FRM4Veg - Fiducial Reference Measurements for Vegetation: Status and way forward

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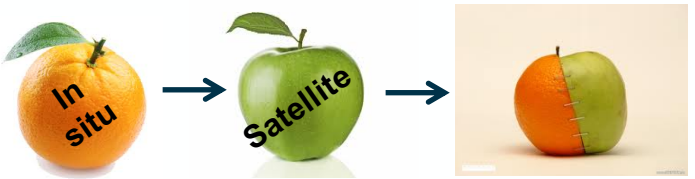
Why FRM?

Current Challenges in Satellite Data Validation:

- Lack of **multi-mission** & **long-term** strategy for **validation**.
- Lack of networks for validation of **land products**, to give continuity to the validation activities.
- Lack of international **standards** (with some exceptions: CEOS LPV “Global Leaf Area Index Product Validation Good Practices”).
- Product **uncertainties** not always assessed trough a statistically representative set of locations and time periods.
- **Spatial representativeness** of the in situ measurements, and upscaling to satellite resolution.
- Need to **automate** individual measurements.

… and this is becoming more and more important because nowadays there are:

-> Many satellite sensors
-> Similar products
-> Different algorithms used
-> BUT limited validation data, and (often) without any traceability



What is a Fiducial Reference Measurement ?

FRM (Fiducial Reference Measurement) :

is the suite of independent ground measurements that provide **independent validation results** and satellite measurement **uncertainty estimation**, over the entire **end-to-end duration of a satellite mission**.

- ✓ Have documented evidence of **metrological traceability to SI** (or appropriate international community standard) including **full uncertainty budget** (instrumentation and usage);
- ✓ Consider all **spatial/temporal/scaling issues**;
- ✓ Be independent of any satellite geophysical retrieval process;
- ✓ Provide **long-term sustainable mission validation** information;
- ✓ Be carried out following **community agreed good practice protocols** (some of which still need to be written…!)
- ✓ Be a direct translation of **QA4EO** to in-situ data;
- ✓ **Facilitate interoperability** between sensors;
- ✓ Building on the **existing capabilities**.

FRM4Veg
for Land products

fiducial reference measurements for vegetation

The FRM4Veg Team

- Joanne Nightingale *(NPL, UK)*
- Kevin Page *(NPL, UK)*
- Nial Origo *(NPL, UK)*
- Jadu Dash *(University of Southampton, UK)*
- Luke Brown *(University of Southampton, UK)*
- Fernando Camacho *(EOLab, Spain)*
- Rosalinda Morrone *(NPL, UK)*
- Valentina Boccia *(ESA)*

What is FRM4Veg ?

FRM4VEG is an ESA-founded project aiming at **applying the FRM concept to in-situ measurements of the several land products ESA distributes** (surface reflectance, the fraction of absorbed photosynthetically active radiation (FAPAR), canopy chlorophyll content, etc.).

FRM4VEG is based on:

- ✓ Definition of **methodology and protocols** for validation;
- ✓ Provision of **SI traceability**;
- ✓ Estimation of **full uncertainty budget;**
- ✓ Building on **existing capacity.**

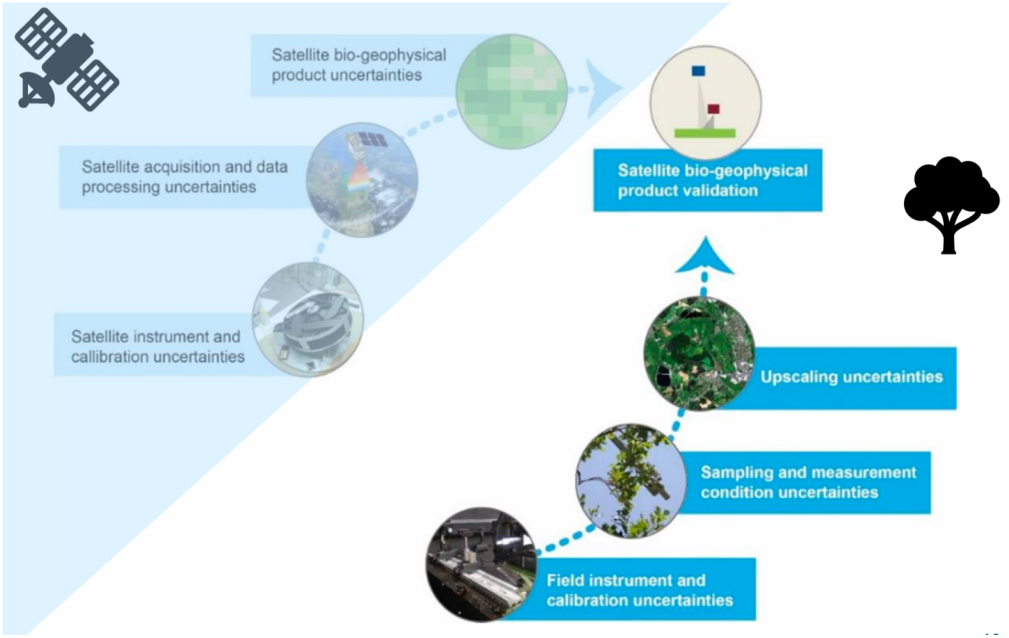
SENTINEL 2

proba-v

SENTINEL 3

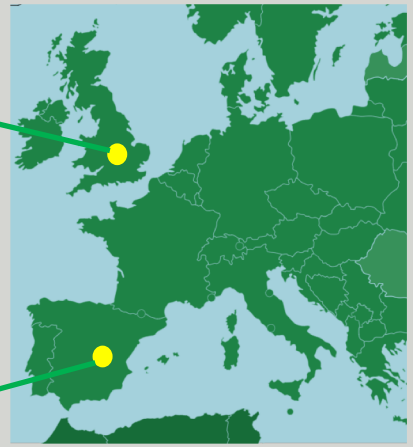
flex

CHIME



FRM4Veg - What has been done so far?

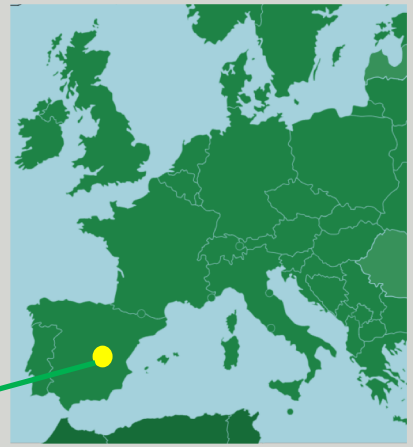
Wytham Woods (UK)
[**FOREST**]



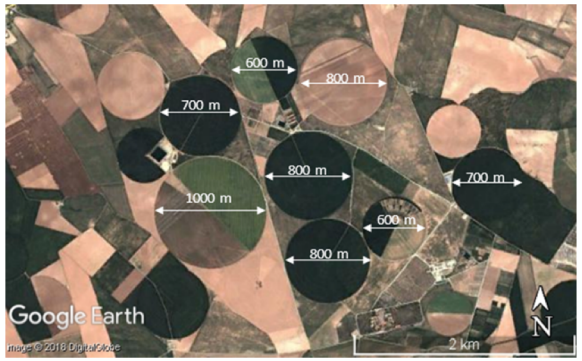
Barrax (Spain)
[**AGRICULTURAL**]

2 FRM4Veg campaigns have been performed

FRM4Veg - What has been done so far?



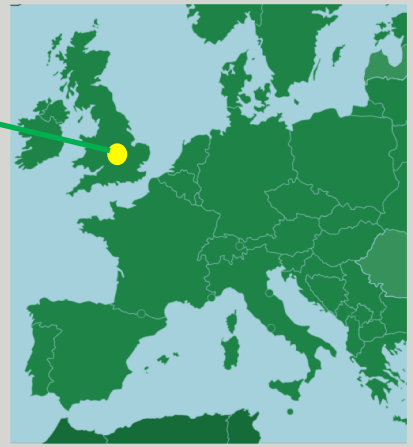
Barrax (Spain)
[**AGRICULTURAL**]

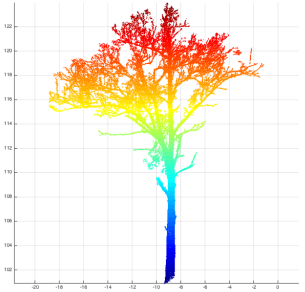


- Experimental farm.
- Flat terrain.
- Generally clear skies.
- 2 hours driving from Valencia

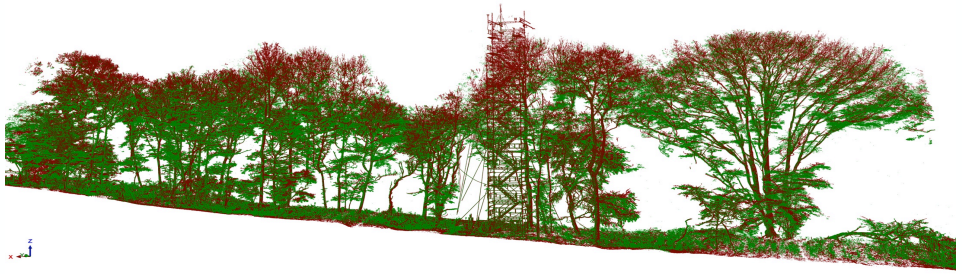
FRM4Veg - What has been done so far?

Wytham Woods (UK)
[**FOREST**]



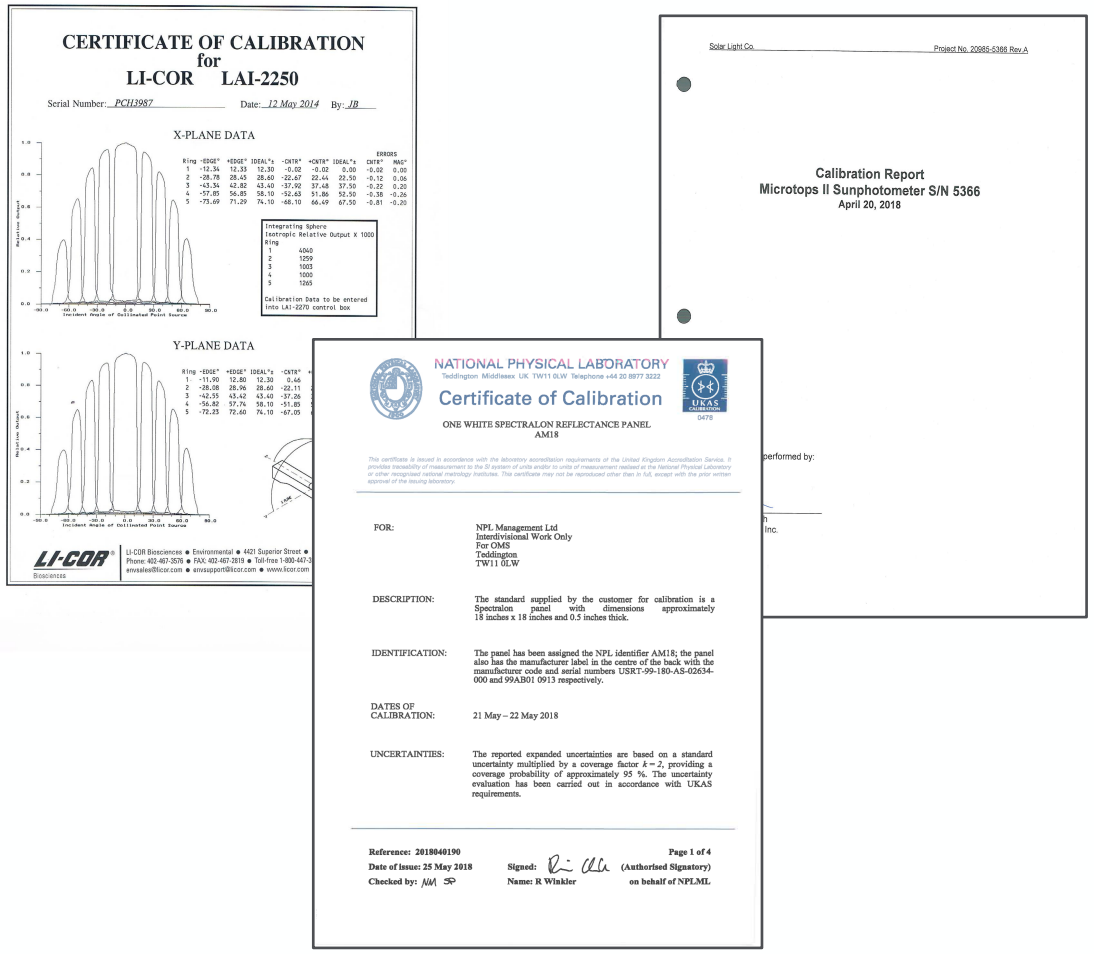


- Semi-natural woodland (Oak, Ash, Beech, Hazel, Sycamore);
- Managed research forest with ~ 75 years of ecological monitoring;
- Canopy walkway, Flux tower
- A 3D model of the Wytham Woods site has been generated.



FRM4Veg - What has been done so far?

Instrument Calibration history and certificates



CERTIFICATE OF CALIBRATION
for
LI-COR LAI-2250

Serial Number: PCI3987 Date: 12 May 2014 By: JB

X-PLANE DATA

Y-PLANE DATA

LI-COR Biosciences

Solar Light Co. Project No. 20985-5366 Rev A

Calibration Report
Microtops II Sunphotometer S/N 5366
April 20, 2018

NATIONAL PHYSICAL LABORATORY
Teddington Middlesex UK TW11 0LW Telephone +44 20 8977 3222

Certificate of Calibration

ONE WHITE SPECTRALON REFLECTANCE PANEL
AM18

FOR: NPL Management Ltd
Interdivisional Work Only
For OMS
Teddington
TW11 0LW

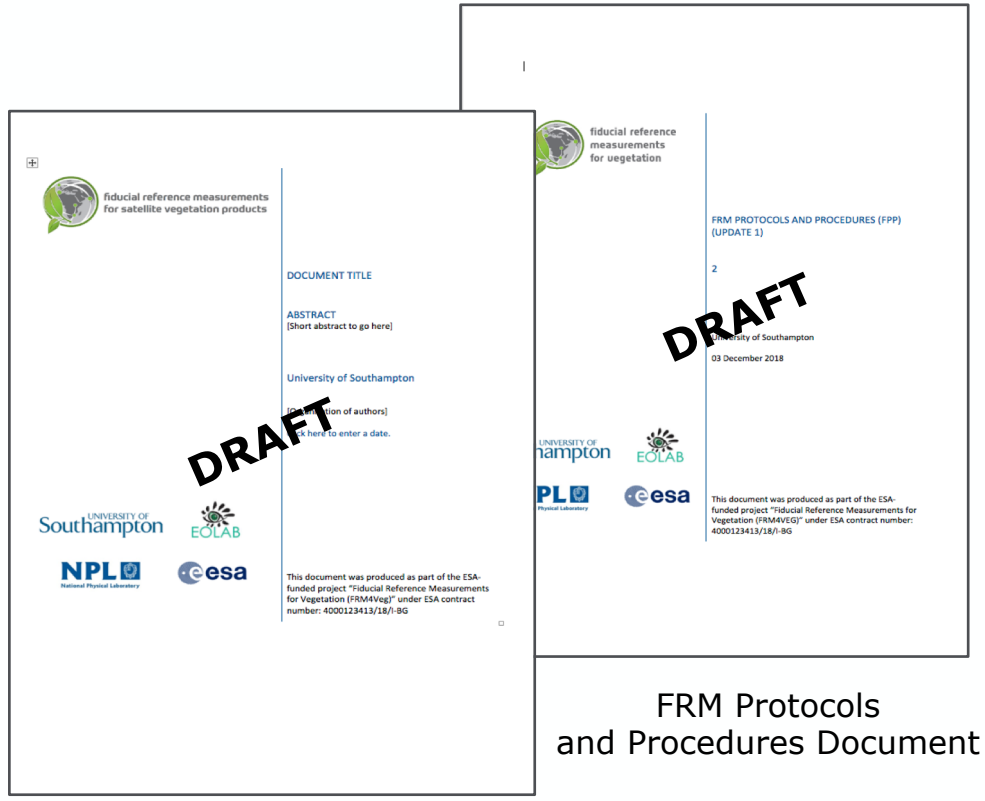
DESCRIPTION: The standard supplied by the customer for calibration is a Spectralon panel with dimensions approximately 18 inches x 18 inches and 0.5 inches thick.

IDENTIFICATION: The panel has been assigned the NPL identifier AM18; the panel also has the manufacturer label in the centre of the back with the manufacturer code and serial numbers USRT-99-180-AS-02634-000 and 99AB01 0913 respectively.

DATES OF CALIBRATION: 21 May – 22 May 2018

UNCERTAINTIES: The reported expanded uncertainties are based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a coverage probability of approximately 95 %. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Reference: 2018040190 Page 1 of 4
Date of Issue: 25 May 2018 Signed: (Authorised Signatory)
Checked by: Name: R Winkler on behalf of NPLML



fiducial reference measurements for satellite vegetation products

DOCUMENT TITLE

ABSTRACT
[Short abstract to go here]

University of Southampton

DRAFT

This document was produced as part of the ESA-funded project "Fiducial Reference Measurements for Vegetation (FRM4Veg)" under ESA contract number: 4000123413/18/I-BG

Validation Methodology Document

fiducial reference measurements for vegetation

FRM PROTOCOLS AND PROCEDURES (FPP)
(UPDATE 1)

2

DRAFT

University of Southampton

03 December 2018

This document was produced as part of the ESA-funded project "Fiducial Reference Measurements for Vegetation (FRM4VEG)" under ESA contract number: 4000123413/18/I-BG

FRM Protocols and Procedures Document

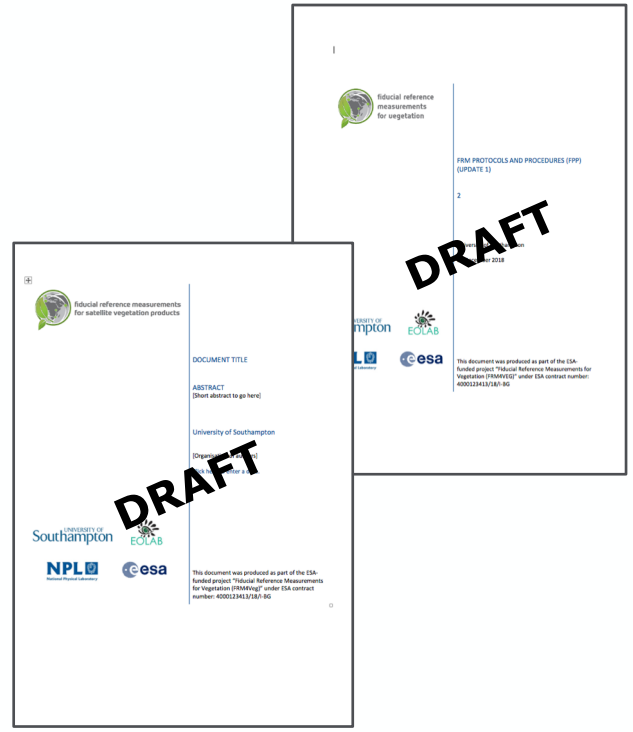
FRM4Veg - Next steps until end 2022

- FRM4Veg **campaign** in summer 2021 in Wytham Woods (UK) in order to consolidate the methodology;

- **SRIX4Veg** (Surface Reflectance Inter-comparison eXercise for Vegetation) using **drones** with the international Surface Reflectance validation community **in 2022**, over an agricultural site in Europe;

- Consolidation of **documentation**, also together with the international community:
  - Validation Methodology document;
  - FRM4Veg Protocols and Procedures;

and their submission to CEOS WG LPV for endorsement.



SRIX4Veg – Surface Reflectance Inter-comparison eXercise for Vegetation

SRIX4Veg – Surface Reflectance Inter-comparison eXercise for Vegetation

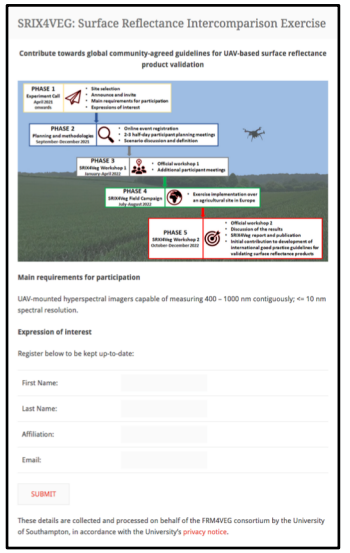
SRIX4Veg represents a joint effort **to ensure consensus on surface reflectance validation protocols using drones.**

It has been endorsed by CEOS and is conducted in the framework of the ESA FRM4Veg project.

Objectives:

- Testing user-based differences in surface reflectance UAV-based measurements (including instrument and operator biases as well as measurement collection procedures);
- Helping design field measurement protocols and validation methodology that are clear and can be easily applied by all users;
- Ensuring international buy-in and consensus on the field measurement protocols and global SR validation methodology developed.

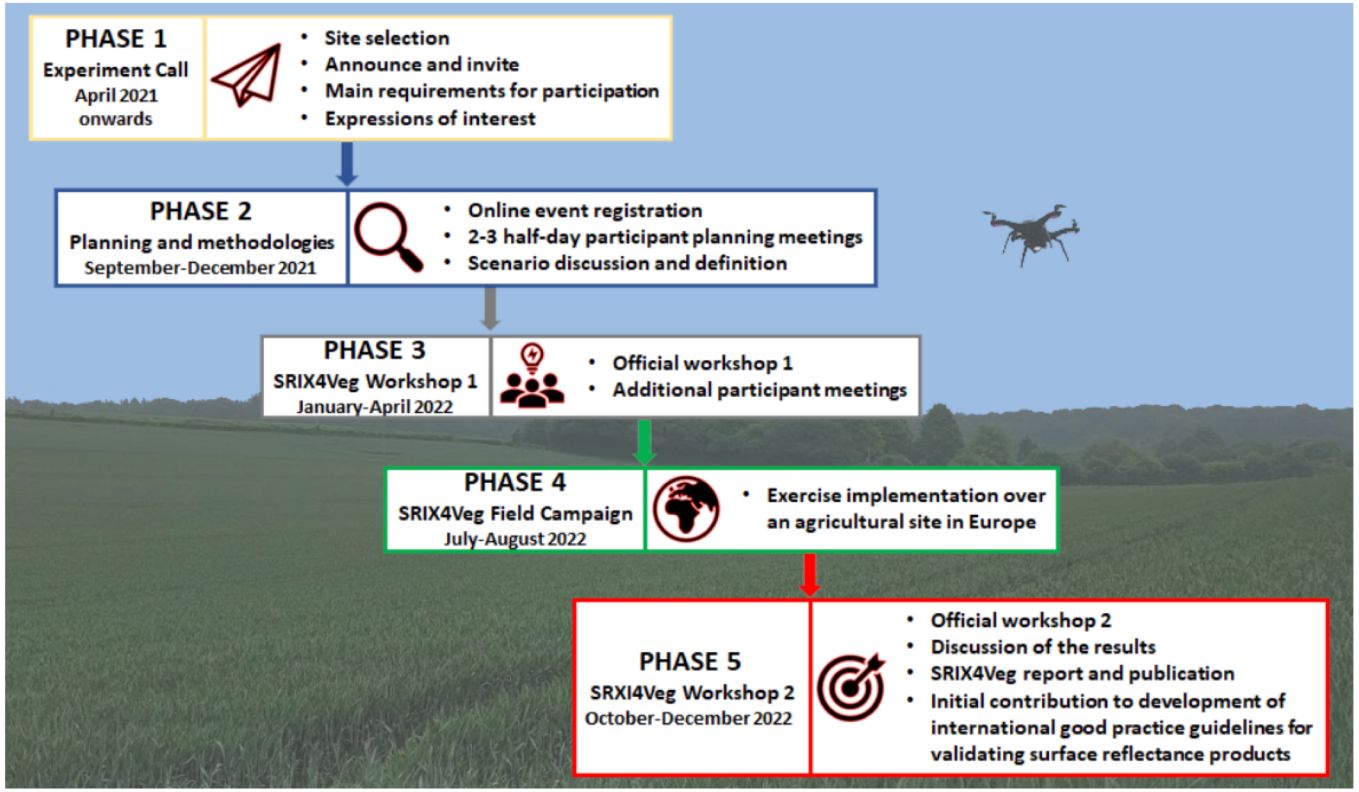
https://frm4veg.org/srix4veg/



Requirements for participation:
UAV-mounted hyperspectral imagers capable of measuring 400 – 1000 nm contiguously; <= 10 nm spectral resolution.

REGISTRATION now OPEN!

SRIX4Veg – Surface Reflectance Inter-comparison eXercise for Vegetation



https://frm4veg.org/srix4veg/

Main requirements for participation

UAV-mounted hyperspectral imagers capable of measuring 400 – 1000 nm contiguously; <= 10 nm spectral resolution.

Expression of interest

Register below to be kept up-to-date:

First Name:

Last Name:

Affiliation:

Email:

SUBMIT

These details are collected and processed on behalf of the FRM4VEG consortium by the University of Southampton, in accordance with the University's privacy notice.

The international validation community is **invited**

REGISTRATION now OPEN!

Contribute towards global community-agreed guidelines, protocols and procedures for UAV-based surface reflectance product validation

Next steps – after 2022

ESA Long Term Vision for Satellite Data Validation…

- Investment in one/two selected sites in Europe in order to **start to build a Network of Land Product Validation Supersites following the FRM4Veg Protocols and Procedures**, under coordination with CEOS WGCV LPV.

24 Networks reviewed

What do we mean with Supersite?

- ✓ Endorsed by CEOS WGCV LPV for the **validation of (at least 3) land satellite products** and for radiative transfer modelling approaches.
- ✓ **Super characterized** (canopy structure and bio-geophysical variables) sites following well-established protocols.
- ✓ **Active, long-term operations**, supported by appropriate funding and infrastructural capacity.

- Not relying only on dedicated campaigns BUT installing **permanent equipment** on selected sites (Supersites).
- Looking for potential **synergies** with international entities (e.g. Space Agencies, Research Institutes).

Plan for a European Optical Sensors Cal/Val Park

A new concept: Cal/Val Park

- ✓ Dedicated to **VHR** and **HR** optical missions;
- ✓ Open to both **multi-spectral** and **hyperspectral** missions;
- ✓ For both **TOA radiance and reflectance** and **BOA reflectance**;
- ✓ Open to be used by both the **“institutional space”** and the **“commercial/new space”**;
- ✓ Common “playground” to test and run **new cal/val methodologies, instruments, and initiatives**;
- ✓ Open to include **temporary and long-term instrumentation** and initiatives;
- ✓ **Scalable** (as far as possible) to accommodate new needs and new types of EO missions that may come in the next years;
- ✓ Building on already existing cal/val technologies AND new technologies and methods;
- ✓ Able to support the ever growing European and international EO industrial ecosystem;
- ✓ **Multi-Agency joint effort**;
- ✓ Synergetic approach not to duplicate efforts (and budgets).

A new concept: Cal/Val Park

- The “Cal/Val Park” idea is **still in the definition phase**.

- Discussions are on-going for a **joint ESA-ASI effort** (interest from other space agencies and institutions to be investigated).

OTHERS ?

A new concept: Cal/Val Park

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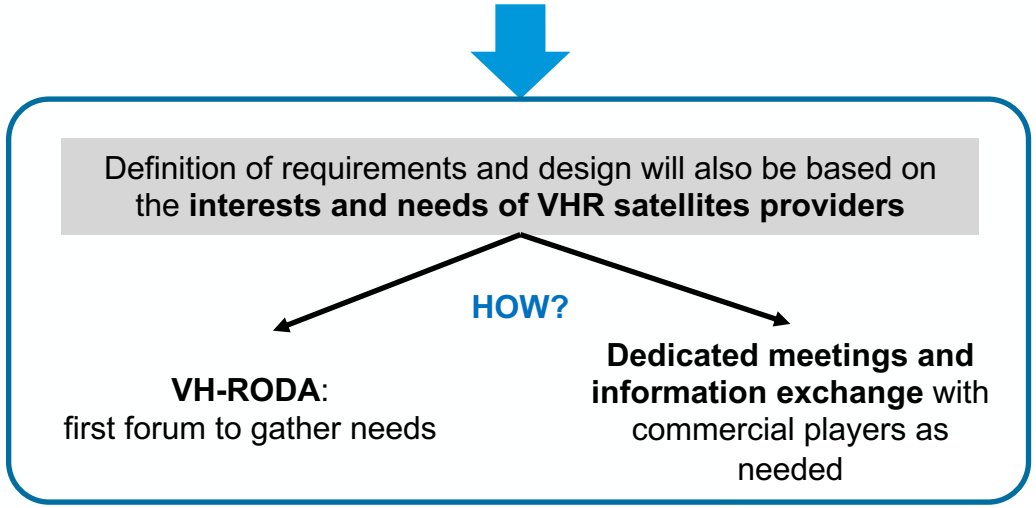


OTHERS ?

Cal/Val Park: baseline requirements? (1/2)

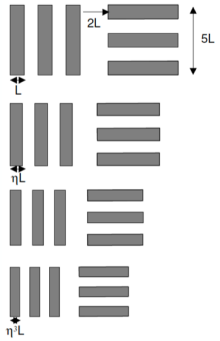
❑ **MTF** computation

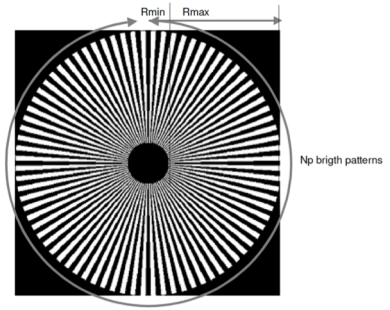
- Edge targets?
- Adjustable orientation?
- Size?
- Others?

Shadnagar: 20 to 140 m

❑ Quick visual assessment of the instrument **resolving power**

- Periodic patterns?
- Others?





❑ Absolute and multi-temporal geolocation assessment with a **common well-geolocalized Ground Control Point (GCP)**

Cal/Val Park: baseline requirements? (2/2)

- ❑ Installation of equipment for **radiometric performance assessment**:
  - Aeronet site?
  - RadCalNet site?
  - Hypernets site?

- ❑ For both **multi-spectral** and **hyper-spectral** missions
  - Spectrometer
  - What else?

- ❑ Open for **temporary or long-term commercial cal/val services** and/or **new cal/val technologies** depending on satellite providers' needs
  - What are the needs?
  - What should we include to make the Cal/Val Park really useful for VHR missions?

- ❑ Well maintained **on the long-term**, safe, with a storage facility and a meeting room

Cal/Val Park: open points

- Analysis and definition of requirements is **on-going**
- Actual **needs from VHR** commercial/new space satellite providers
  - Specific needs?
  - Different than HR missions from Agencies?
  - Specific or new cal/val technologies/services to be added in the Cal/Val Park?
  - Also thermal missions?
  - Etc.
- **Commercial/New Space contribution** to the Cal/Val Park
  - What's the interest?
  - Shared investment?
  - Under-request service?
  - Other?
- **Location** still to be decided
  - discussions on-going with ASI for a site in Italy
  - Main drivers: ✔ high probability of clear sky, ✔ big enough to include all the needed equipment, ✔ being scalable for new/developing needs, ✔ good accessibility, ✔ flat terrain
- Interest from **other Space Agencies and Institutions** at international level

Q&A

Thank you!

For any enquiries about SRIX4Veg:
srix4veg@frm4veg.org

For more info about FRM4Veg:
https://frm4veg.org/

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