

# A framework for Fiducial Reference Measurements (FRM) for Vegetation: results and experiences from phase one of the FRM4VEG project

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## Abstract

Fiducial Reference Measurements for Vegetation (FRM4VEG) is a European Space Agency (ESA) managed project funded under the Copernicus programme, which aims to establish reliable and transparent in-situ measurement and validation standards for Copernicus products derived from Sentinel-2, -3, and PROBA-V. Although the concept of FRM has been evaluated for other satellite-derived variables such as ocean colour and surface temperature, FRM4VEG is for the first time exploring the application of metrological principals to vegetation and land surface reflectance products. By demonstrating and documenting traceable validation methodologies, the goal of the project is to provide confidence to users in their application of products. In the context of the FRM4VEG project, three bio-geophysical variables are considered: surface reflectance, the fraction of absorbed photosynthetically active radiation (FAPAR) and canopy chlorophyll content (CCC).

The first phase of the project combined data from laboratory calibration exercises and two dedicated field campaigns to define the evaluation and propagation of in-situ measurement uncertainties and achieve traceability. Two field sites were investigated: Wytham Woods (a broadleaf deciduous forest in the UK recently designated as a Land Product Validation (LPV) supersite) and Las Tiesas – Barrax (an agricultural site in Spain with a legacy of previous ESA calibration/validation activities). In-situ measurements and their associated uncertainties were upscaled to the Sentinel-3 OLCI and PROBA-V spatial resolutions using contemporaneous Sentinel-2 MSI data. Overall, it is expected that the project will build a consensus for good practices in the measurement of vegetation bio-geophysical variables, resulting in a legacy for the community, and clear CEOS-endorsed protocols for future practitioners.

**Keywords** - Fields campaigns / In-situ measurements / FRM