LPVE23 - WORKSHOP ON LAND PRODUCT VALIDATION AND EVOLUTION

Web-based tool for validation of Sentinel-2 and Sentinel-3 derived bio-geophysical products against ICOS terrestrial ecosystems measurements

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Introduction

The aim of this study is to demonstrate that **Integrated Carbon Observation System (ICOS)** terrestrial ecosystems sites can serve as **a network for the validation of Earth Observation products**. Focusing on the current ESA optical imaging sensors, the project aims to **generate a match-up dataset of Sentinel-2 (S2) and Sentinel-3 (S3) observations over ICOS ecosystem sites** for easing the validation of satellite-derived bio-geophysical products.

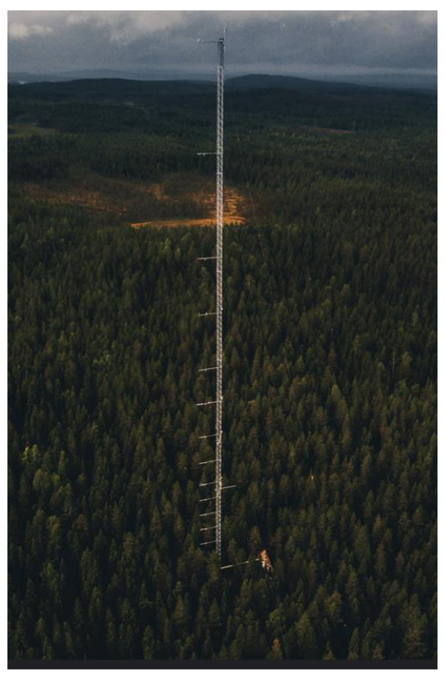

Figure 1. SE-Svb ICOS site (Svartberget, Sweden)

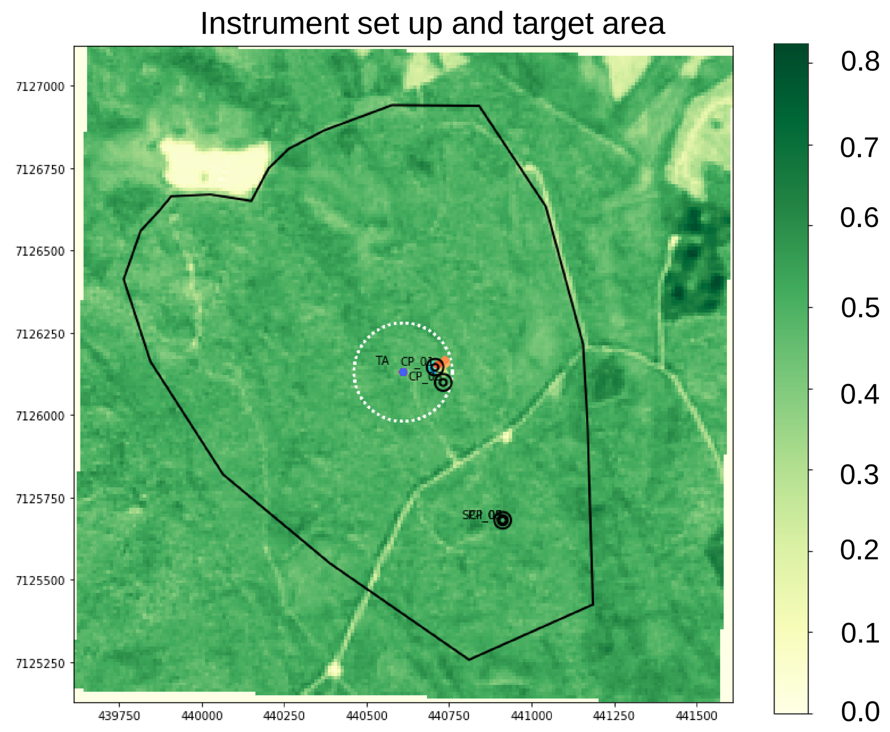

Figure 2. SE-Svb ICOS site with S2 FAPAR, plots, target area and tower footprints

Ground FAPAR is computed as a function of incoming and outgoing **Photosynthetic Photon Flux Density (PPFD)** above, as well as incoming PPFD below canopy (not measured at all sites). Measurements are available every 30 minutes.

$$FAPAR = \frac{PPFD_{IN} - PPFD_{OUT} - PPFD\_BC_{IN}}{PPFD_{IN}}$$

GAI/PAI (definition not consistent) are measured several times each year at different locations within the Target Area, depending on the site. Satellite measurements are interpolated to match the dates.

Ground measurement	EO product	Resolution
FAPAR at overpass time	Terrascope S2 FAPAR	10 m
Sporadic GAI/PAI measurements	Interpolated Terrascope S2 LAI	10 m
10-day aggregated FAPAR at overpass time	Copernicus Global Land V2 FAPAR	300 m
Sporadic GAI/PAI measurements	Interpolated Copernicus Global Land V1 LAI	300 m

Discussion

Ground FAPAR measurements are consistently underestimated

- No measurement of outgoing PPFD below canopy (or proxy surface albedo)
- Unevenly distributed measurements of PPFD below canopy in the tower footprint
- Spatial variability within the plots and ground measurement uncertainty, e.g. instruments, wind speed
- FAPAR algorithm for S2/S3

Ground GAI measurements are consistently underestimated for S2, upscaled S3 values show an underestimation of low and an overestimation of high values

- Measurement of different variables: GAI on the ground, LAI by satellite
- Upscaling depends on the homogeneity of the site
- Effect of temporal interpolation, only infrequent measurements
- LAI algorithm for S2/S3

Selected references

1. Carrara, A., Kolari, P., de Beeck, M. O., Arriga, N., Berveiller, D., Dengel, S., Ibrom, A., Merbold, L., Rebmann, C., Sabbatini, S., Serrano-Ortíz, P., & Biraud, S. C. (2018). Radiation measurements at ICOS ecosystem stations. In International Agrophysics (Vol. 32, Issue 4, pp. 589–605). Walter de Gruyter GmbH. https://doi.org/10.1515/intag-2017-0049
2. Román, M. O., Schaaf, C. B., Woodcock, C. E., Strahler, A. H., Yang, X., Braswell, R. H., Curtis, P. S., Davis, K. J., Dragoni, D., & Goulden, M. L. (2009). The MODIS (Collection V005) BRDF/albedo product: Assessment of spatial representativeness over forested landscapes. In Remote Sensing of Environment (Vol. 113, Issue 11, pp. 2476–2498). Elsevier BV. https://doi.org/10.1016/j.rse.2009.07.009
3. Putzenlechner, B., Castro, S., Kiese, R., Ludwig, R., Marzahn, P., Sharp, I., & Sanchez-Azofeifa, A. (2019). Validation of Sentinel-2 fAPAR products using ground observations across three forest ecosystems. In Remote Sensing of Environment (Vol. 232, p. 111310). Elsevier BV. https://doi.org/10.1016/j.rse.2019.111310

Jupyter Notebooks

As a main outcome of this activity, a set **of Jupyter Notebooks hosted on the Terrascope server** will be shared within the satellite Cal/Val community**.**

I. Assessment **of spatial representativeness.**
II. **Match-up of S2 and S3 based FAPAR/LAI with ICOS ground measurements.**
III. **Upscaling of ground measurements** in specific measurement plots/tower footprint to target area using S2 observations for S3 validation.

I. Spatial representativeness

The issue of **spatial representativeness** will be assessed with **statistical metrics and semi-variograms** to estimate the suitability of the various sites for the validation at S2 and S3 pixel size.

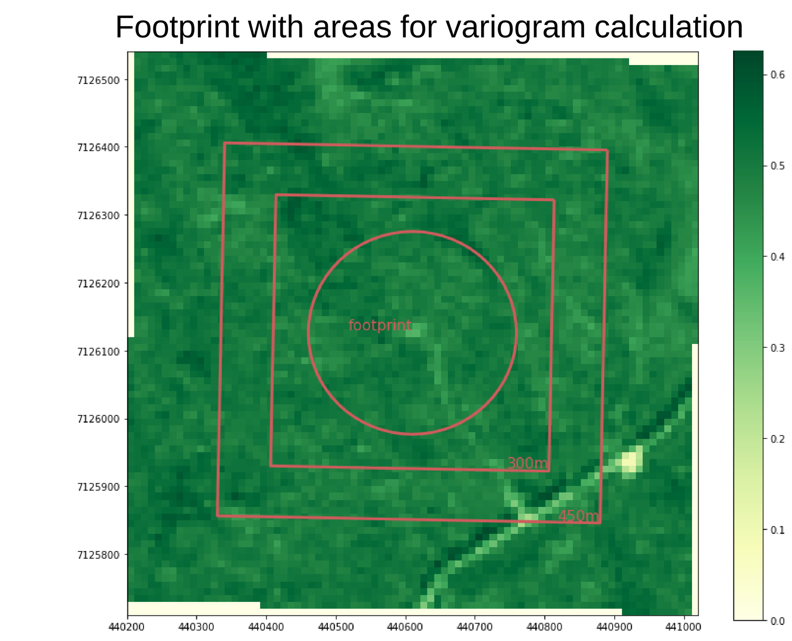

Figure 3. Circular tower footprint and square footprints used for semi-variogram calculation (SE-Svb, FAPAR, summer)

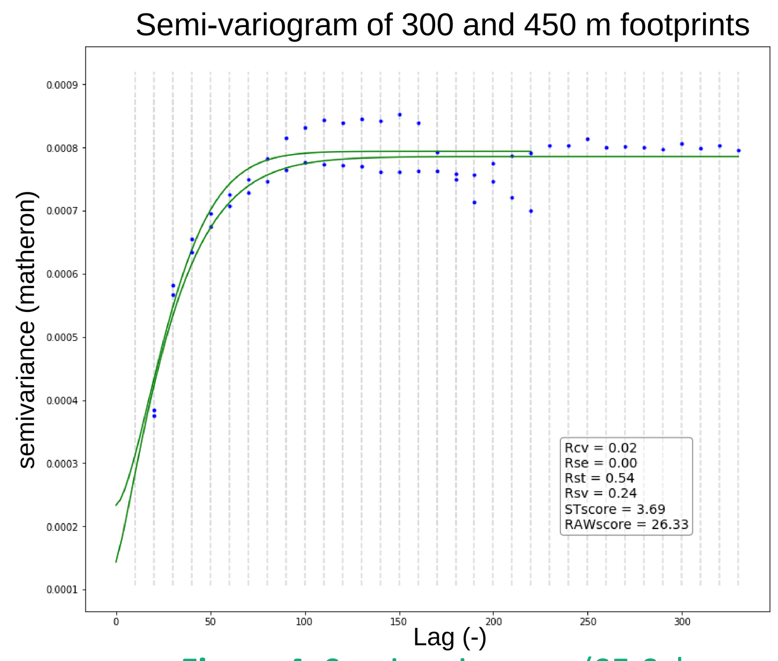

Figure 4. Semi-variogram (SE-Svb, FAPAR, summer)

II. Match-up Database

The match-up database generates a **table of matched acquisitions** at an adjustable footprint, **a time-series of FAPAR/LAI ground measurements and satellite acquisitions** with associated uncertainties and a **scatterplot**.

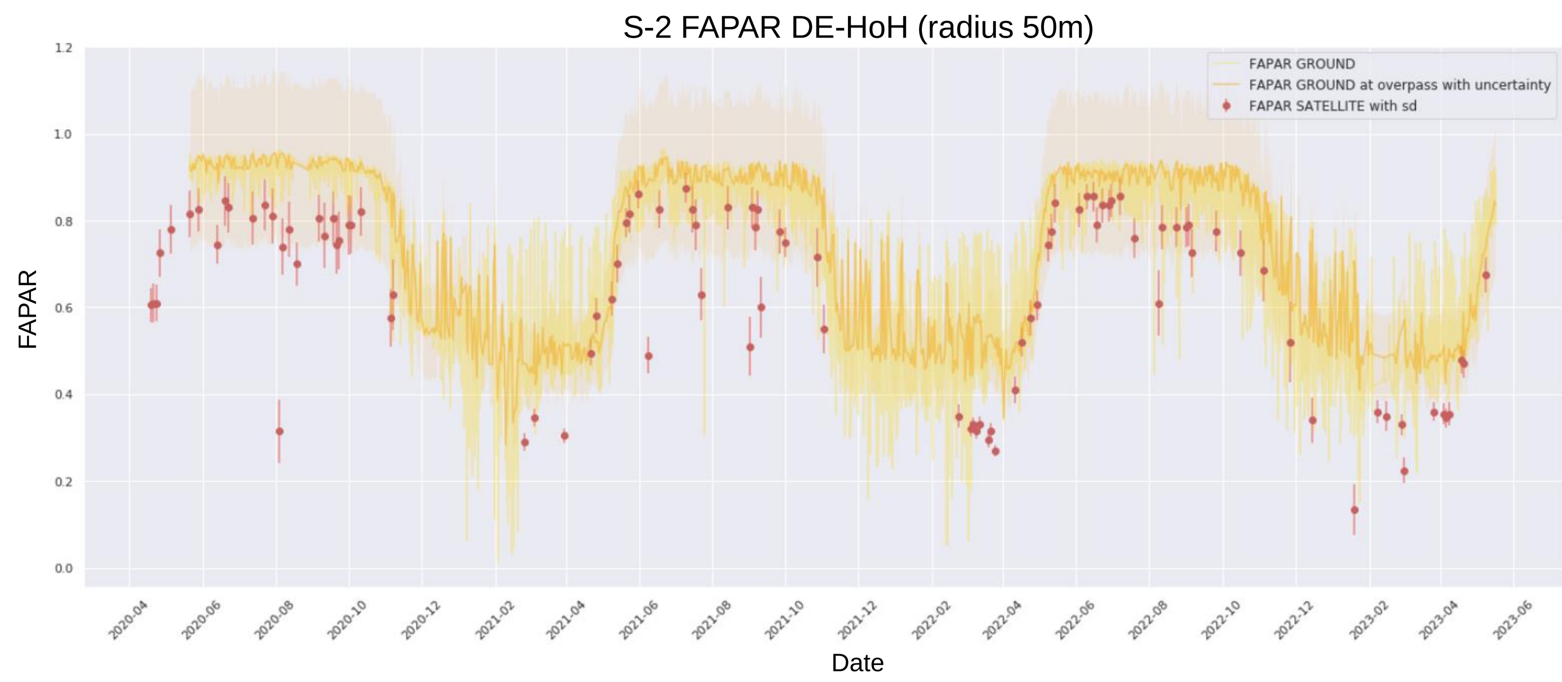

Figure 5. FAPAR ground and satellite measurements at DE-HoH (Hohes Holz, Germany)

III. Upscaling

Ground measurements at CP and SP plots are compared to S2 measurements. The resulting regression is applied to all pixels and **upscaled to the Target Area**. The **upscaled "ground" values are used for validating the S3 measurements**.

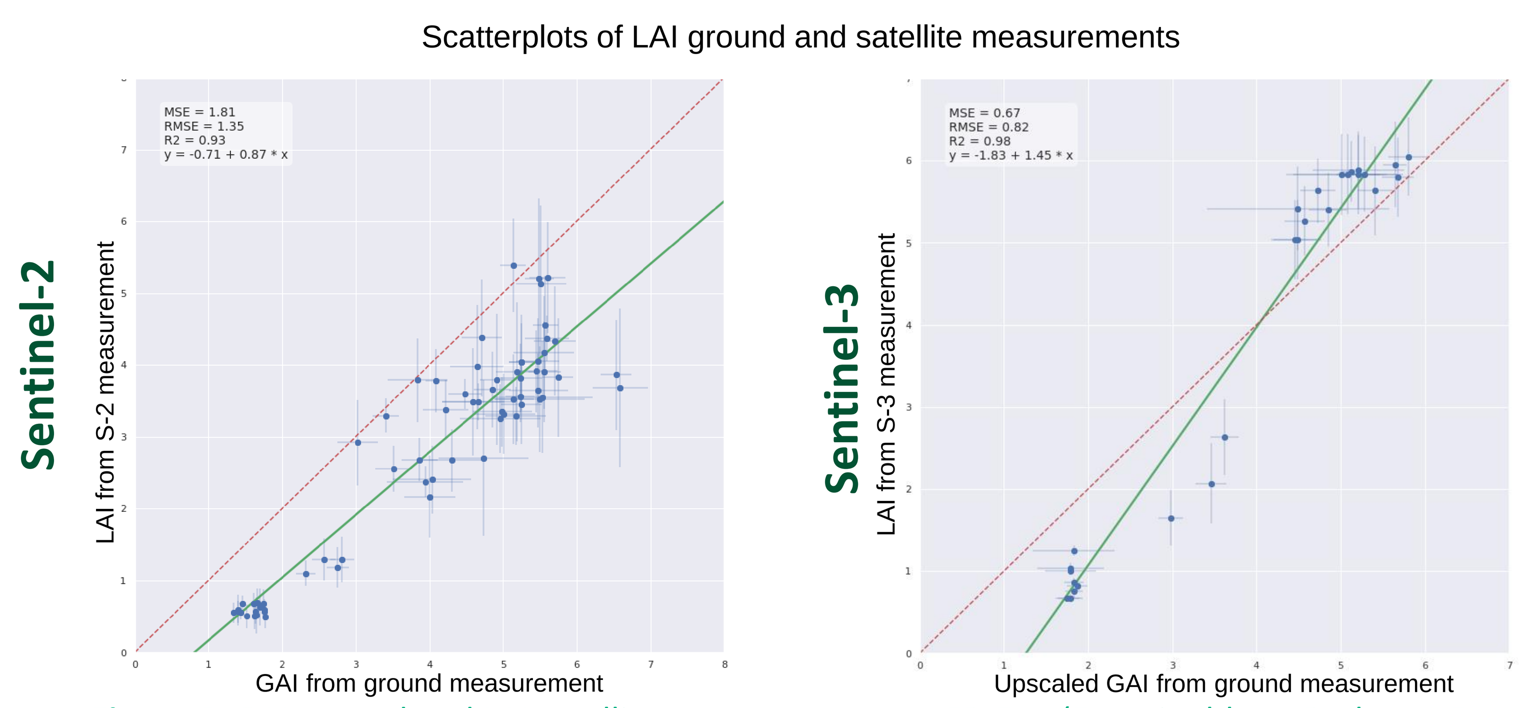

Figure 6. GAI ground and LAI satellite measurements at FR-Fon (Fontainebleau-Barbeau, France)

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