Fiducial Reference Measurements (FRM)

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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 through 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**.

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**FRM4Veg** for Land products

**FRM4SAR** for Land products
Fiducial Reference Measurements for Vegetation (FRM4Veg)

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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.
FRM4Veg - What has been done so far?

2 FRM4Veg campaigns have been performed

Wytham Woods (UK) [FOREST]
Barrax (Spain) [AGRICULTURAL]
FRM4Veg - What has been done so far?

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

Barrax (Spain) [AGRICULTURAL]
FRM4Veg - What has been done so far?

- 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

Validation Methodology Document

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 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.

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

https://frm4veg.org/srix4veg/

REGISTRATION now OPEN!
SRIX4Veg – Surface Reflectance Inter-comparison eXercise for Vegetation

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

REGISTRATION now OPEN!

https://frm4veg.org/srix4veg/

The international validation community is invited
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.

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).
Thank you!

Q&A

https://frm4veg.org/

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