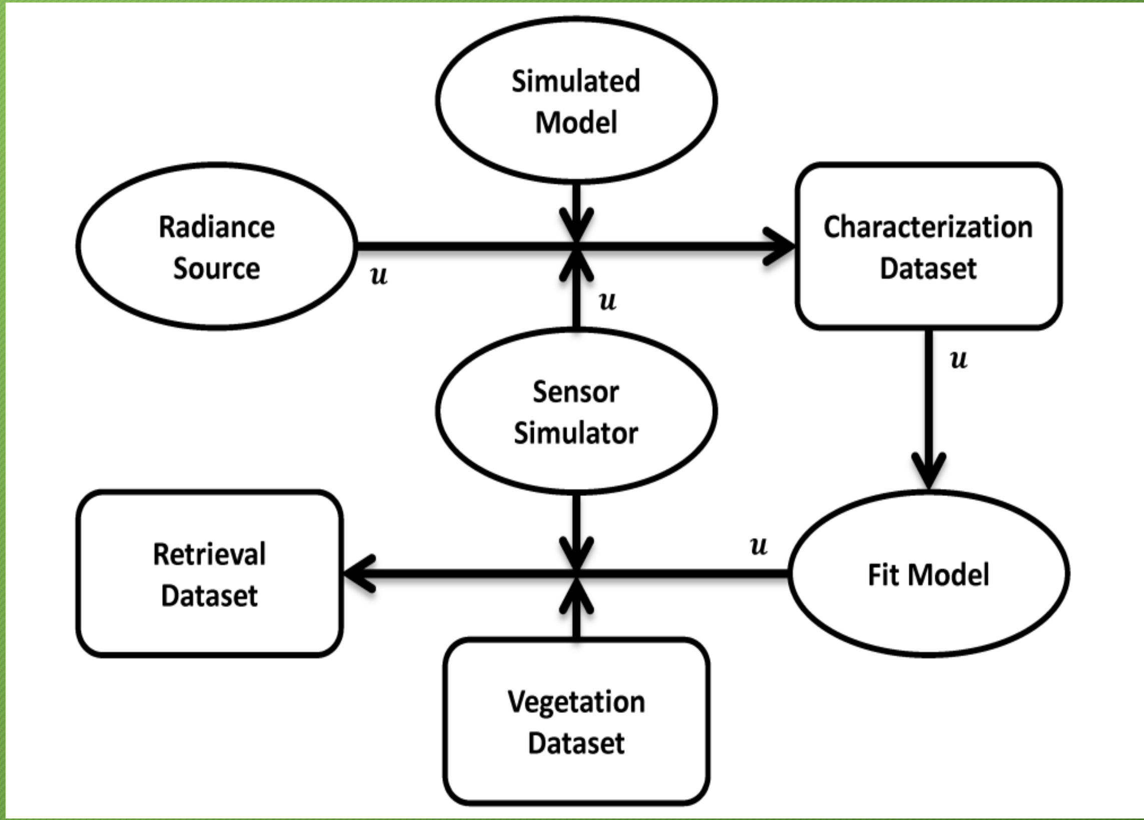
Aims to provide a better understanding on some possible instrumental sources of error on the retrieval of SIF, more specifically for the latest generation sensors available and on a single SIF retrieval method adapted to their features.

Steps:

→ **Simulation of a typical field spectroradiometer** used **for retrieval of SIF** in O2-A and O2-B absorption bands.

→ **Sensor characterization** → signal changes to different environmental variables (e.g., temperature, θs…) or the sensor configuration.

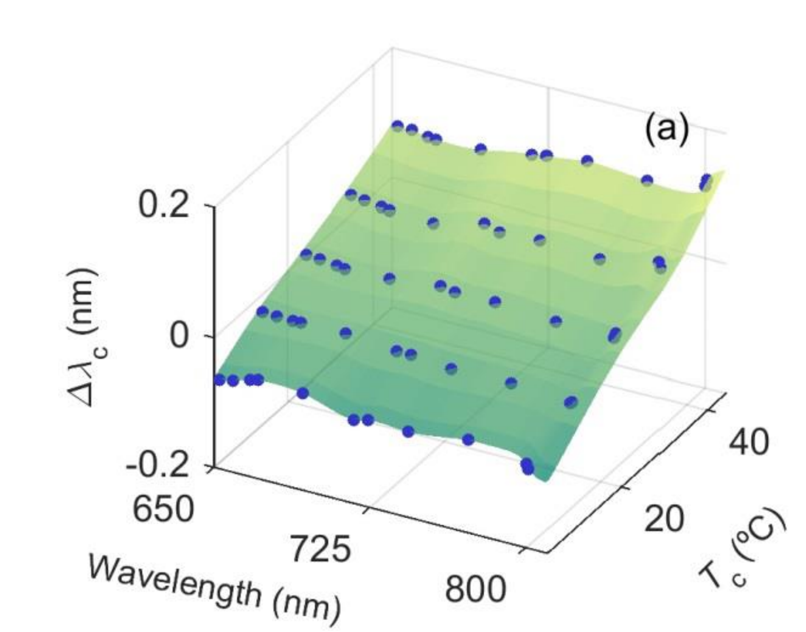
→ Were determined the calibration coefficients → **propagating the uncertainties in the process**.



PROTOCOLS FOR SIF MEASUREMENTS

Paper 1
→instrument characterization

- Spectral Calibration Uncertainties
- Temperature-Induced Spectral Changes
- Radiometric Calibration Uncertainties
- Temperature-Induced Changes in Photoresponse
- Non-linearity
- Directional response characterization



Chamber temperature effects on central position of the spectral band. Blue dots represent observations, whereas Biharmonic interpolated values are represented with surfaces.

PROTOCOLS FOR SIF MEASUREMENTS

Paper 2
→ measurement setups and protocols

Review the current approaches to measure F from leaf to canopy scale from ground based and airborne platforms: instrumentation, measurement setups, protocols, quality checks and data processing strategies.

Paper structure:

→ Review on measuring F on:

- → the leaf level: setups and protocols
- → Canopy level: setups and protocols used from the proximal to the airborne scale

→ Current approaches to open challenges of F estimations from proximal to airborne scale: atmospheric influences (at different altitudes), data quality check (before analysis), metadata documentation, influence of the spatial measurement scale, development of computer models for radiative transfer of fluorescence

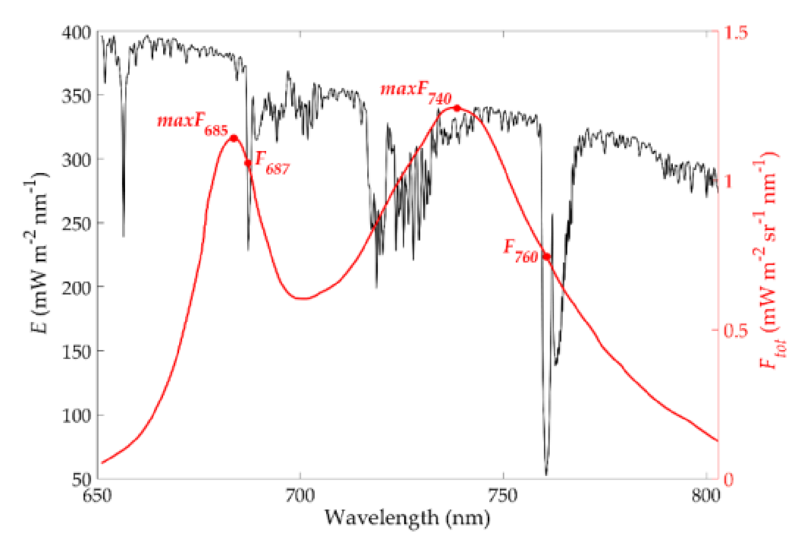
Paper 3

Paper 3
→ retrieval methods

Guideline on how to pre-evaluate possible SIF retrieval accuracies for *FR* (F emitted at the red region of the spectrum) and *F*FR (F emitted at the far-red region of the spectrum) considering the characteristics of novel instrumentation (i.e. *SR*, spectral sampling interval (*SSI*), signal-to noise ratio (*SNR*)) in combination with frequently applied retrieval schemes (i.e. sFLD, 3FLD, iFLD, and SFM).

Paper is divided in two section:

- most commonly used retrieval methods and outline their advantages and disadvantages → evaluation of uncertainties in SIF retrievals (i.e. FLD approaches and Spectral Fitting Method, SFM) for a combination of state-of-the-art spectrometers (i.e. ASD, MAYA, HR4000, QE Pro).
- sensitivity analysis including used simulated dataset and methodology to benchmark the performance of the retrieval methods under different sensor characteristics→ evaluation of effects when the retrieval methods are implemented in a wrong way and the increase of uncertainty when retrieving SIF



Down-welling irradiance ($E\downarrow$, black line) at ground level and Solar-induced chlorophyll fluorescence spectrum (red line). Maximum value of fluorescence at 685 nm (*maxF*685) and 740 nm (*maxF*740). Sun-induced fluorescence at the O2B (*F*687) and O2A (*F*760) absorption bands

SENSORS EMPLOYMENT

Beskydy, 2017, 10 (1, 2): 75–86
© Mendelova univerzita v Brně
ISSN: 1805-9538 (Online)
http://dx.doi.org/10.11118/beskyd201710010075

In situ data supporting remote sensing estimation of spruce forest parameters at the ecosystem station Bílý Kříž

*Lucie Homolová[1], Růžena Janoutová[1], Petr Lukeš[1], Jan Hanuš[1], Jan Novotný[1], Olga Brovkina[1], Rolling Richard Loayza Fernandez[1]

[1] Global Change Research Institute CAS, Bělidla 986/4a, 603 00 Brno, C
e-mail: homolova.l, lukes.p, janoutova.r, hanus.j, novotny.j, brovkina.o, lo

Abstract: Homolová L., Janoutová R., Lukeš P., Hanuš J., Novotn
R. R. 2017: In situ data collection supporting remote
parameters at the ecosystem station Bílý Kříž – *Besky*

Remote sensing offers an effective way of mapping
continuous manner, at larger spatial scales and repeat
in situ mapping approaches that are typically accur
location and few repetitions. In case of forest ecosys
quantitative parameters or indicators related to fo
index, leaf pigment content, chlorophyll fluoresce
and validation of remote sensing-based methods, ho
data. The aim of this contribution is to introduce th
the framework for the retrieval of forest quantitative
spectroscopy data. All measurements were acquire
campaign that took place at the Norway spruce domi
Silesian Beskydy Mts., Czech Republic) during Au
remote sensing data acquisition, the in situ activitie
for tree 3D modelling, measurements of needle bioc
area index measurements and spectral measureme
surfaces. Leaf pigments varied between 25.2 and 49.1
4.9 – 10.6 µg cm⁻² for carotenoid content depending

nature COMMUNICATIONS

ARTICLE

DOI: 10.1038/s41467-017-01530-3 OPEN

Mapping functional diversity from remotely sensed morphological and physiological forest traits

Fabian D. Schneider [1], Felix Morsdorf [1], Bernhard Schmid [2], Owen L. Petchey [2], Andreas Hueni [1], David S. Schimel [3] & Michael E. Schaepman [1]

Assessing functional diversity from space can help predict productivity and stability of forest ecosystems at global scale using biodiversity-ecosystem functioning relationships. We present a new spatially continuous method to map regional patterns of tree functional diversity

remote sensing

Article

Analysis of Airborne Optical and Thermal Imagery for Detection of Water Stress Symptoms

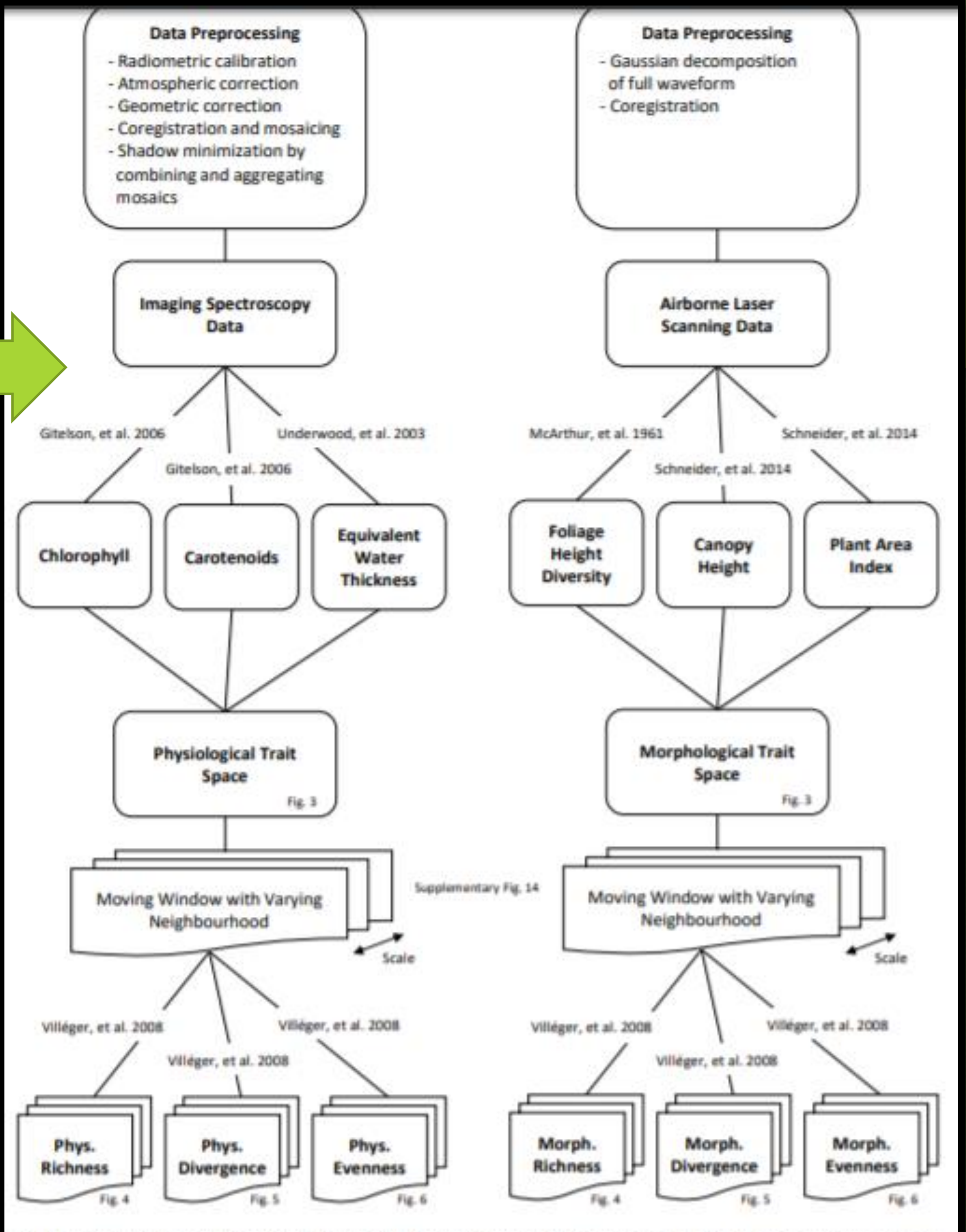
Max Gerhards [1,2,*], Martin Schlerf [1], Uwe Rascher [3], Thomas Udelhoven [2], Radoslaw Juszczak [4], Giorgio Alberti [5], Franco Miglietta [6] and Yoshio Inoue [7]

1 Luxembourg Institute of Science and Technology (LIST), Environmental Research and Innovation (ERIN) Department, 41 Rue du Brill, L-4422 Belvaux, Luxembourg; martin.schlerf@list.lu
2 Remote Sensing & Geoinformatics Department, Behringstrasse, Faculty of Geography and Geosciences, University of Trier, D-54296 Trier, Germany; udelhoven@uni-trier.de
3 Forschungszentrum Jülich, Institute of Bio- and Geosciences, IBG-2: Plant Sciences, 52425 Jülich, Germany; u.rascher@fz-juelich.de
4 Department of Meteorology, Poznan University of Life Sciences, 60649 Poznan, Poland; radjusz@up.poznan.pl
5 Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, 33100 Udine, Italy; giorgio.alberti@uniud.it
6 National Research Council, Institute of Biometeorology, 50145 Firenze, Italy; f.miglietta@ibimet.cnr.it
7 Research Center for Advanced Science and Technology, University of Tokyo, Tokyo 153-8904, Japan; yinoue@affrc.go.jp
* Correspondence: gerhardsm@uni-trier.de; Tel.: +49-651-201-4596

Received: 13 June 2018; Accepted: 16 July 2018; Published: 19 July 2018

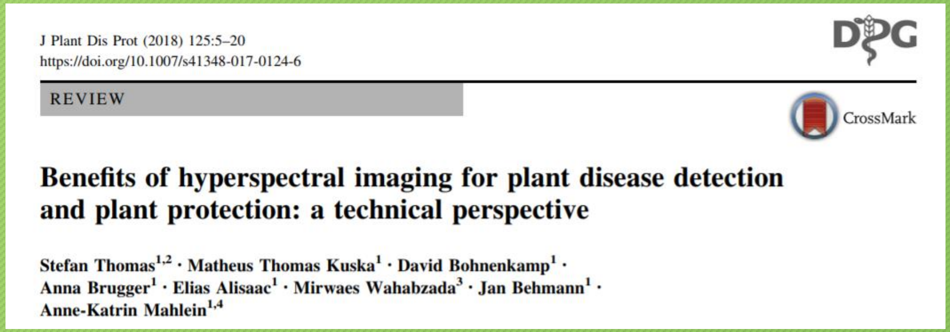
check for updates

Abstract: High-resolution airborne thermal infrared (TIR) together with sun-induced fluorescence (SIF) and hyperspectral optical images (visible, near- and shortwave infrared; VNIR/SWIR) were jointly acquired over an experimental site. The objective of this study was to evaluate the potential of these state-of-the-art remote sensing techniques for detecting symptoms similar to those occurring during water stress (hereinafter referred to as 'water stress symptoms') at airborne level. Flights with two camera systems (Telops *Hyper-Cam LW*, Specim *HyPlant*) took place during 11th and 12th June



Supplementary Figure 14: Flowchart visualising the work-flow from remote sensing data to physiological (left) and morphological (right) diversity measures. The functional traits are combined to a three-dimensional trait space. By iterating through the pixels using a moving window approach and changing the extent of the neighbourhood, functional diversity measures can be calculated for many scales.

DATA FUSION PROTOCOLS



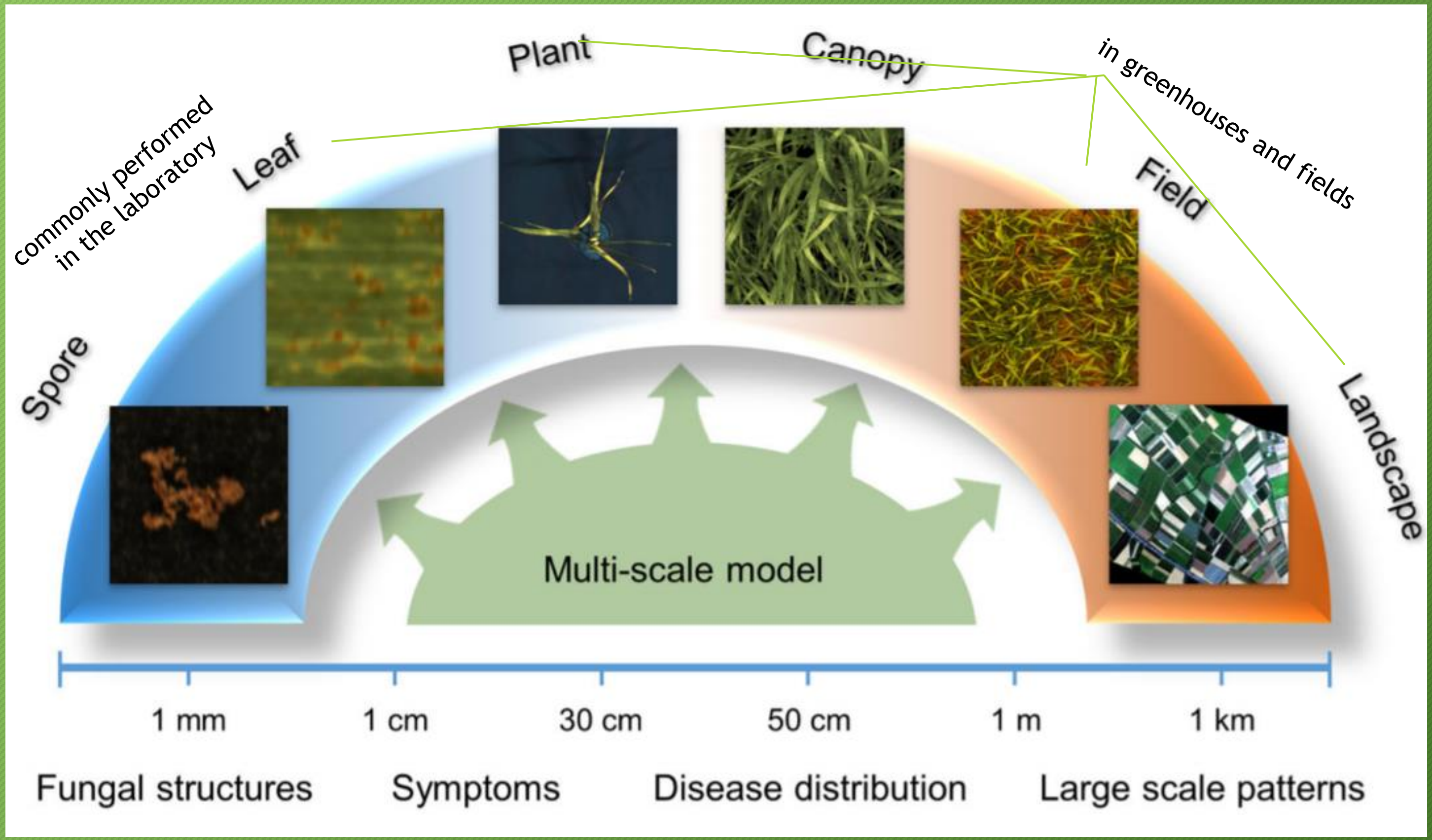
J Plant Dis Prot (2018) 125:5–20
https://doi.org/10.1007/s41348-017-0124-6

REVIEW

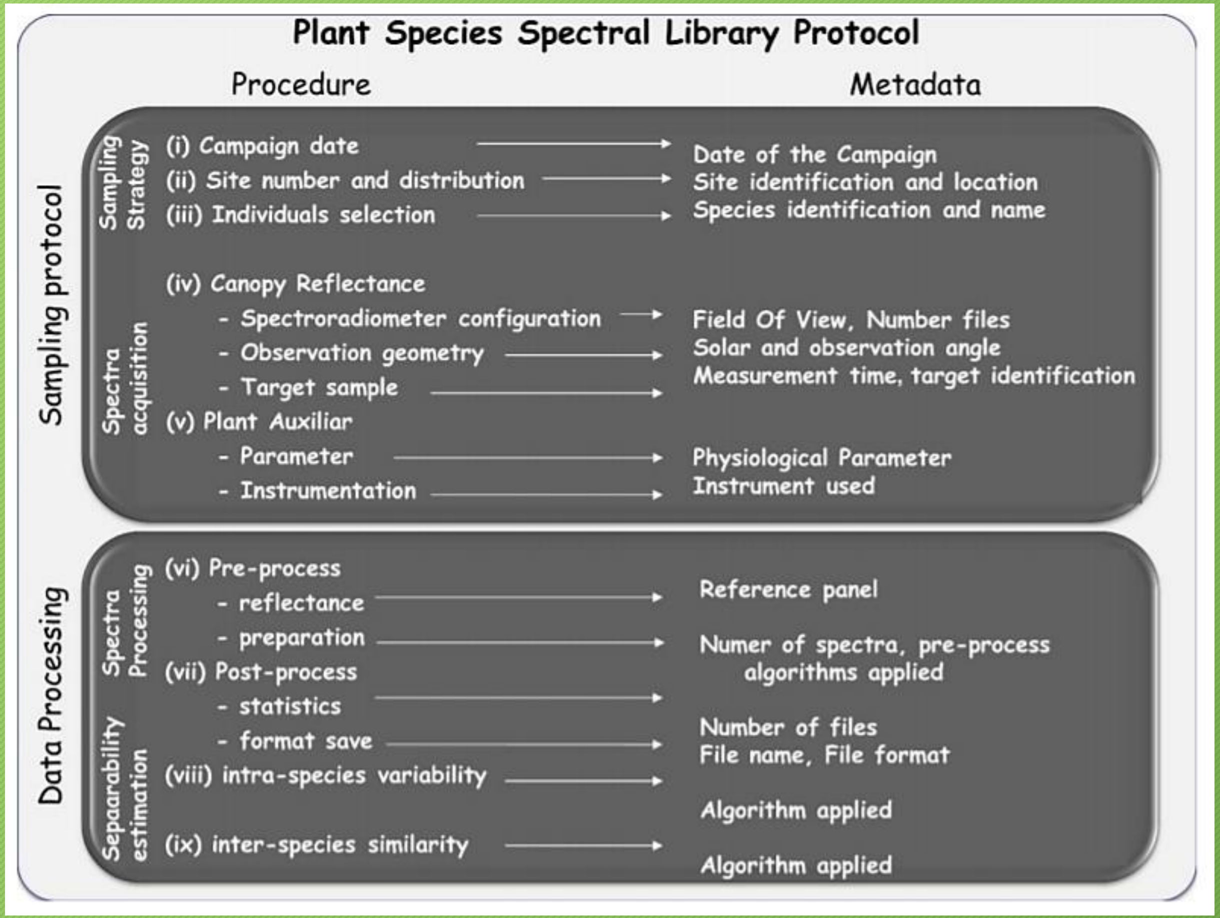
Benefits of hyperspectral imaging for plant disease detection and plant protection: a technical perspective

Stefan Thomas[1,2] · Matheus Thomas Kuska[1] · David Bohnenkamp[1] · Anna Brugger[1] · Elias Alisaac[1] · Mirwaes Wahabzada[3] · Jan Behmann[1] · Anne-Katrin Mahlein[1,4]

overview on hyperspectral sensors for plant disease detection from the laboratory to the field



DATA FUSION PROTOCOLS



ISPRS Int. J. Geo-Inf. **2015**, *4*, 2472-2495; doi:10.3390/ijgi4042472

OPEN ACCESS

ISPRS International Journal of

Geo-Information

ISSN 2220-9964

www.mdpi.com/journal/ijgi/

Article

Towards a Standard Plant Species Spectral Library Protocol for Vegetation Mapping: A Case Study in the Shrubland of Doñana National Park

Marcos Jiménez [1,*] and Ricardo Díaz-Delgado [2]

[1] Remote Sensing Area, National Institute of Aerospace Technologies (INTA), Ctra. Ajalvir s/n, Torrejón de Ardoz, 28850 Madrid, Spain

[2] Remote Sensing and GIS Lab., Doñana Biological Station, CSIC, Avda. Americo Vespucio, 41092 Sevilla, Spain; E-Mail: rdiaz@ebd.csic.es

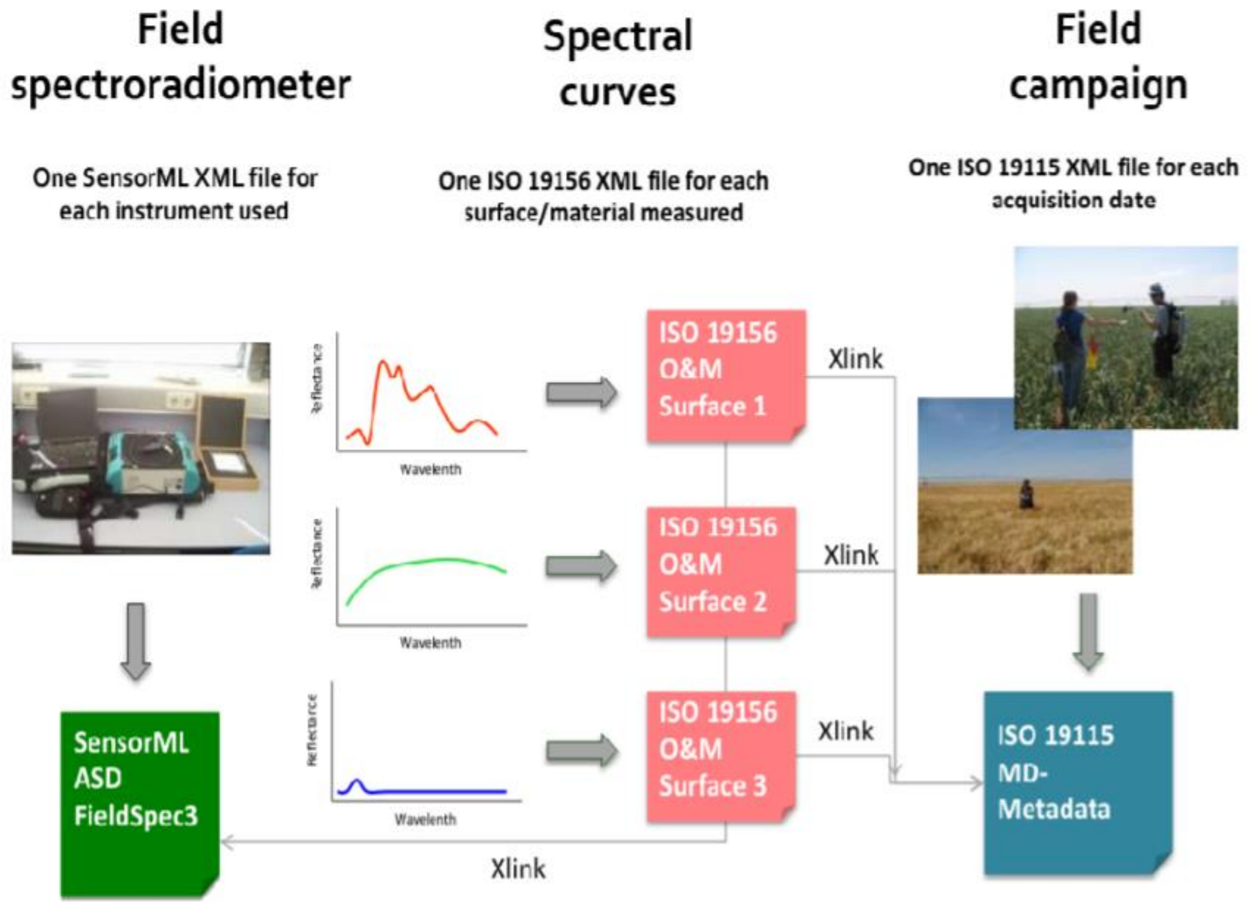
* Author to whom correspondence should be addressed; E-Mail: jimenezmm@inta.es;

→ establish standard procedures for the acquisition of plant spectra in the field, based on a number of solid bases for any plant type, but also including flexible procedures depending on the type of plant considered (i.e., forest, shrub, pasture).

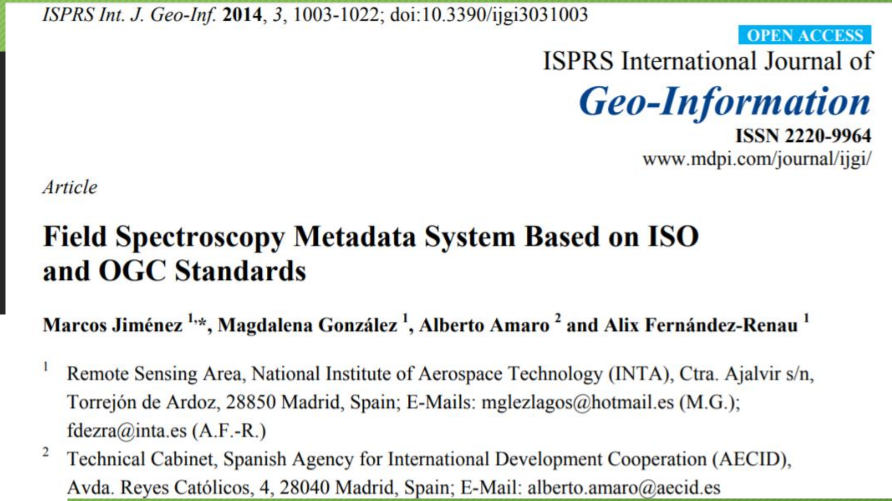
→ One of these solid bases for the protocol is to estimate inter-species spectral similarity and intra-species variability by accounting for environmental gradients and phenological changes.

→ To demonstrate the usability of the protocol→ a practical example

DATA FUSION PROTOCOLS



Metadata structure for field spectroscopy based on ISO 19156 (O&M), ISO 19115 (MD) and Sensor Model Language (SensorML).



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]

[1] Remote Sensing Area, National Institute of Aerospace Technology (INTA), Ctra. Ajalvir s/n, Torrejón de Ardoz, 28850 Madrid, Spain; E-Mails: mglezlagos@hotmail.es (M.G.); fdezra@inta.es (A.F.-R.)

[2] Technical Cabinet, Spanish Agency for International Development Cooperation (AECID), Avda. Reyes Católicos, 4, 28040 Madrid, Spain; E-Mail: alberto.amaro@aecid.es

PROTOCOLS FOR EXPERIMENTS

Experimental Protocol for Field trials assessing drought stress

Field Lay Out

The experimental fields should be split into three plots. It has to be possible to give different amounts of irrigation water to the three blocks. Water inflow from one block into the other has to be avoided.
In each plot, the experimental clones are planted in blocks of 10 plants in a random complete block design with 3 replicated blocks for each treatment. For trials that also serve to collect modeling parameters, 5 replicate blocks for control and terminal drought have to be planted. 2 of the 5 blocks serve for sequential harvest, 3 for drought susceptibility evaluation. Distance between rows should be 80 cm and between plants 30 cm. We might choose 25 cm plant- and 70 cm row distances in India in order to test the clones under the local conditions.

PrometheusWiki

Protocols in ecological & environmental plant physiology

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Protocol

(Cached)

Field Experiments in Crop Physiology

Kathy Schneebeli

Contributors :Kathy Schneebeli

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bio-protocol

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Experimental Design to Determine Drought Stress Response and Early Leaf Senescence in Barley (*Hordeum vulgare* L.)

Gwendolin Wehner Christiane Balko Frank Ordon

DOI: 10.21769/BioProtoc.1749 Published: Vol 6, Iss 5, March 05, 2016

Plant Science > Plant physiology > Abiotic stress
Plant Science > Plant physiology > Photosynthesis
Plant Science > Plant physiology > Plant growth
Plants > Barley > Leaf > Other compound

Protocols for experimental plot sampling, handling and processing of cereals in field experiments

Standardised methods for use in large agronomic, physiological and genetic field studies

G. Rebetzke[af], A. van Herwaarden[b], K. Chenu[c], C. Moeller[d], B. Biddulph[e], R. Richards[a], A. Rattey[a]

INTEREST IN MULTI-SENSOR USE

Geophysical Research Abstracts
Vol. 21, EGU2019-12877, 2019
EGU General Assembly 2019

An optimized high spatial resolution fluorescence dataset to better understand terrestrial ecosystem dynamics of productivity

Gregory Duveiller (1), Federico Filipponi (1), Sophia Walther (2), Christian Frankenberg (3,4), Philipp Kölher (3), Luis Guanter (5), and Alessandro Cescatti (1)

(1) European Commission Joint Research Centre, Ispra, Italy (gregory.duveiller@ec.europa.eu), (2) Max Planck Institute for Biogeochemistry, Jena, Germany, (3) Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, USA, (4) Jet Propulsion Lab, California Institute of Technology, Pasadena, CA, USA, (5) Helmholtz Centre Potsdam, German Research Centre for Geosciences, Potsdam, Germany

Mapping and monitoring the spatial and temporal patterns of gross primary productivity (GPP) through the use of satellite remote sensing is of paramount interest to enhance our understanding of terrestrial ecosystem dynamics. While the rate of terrestrial photosynthesis cannot be directly measured from space, research in the last years
ll fluorescence (SIF) retrieved from satellite spectrometers can be a
al is very small and notoriously difficult to measure, requiring high
vhich generally comes at the expense of revisit frequency and spatial
decently long time series, such as the widely used GOME-2 data,
approximately 50 km), which is too coarse for many applications in
will provide information at finer spatio-temporal scales, this doesn't
est possible archive is necessary.

thodology, here we provide an optimized SIF dataset at a 0.05°
ring the period 2007-2018 with a revisit frequency of 8 days. The
GOME-2 SIF retrieval is obtained by locally constraining a light
very time step based on different explanatory biophysical variables
atial resolution from other satellite instruments (namely MODIS
g approach, we ensure that this data-driven downscaling follows
al understanding of the relationships between GPP, radiation, water
roaches based on purely empirical machine learning techniques. An
luct is done based on yet another satellite, OCO-2, which provides
ry sparse and discontinuous spatial sampling scheme for the period

for improving our understanding of the dynamics in terrestrial
it for distinct plant functional types across various gradients of
ion, precipitation). This enables the characterization of ecosystem
mental drivers and stresses, which should further lead to potential

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Multisensor distribution regression for crop yield estimation

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Earth observation (EO) remote sensing data provide a unique source of informatio
temporally resolved and spatially explicit manner. This is of paramount relevance given
of biofuels and food. Traditional remote sensing applications have exploited vegetation
crop phenology cycles, and have vastly relied on summarizing the time series in a set c
descriptors. It is customary to summarize EO time series with temporal metrics like tl
start/end of season, as well as to summarize all pixel-based observations within a region
We posit here that summarizing is not a good idea, and propose two nonlinear regressio
all time and space observations that allows blending multisensor (e.g. optical and microv
We illustrate the performance of the methods in two scenarios. First, we combine synergi
EVI) and microwave (SMAP-VOD) data using full time series stacked at county level
into a standard linear and nonlinear (kernel-based) machine learning regression to obtair
estimates over the U.S. corn belt. It is shown that the kernel regression outperforms the li
the use of full time series from multisensor data improves the results obtained with sta
sensors. The second experiment takes into account all goals simultaneously. In this case
regression strategy that does not need to summarize the behavior of a county in an averag
machine learning method exploits higher-order relations between all time series in a cou
the native spatial resolution of each sensor, improves accuracy and bias over previous r
the validity of the multisensor fusion and the advantage of using distribution regressi
series for crop yield estimation.

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A multi-sensor approach for monitoring vegetation biophysical variables

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Monitoring vegetation biophysical parameters at global scale over a climate timescale (25+ years) is needed to understand long-term land surface processes such as desertification and degradation. In order to create a time series capable of capturing the variability of vegetation and ecosystem properties a multi-sensor approach is needed to generate consistent climate data records.

Using observations from different sensors onboard of different platforms requires a consistent treatment in order to combine data and keep track of the uncertainties along the whole processing chain, since not all sensor will have the same characteristics and radiometric accuracy. This communications uses the MODIS (onboard Terra and Aqua) and OLCI (onboard Sentinel-3) sensors to demonstrate the synergistic approach. The synergistic approach uses the Sensor Independent Atmospheric Correction (SIAC) approach applied to MODIS and OLCI data to derive surface reflectance on a set of common spectral bands. Then all the daily observations are used within a optimal estimation framework to derived BRDF descriptors with associated uncertainties. The final step comprises using Data Assimilation techniques to produced different vegetations parameters. The demonstrator product uses one year of MODIS and OLCI data over different geographic areas with heterogeneous vegetation coverage. The results show that using the two sensors the uncertainties in the vegetation parameters are reduced and that the land surface characterisation is better than using a single sensor, nevertheless the synergistic approach can be applied to different Earth Observation coarse resolution data products such as AVHRR, VIIRS and PROBA-V.

WE STILL NEED PROTOCOLS FOR MULTI-SENSORS RESPONSE SYNERGY!!!!