Biophysical (LAI/FAPAR)

Focus area co-leads

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- L. Brown (University of Salford)

Outline

- Latest updates from GBOV
- FRM4VEG Phase 2 outcomes & implications
- Validation of LAI/FAPAR with GBOV & CCRS data
- Emerging validation needs
- New initiatives of relevance & recent publications
- Upcoming workshops/conference sessions

Latest updates from GBOV (1)

- Further in situ LAI/FAPAR reference measurements (RMs) and upscaled land products (LPs) over 24 NEON sites and 5 GBOV-equipped sites
  - Automated processing of NEON-collected DHP
  - GBOV-equipped sites incorporate automated DHP & PAR sensor networks
  - 2022 release available since December, review has been performed by Copernicus Land Monitoring Service (October 2022)

- Data from additional third-party sites to be processed and added to the RM and LP database to improve geographic representativeness
  - 8 ICOS sites:
    - Bilos, France
    - Fontainebleau-Barbeau, France
    - Hohes Holz, Germany
    - Hyltemossa, Sweden
    - Hyytiala, Finland
    - San Rossore 2, Italy
    - Vielsalm, Belgium
  - 1 FRM4VEG site:
    - Wytham Woods, United Kingdom

Latest updates from GBOV (2)

- Work on GBOV-equipped sites continues
  - 4-flux PAR sensor network deployed at Hainich, Germany (beech forest) in March 23
  - Same plot as automated DHP system & manual DHP sampling



  - Further PAR sensor network & automated DHP installation planned at Fuji Hokuroku Japan (larch forest, as yet unrepresented in GBOV) in August 23


Latest updates from GBOV (3)

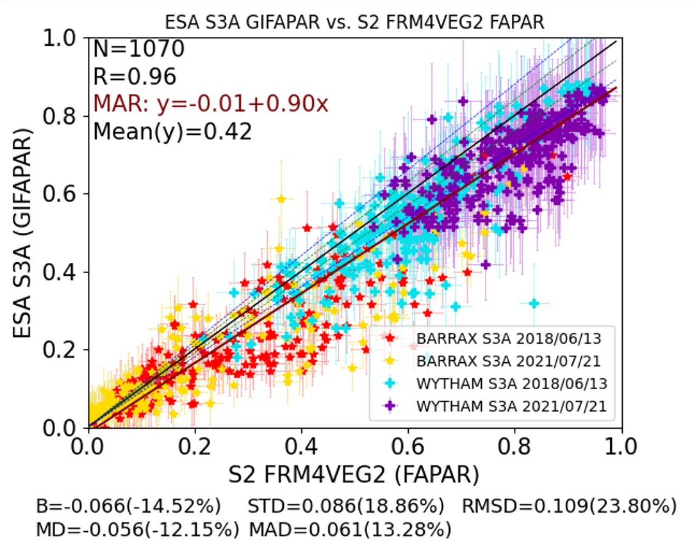
- Work on GBOV-equipped sites continues
  - PAR sensor network at Tumbarumba, Australia (lost to bushfires in 2020) has been reinstated

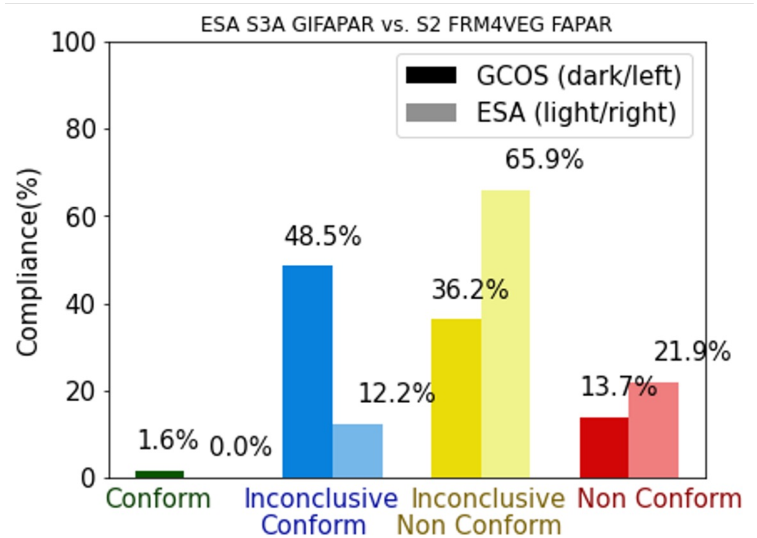



- Efforts being made to improve upscaling for sparsely vegetated sites
- NRT and consolidated LPs are envisaged, as well as improvements to the data portal
- External independent review of GBOV will be handled by CGLOPS lot 4

FRM4VEG Phase 2 outcomes & implications (1)

- Validation and conformity testing of Sentinel-3 GIFAPAR over Wytham Woods (UK) and Barrax (Spain) using upscaled maps with uncertainties
  - Good overall agreement, but conformity with GCOS and ESA requirements inconclusive in the majority of cases

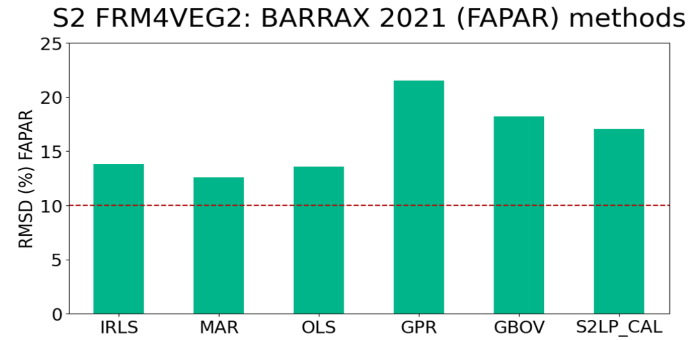


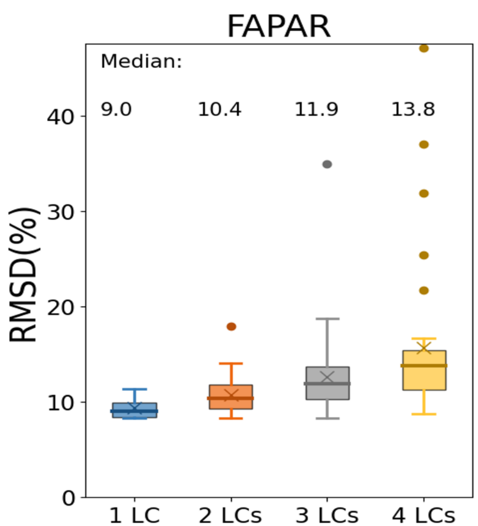


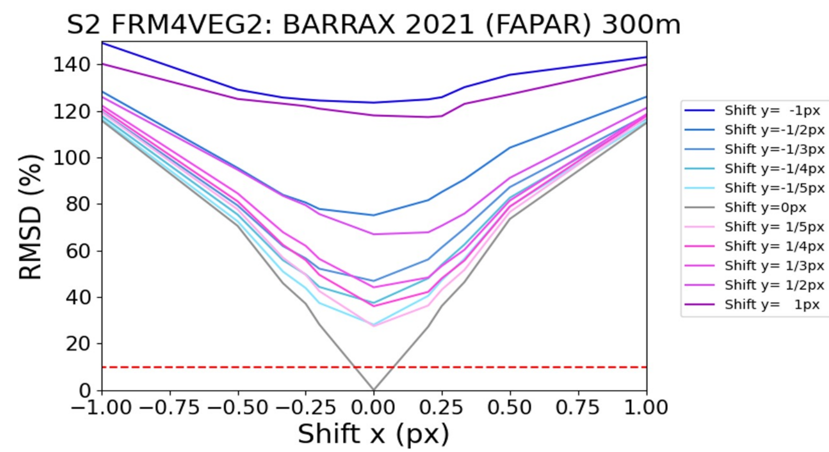
  - Uncertainty in upscaled maps often larger than the requirement, so conformity cannot reliably be assessed

FRM4VEG Phase 2 outcomes & implications (2)

- Analysis of additional sources of uncertainty by EOLAB over Las Tiesas – Barrax
  - Number of crops sampled
  - Upscaling method
  - Geolocation



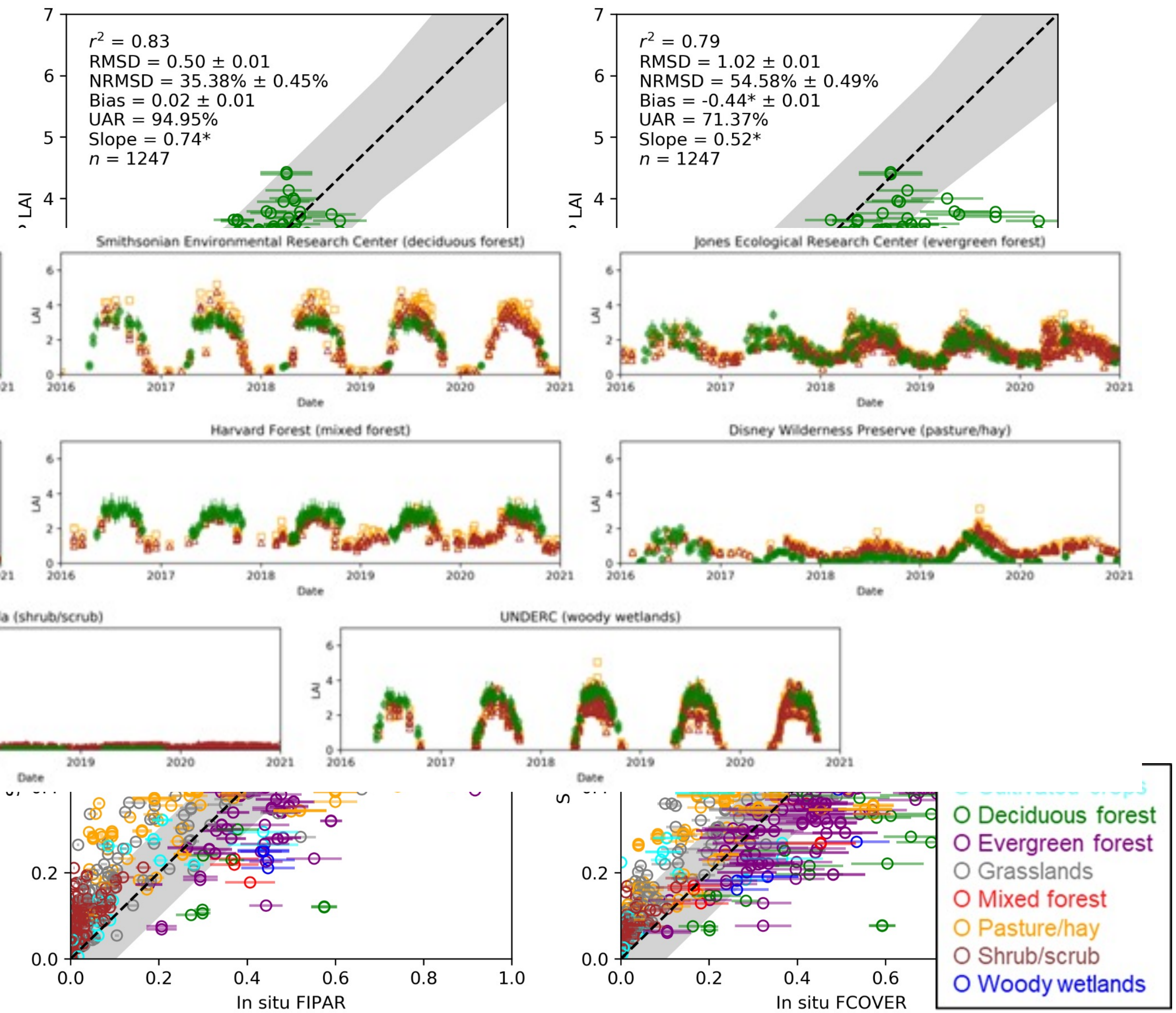




- Need for:
  - More realistic threshold requirements reflecting the uncertainty achievable in situ?
  - Alternative in situ sampling to facilitate conformity testing without upscaling?

Validation of LAI/FAPAR with GBOV & CCRS data (1)

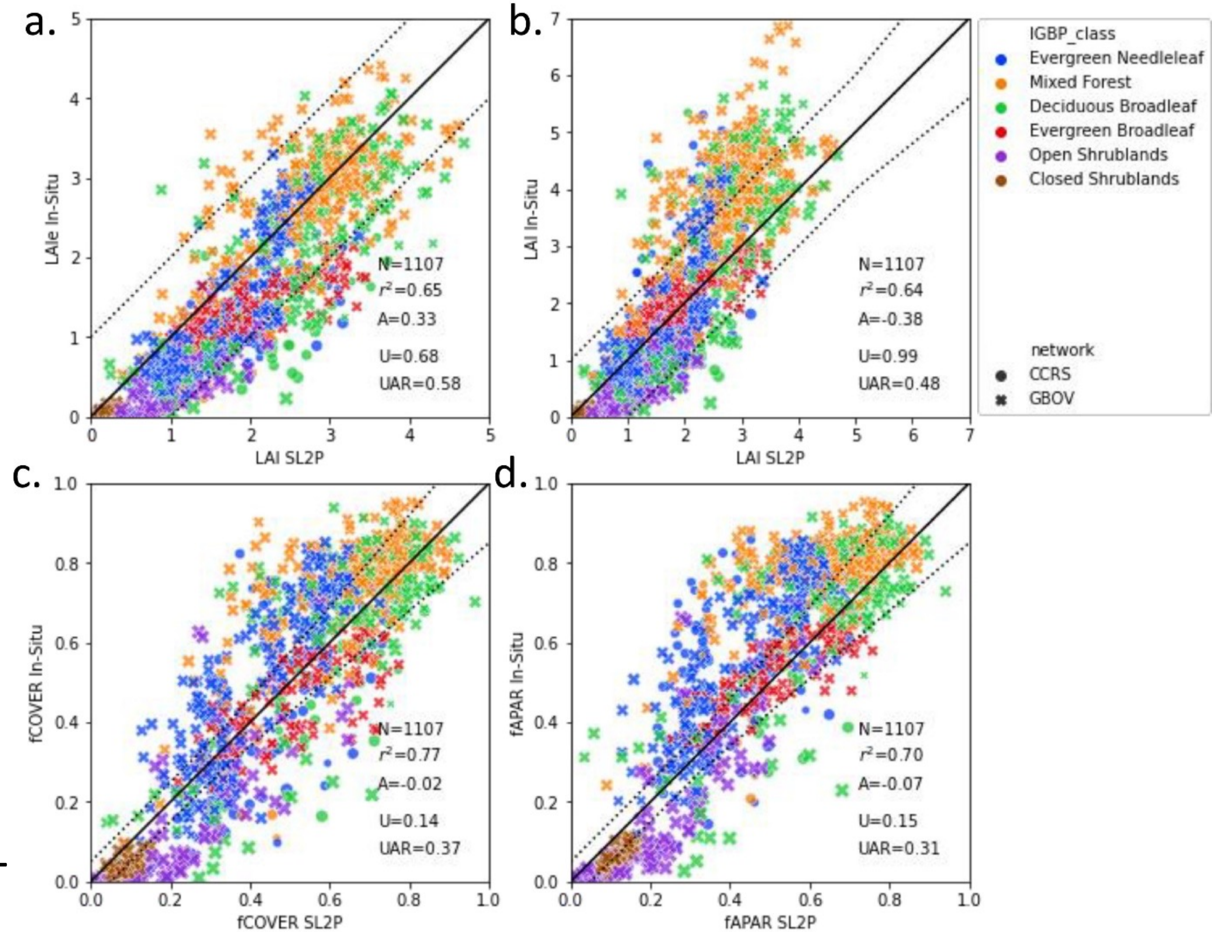
- SL2P validation results from Brown et al. (2021) updated



- Positive bias for low FAPAR values

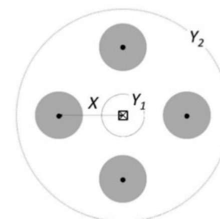
Validation of LAI/FAPAR with GBOV & CCRS data (2)

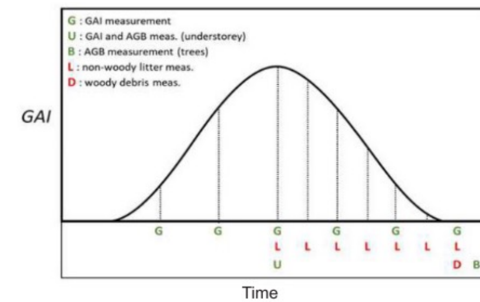
- SL2P validation extended by Fernandes et al. (2023, *Remote Sensing of Environment)* for North American forests
  - 11 sites in Canada
  - 133 ESUs
- Modest bias for LAIe, LAI < 2 relatively unbiased
- LAI > 2 underestimated by 20% to 50%
- Bias for FAPAR transitions from 0.1 -0.1 at high values



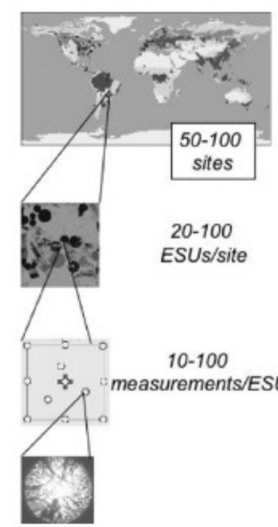
Emerging validation needs (1)

- Environmental monitoring networks (NEON, ICOS) and automated instruments are providing spatially limited but temporally repeated measurements
  - NEON: 3 ESUs every 2 weeks
  - ICOS: 2-4 ESUs, 6 times per year
  - Automated instruments: 1 ESU, daily





- Traditional upscaling methods (requiring spatially representative sampling of 20+ ESUs, covering a large range of values) are not well-suited to these data



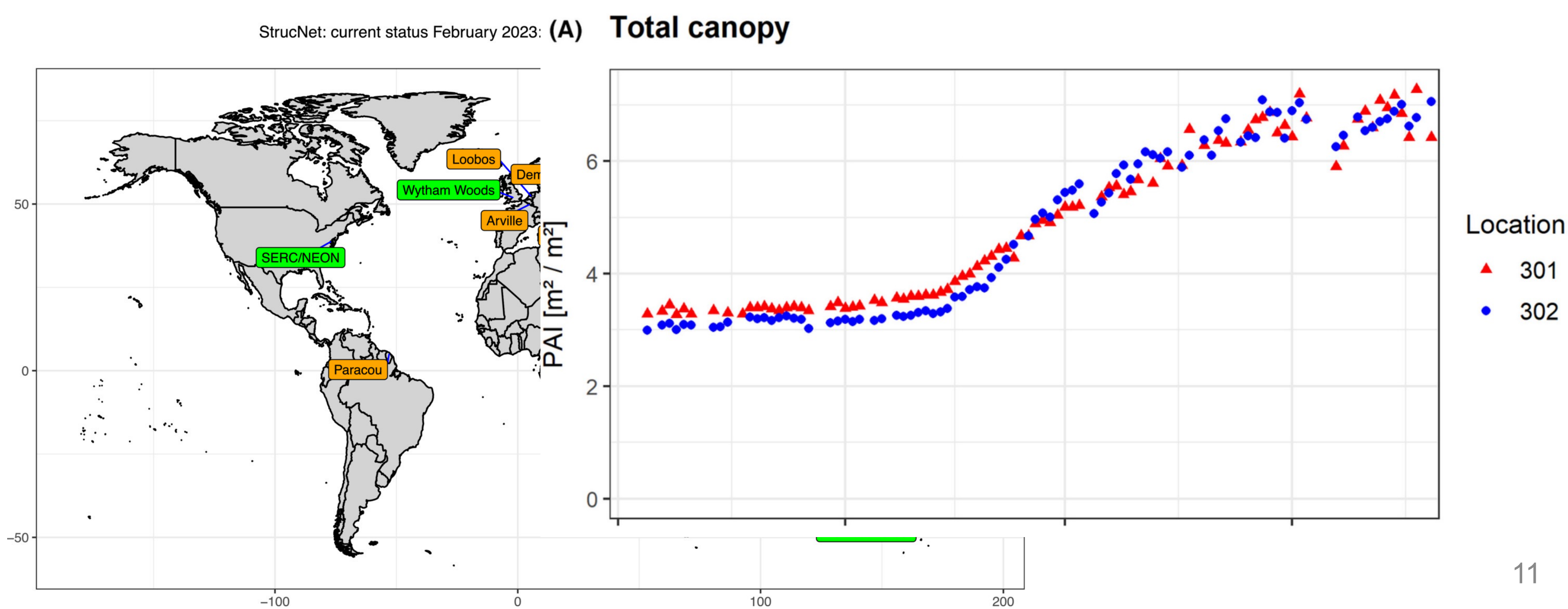
- How do we best handle these new sources of in situ data for validation?

Emerging validation needs (2)

- Reference data to validate products providing vertical profiles/layers
  - GEDI 5 m PAI profile
  - GCOM-C total and overstory LAI & FAPAR
  - GLOBMAP total and overstory LAI
- Understory and overstory values not always provided
  - For GBOV & FRM4VEG, available at in situ reference measurement level, but not separately upscaled so far
- Profiling = terrestrial laser scanning, extendible platforms, UAVs within canopy gaps

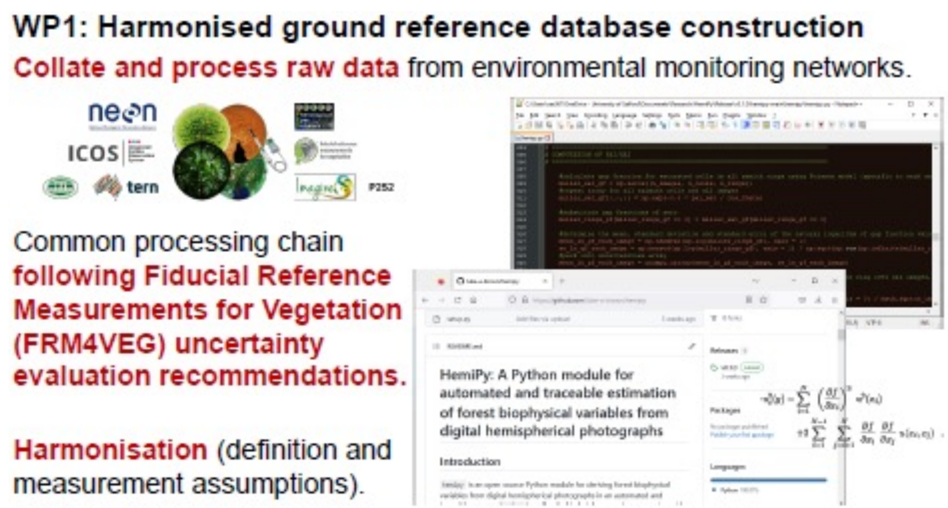
New initiatives of relevance: StrucNet

- New network of automated terrestrial laser scanners
  - Active sensor, potential to avoid sensitivity to illumination conditions
  - Funded by individual institutions & respective projects, data policy TBD (likely at site-level)
  - First workshop recently held (Potsdam, 30 May – 1 June 23)
  - Comparison with GBOV automated DHP planned at several sites
  - Calders et al. (2023, *Remote Sensing in Ecology and Conservation*)



New initiatives of relevance: GROUNDED EO

- Ground Reference Observations Underlying Novel Decametric Vegetation Data Products from Earth Observation (GROUNDED EO)
  - ESA Living Planet Fellowship project, focus on decametric in situ data
  - First work package is collating and processing suitable raw data from environmental monitoring networks (NEON, ICOS, TERN)



  - Resulting database to be publicly available (Cal/Val portal?) – link to data-sharing platform (ESA LPV-REC-22)?

(Some) recent validation publications

- Fernandes et al. (2023), **Validation of Simplified Level 2 Prototype Processor Sentinel-2 fraction of canopy cover, fraction of absorbed photosynthetically active radiation and leaf area index products over North American forests**, *Remote Sensing of Environment*, 293, https://doi.org/10.1016/j.rse.2023.113600

- Pu et al. (2023), **Improving the MODIS LAI compositing using prior time-series information**, *Remote Sensing of Environment*, 287, https://doi.org/10.1016/j.rse.2023.113493

- Lin et al. (2023), **Reprocessed MODIS Version 6.1 Leaf Area Index Dataset and Its Evaluation for Land Surface and Climate Modeling**, *Remote Sensing*, 15 (7), https://doi.org/10.3390/rs15071780

- Wang et al. (2023), **Retrieval and validation of vertical LAI profile derived from airborne and spaceborne LiDAR data at a deciduous needleleaf forest site**, *GIScience & Remote Sensing*, 60 (1), https://doi.org/10.1080/15481603.2023.2214987

- Chen et al. (2023), **Retrieving leaf area index from FY-3D MERSI-II data using a sensor-adaptive algorithm**, *International Journal of Remote Sensing*, 44 (7), https://doi.org/10.1080/01431161.2023.2201383

Upcoming conference sessions/special issues (1)

- Special validation session in IGARSS (Pasadena, July 16-21, 2023)
  - CCS.54: From Need to Product: Recent Advances in Mapping and Validation of Vegetation Biophysical Parameters at Regional to Global Extents
    1. What are the emerging requirements for systematic vegetation mapping over large areas?
    2. What are gaps in current observing systems to address existing and new requirements?
    3. What is required in terms of new observing systems, science and computing to meet these requirements?
    4. How can we exploit new developments in high resolution constellations, UAVs and in-situ networks to quantify the validate new, mapping systems?

- Workshop on Remote Sensing Observation and Research Station Network (Chongqing, China, Apr 7-10, 2023)

Upcoming conference sessions/special issues (2)

- Two relevant special issues in *Remote Sensing*:
  - Recent Advances in Satellite Derived Global Land Product Validation: Part II (https://www.mdpi.com/journal/remotesensing/special_issues/global_land_product_val2)
  - Copernicus Sentinels Missions Calibration, Validation, FRM and Innovation Approaches in Satellite-Data Quality Assessment (https://www.mdpi.com/journal/remotesensing/special_issues/J3CYH3OQV0)

WORKING GROUP ON CALIBRATION & VALIDATION

CEOS

Actions for the near future (1)

- Biophysical good practices update (AP 19-LPV-15)
  - New chapters to incorporate FAPAR as well as latest developments (uncertainty propagation, automated in situ sensors, decametric products)
  - An outline is being developed by L. Brown
  - Once complete, contributors will be sought for each section (N. Origo and B. Brede have already confirmed interest for new sections)

- Support ESA for the data-sharing platform (ESA LPV-REC-22)
  - Gather existing data at decametric resolution (easier than for coarser resolution)
  - Link to GROUNDED EO?
  - Need standards for metadata, quality information, and documentation (ESA LPV-REC-05)

Actions for the near future (2)

- Newsletter to the community (Q2)
  - Drafted based on updates presented here
  - Introduce new focus area co-lead, provide updates on recent projects/initiatives, upcoming conferences/workshops/special issues

- Review of products and references on website (Q3)
  - S. Leblanc has started to compile a list of LAI-related publications which will be reviewed by the other focus area co-leads