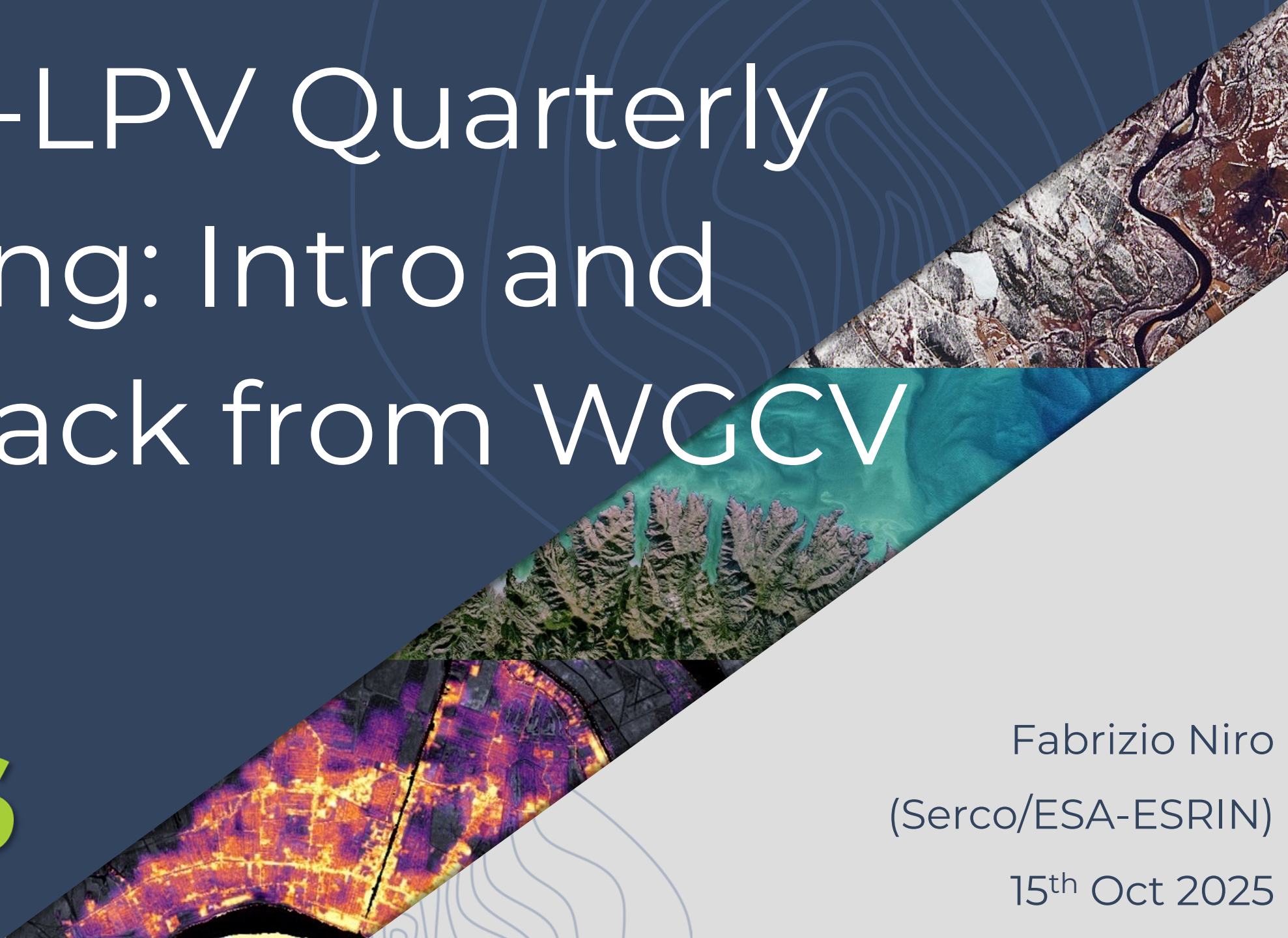
CEOS-LPV Quarterly Meeting: Intro and feedback from WGCV



Committee on Earth Observation Satellites

Fabrizio Niro

(Serco/ESA-ESRIN)

15th Oct 2025

Outline

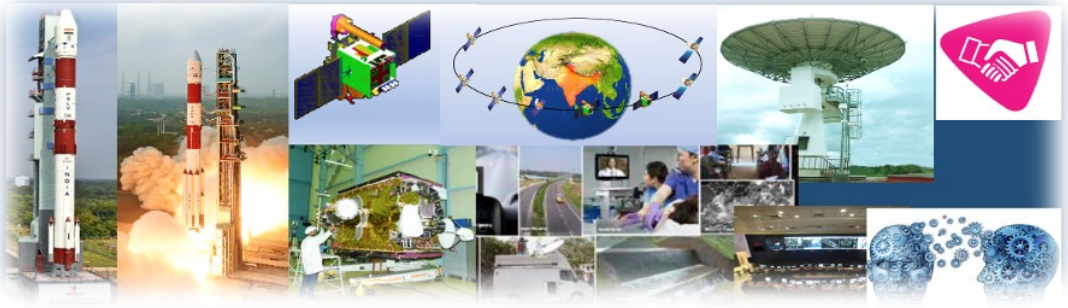
- Feedback from CEOS-WGCV Meeting
- Update on CEOS-ARD
- Update on LPV supersites
- GCOS ECVs review process
- Outreach and Events

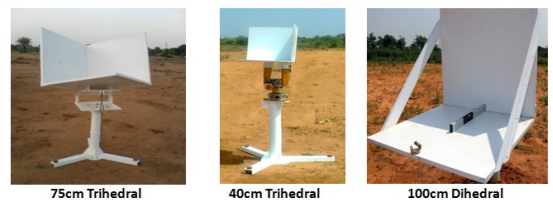
CEOS-WGCV Meeting

- CEOS-WGCV Meeting #55 took place in **Hyderabad** (India) from **8-11 July**, **ISRO** premises
- The meeting brought together sub-group **chairs** along with agencies representatives
- Many Indian **New Space** companies were invited to participate

EO in India

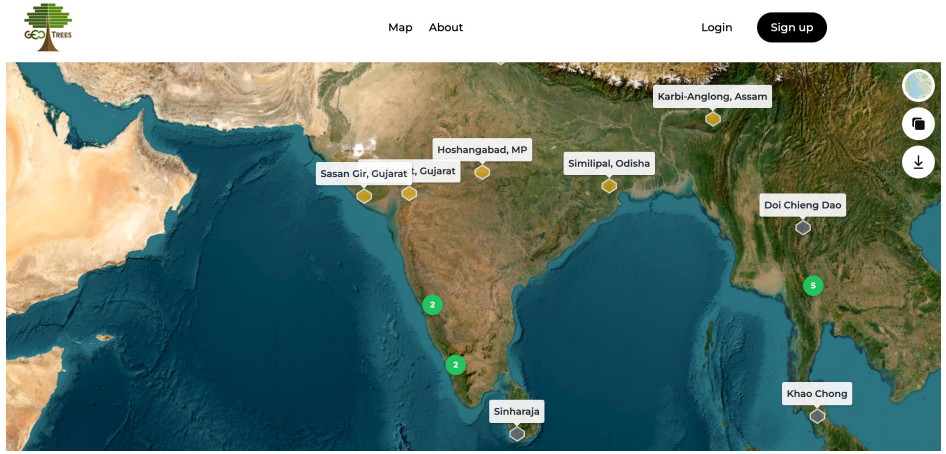
- Expanding **capabilities** in EO: from Space and Ground Segment to downstream services
- Wide range of science (NISAR, TRISHNA) and operational EO **missions** (CartoSat, OceanSat, ResourceSat, RiSat)
- Extensive **Cal/Val facilities** and collaboration in international initiatives: e.g., GEO-TREES





Feedback to LPV

- Strong interest in **LC protocol** ! Propose endorsement at CEOS level
- Further **promote** LPV protocols within the EO community !
- Strong interest in **Biomass** (NISAR), request to include guidelines for biomass changes
- Explore **synergies** with India to fill geographical and thematic gaps



CEOS Analysis Ready Data (ARD)

- CEOS-ARD are **satellite data** that have been processed to a **minimum set of requirements** and organized into a form that allows **immediate analysis** with a **minimum** of additional user effort

https://ceos.org/ard/

- **Aims**

  Reduce barriers to the uptake of EO data

  Enable **new applications** and users

  Improve data **interoperability** across public and private sectors

Product Family Specifications (PFS)

- Since 2016, CEOS has developed nine PFS :

  Require a minimum **degree of pre-processing** – **methods** are up to data provider, only **quality** req. multi-temporal geolocation **½ pixel**

  Providing analysis-ready **geophysical** measurements (primarily **L2**)

  Ensuring robust **metadata** and documentation

Future CEOS-ARD

- The EO sector has come a long way since CEOS-ARD was first conceptualised in 2016:
  - Changing **technology**, including **AI/ML**, cloud-native
  - Evolving **user** base and **expectations**
  - Increasing demands for **interoperability**
- Need to ensure we keep **moving forward**.
  - Where are the opportunities to make **CEOS-ARD better**?
  - **Seeking guidance** from the user community to help shaping the future of CEOS ARD!

Survey and White paper

- Collecting feedback

  User survey → LPV welcome to contribute !

  Elaborate a **white paper** to define and shape the future of CEOS-ARD

- The **WGCV group** is contributing to the white paper by:

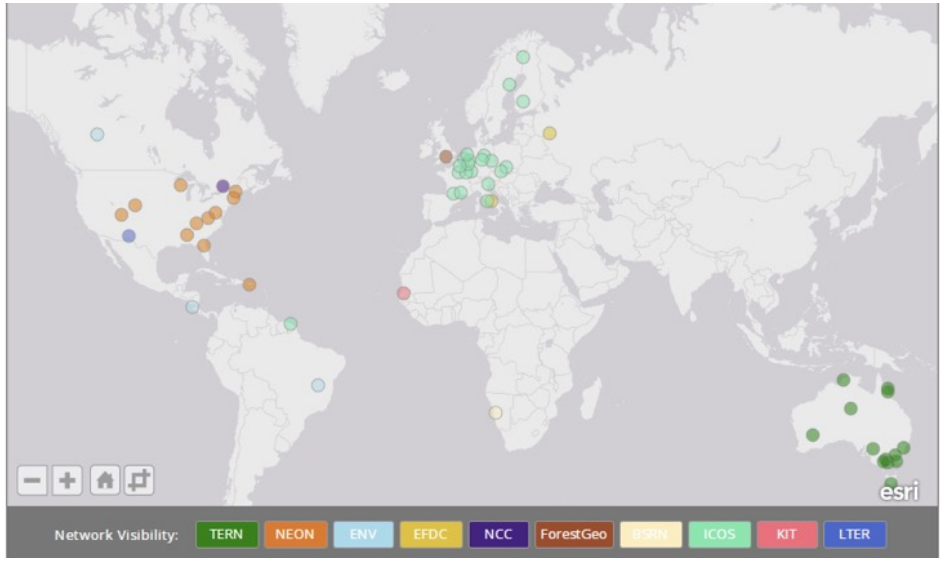
  Defining minimum **quality requirements** for a CEOS-ARD to “protect the brand”

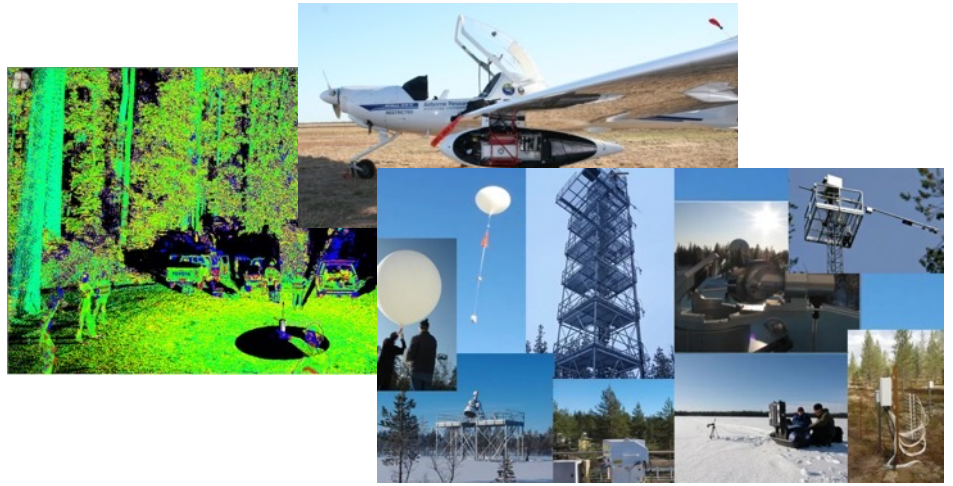
  Supporting users to define **fitness for purpose** for given application

Future of CEOS-ARD Questionnaire
ceos.org/ard/survey

LPV Supersites

- In **2016**, LPV **supersites** (55) defined to address CEOS CV-12 action :
  - Well characterised site canopy **structure** for **RTM-based** validation
  - Useful for validating at least **3 variables**
  - Long term **operations**, part of established networks (e.g., ICOS, NEON, TERN)
  - Community-agreed **protocols**
  - Ideally supported by **airborne** / Lidar
- Since 2016, landscape **evolved**:
  - New sites/networks, new variables, advanced sensors (UAV), new missions



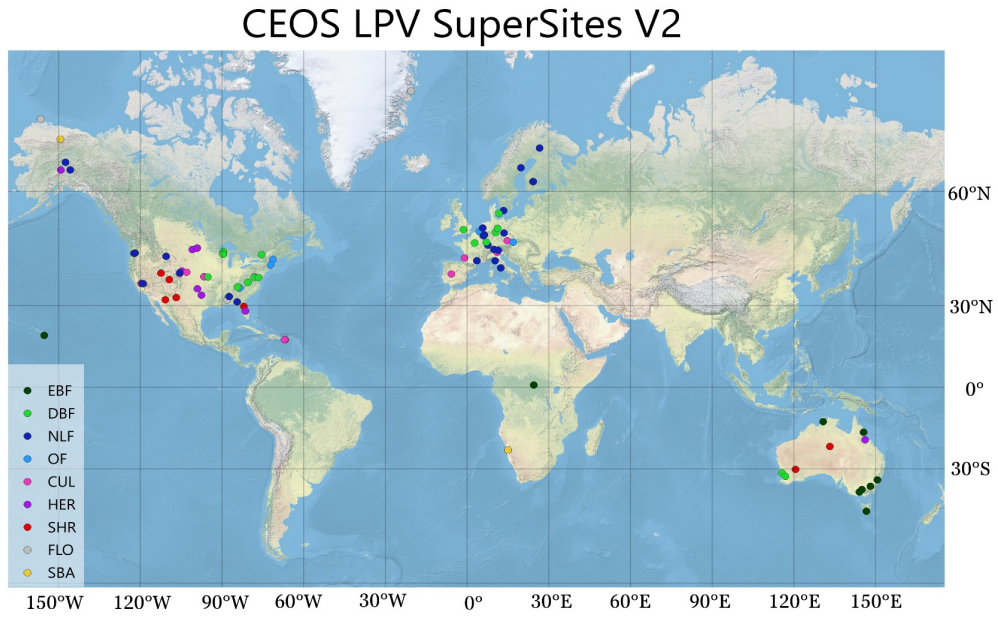


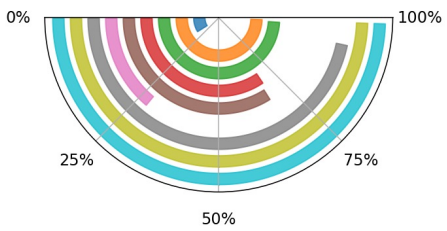
LPV Supersites selection

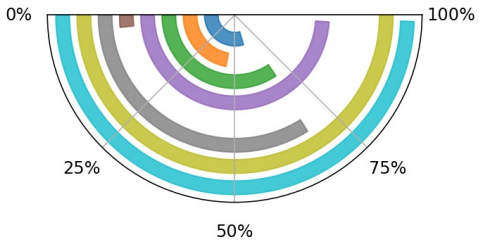
- Review **definition**
  - Expand variables: **BRF**, **ET**, **GPP/NPP**, **SIF**
  - For validation of at least **3 family** of products
  - Adding **UAV-LiDAR** as ideal component
  - Assess spatial **representativeness**
  - Adherence (ideal) to **CEOS-FRM**
- Sites selection (220+ candidate)
  - Review main ecosystem **networks**
  - Include **recent** networks /sites
  - **Ranking:** ancillary data, homogeneity, biomes/geographic relevance

LPV Supersites 2.0

- Selected **92 sites** + 66 candidate
- Remaining **gaps**
  - Geographical gaps remain
  - LST and spectrally-resolved BRF mostly lacking
  - Limited adherence to FRM
- Way forward
  - **Spreadsheet** + **TN** will be circulated for review by LPV
  - **Regular review** recommended to keep the list updated





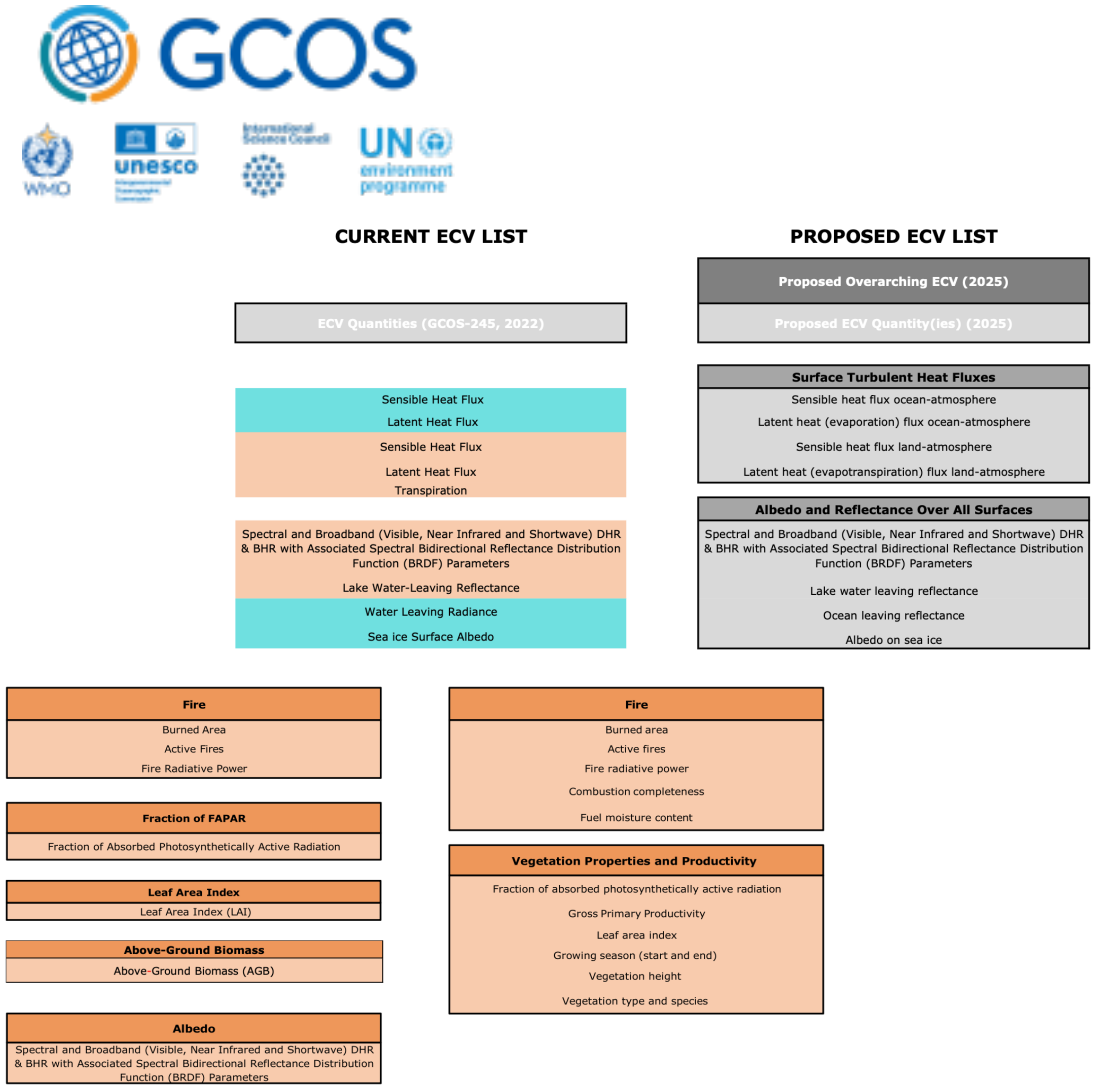


BRF (Hyper) (17.8%)
Albedo (98.9%)
LAI/FAPAR (97.8%)
Phenology (68.9%)
Soil Moisture (67.8%)
LST (27.8%)
AGB (93.3%)
ET (98.9%)
GPP (98.9%)

AOT (58.9%)
Structural TLS (44.4%)
Airborne/drone (68.9%)
Meteo (97.8%)
FRM adherence (3.3%)
Upscaling (67.8%)
Protocol (100.0%)
Open Access (98.9%)

GCOS ECVs Rationalisation

- On-going **review of ECVs**:
  - **Grouping** related variable into a single ECV
  - Identify **cross-domain** ECVs
  - Added ECV quantities, e.g., vegetation type/species, FMC
- **LPV feedback** list collected and sent to WMO
- **Collaboration** with GCOS will continue for defining observation requirements



Outreach and events

- Collaboration with **GEOGLAM**
  - CEOS-SIT action to work in collaboration with GEOGLAM to organise a **joint workshop on ET validation** hosted by **FAO**
  - Discussion is on-going with GEOGLAM representatives
- Upcoming events
  - AGU/EGU
  - Any other ?
  - LPV Plenary 2026 ?

FA leads status

	First Name	Last Name	Institution	Country	End of Term
Admin	Fabrizio	Niro	ESA	Italy	Apr 2028
	Vacant				
	Jaime	Nickeson	GSFC	USA	
Land Cover	Alexandra	Tyukavina	University of Maryland	USA	Mar 2027 (2nd term)
	Nandika	Tsendbazar	Wageningen University	Netherlands	April 2027 (1st term)
	Sophie	Bontemps	Université Catholique de Louvain	Belgium	**ex-officio**
Biophysical	Richard	Fernandes	Natural Resources Canada	Canada	Apr 2027 (one term)
	Hao	Teng	University of Maryland	USA	April 2027 (1st term)
	Luke	Brown	University of Salford	UK	Jan 2026 (1st term)
Fire/Burn Area	Louis	Giglio	University of Maryland	USA	Sep 2026 (2nd term)
	Bernardo	Mota	National Physical Lab	UK	Jan 2026 (1st term)
Surface Rad	Zhuosen	Wang	GSFC	USA	ex-officio
	Angela	Erb	Leidos	USA	Jan 2026 (1st term)
	Jorge	Sanchez-Zapero	EOLab	Spain	Jan 2026 (1st term)
Soil Moisture	John	Bolten	NASA GSFC	USA	Apr 2026 (2nd term)
	Alexander	Gruber	TU Wien	Austria	Oct 2026 (1st term)
LST	Thomas	Holmes	NASA/GSFC	USA	Dec 2028 (1st term)
	Lluis	Perez Planells	Karlsruhe Institute of Technology	Germany	Sept 2026 (1st term)
Phenology	Joshua	Gray	North Carolina State University	USA	Jan 2025 (2nd term)
	Victor	Rodríguez-Galiano	University of Seville	Spain	Aug 2025 (2nd term)
	Qiaoyun	Xie	The University Of Western Australia	Australia	Sep 2028 (1st term)
Snow Cover	Carrie	Vuyovich	NASA GSFC	USA	Jan 2026 (1st term)
	Juha	Lemmetyinen	Finnish Meteorologial Inst.	Finland	Sep 2026 (1st term)
Veg Index	Tomoaki	Miura	University of Hawai'i	USA	**ex-officio**
	Simon	Kraatz	USDA	USA	Apr 2027 (1st term)
	Sarah	Gebruers	VITO	Belgium	Sep 2028 (1st term)
Biomass	Laura	Duncanson	UMD/GSFC	USA	**ex-officio**
	Kim	Calders	Ghent University	Belgium	Feb 2026 (1st term)
	Neha	Hunka	ESA/ESRIN	Italy	Feb 2026 (1st term)
ET	Yun	Yang	Cornell University	USA	Jan 2027 (1st term)
	Carmelo	Cammalleri	Politecnico di Milano	Italy	Jan 2027 (1st term)
GPP/NPP	Arthur	Endsley	University of Montana	USA	Sept 2027 (1st term)
	Álvaro	Moreno	University of Valencia	Spain	Nov 2027 (1st term)

NEW co-lead in **Phenology**
Dr. Qiaoyun Xie
The University Of Western Australia

NEW co-lead in **VI**
Dr. Sarah Gebruers
VITO
Belgium

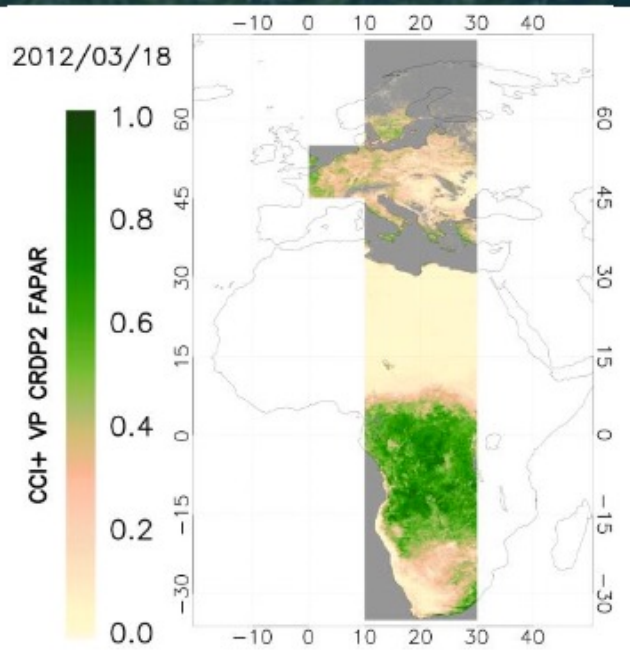
Reports from FA leads

CEOS
Committee on
Earth Observation Satellites

Biophysical

- **Multiple presentations on validation at Living Planet Symposium 2025. Propose we link them under references in separate section.**
- **7th S2 Validation Team Meeting. 3 talks on fiducial reference measurements and 2 on validation.**
- **New network of sites: Tropical Forest Science (CTFS) / ForestGEO meeting. Hao will be presenting an experiment in a tropical peatland forest with measurements of LAI and vertical LAI profile obtained from DHP, LAI-2200, terrestrial lidar, UAV lidar and GEDI**
- **New Product: ESA CCI VP CRDP-2 (Climate Research Data Package) is ready (limited sampling to sites and ROIs by now). It will be delivered this month through CEDA. This dataset is based on multi-sensor input data , using optiSAIL model with Automatic Differentiation inversion.**
- **Outline of paper "A methodology for validating decametric resolution synoptical and global FAPAR and LAI products." complete and ready for internal comments.**

CRDP-2 period: 01/2000-12/2020

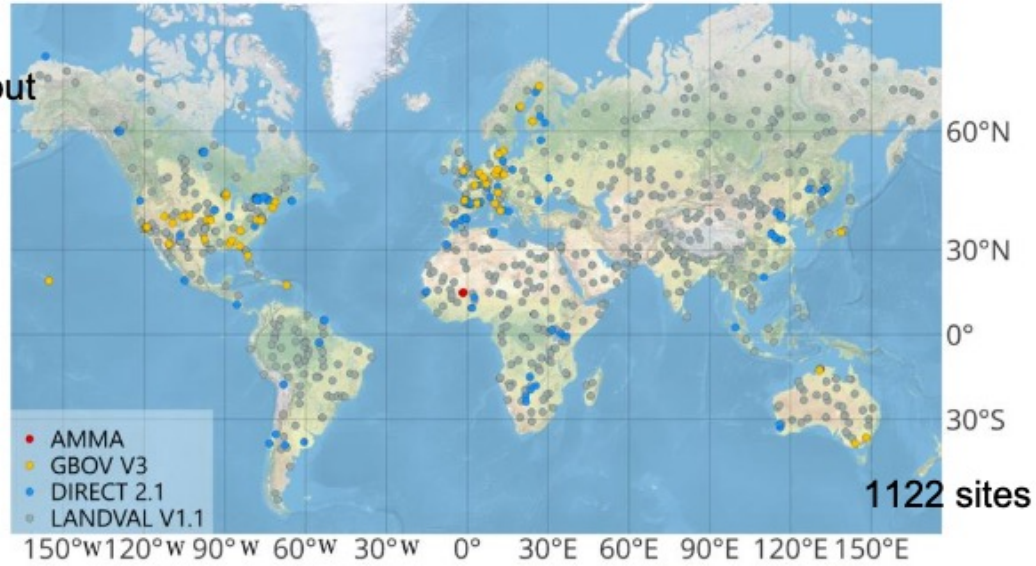


CRDP-2 dataset based on optiSAIL (Blessing et al., 2024) using multiple sensor input data (depending on the period)

LAIeff, FAPAR plus additional paramenters (e.g., Cab x FAPAR).

CRDP-2 dataset validated by EOLab.

Expected delivery end October



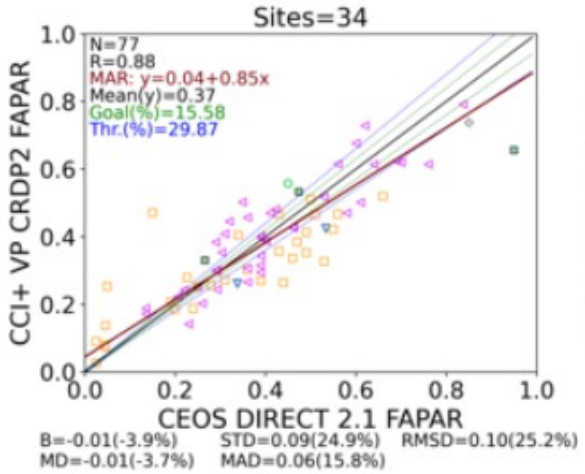
vegetation parameters cci

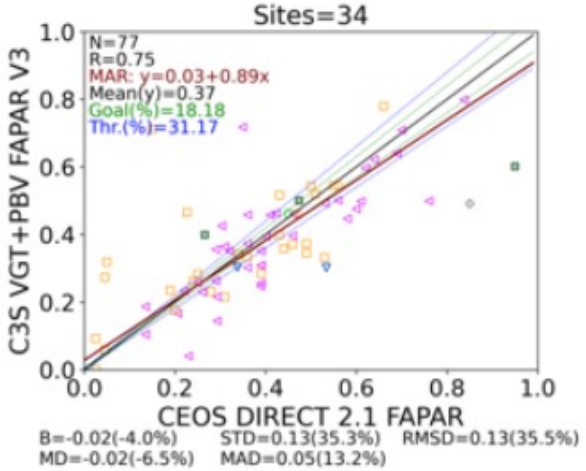
EOLAB

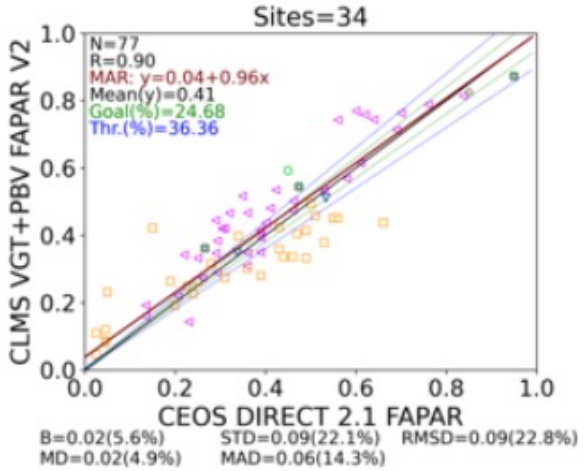
esa

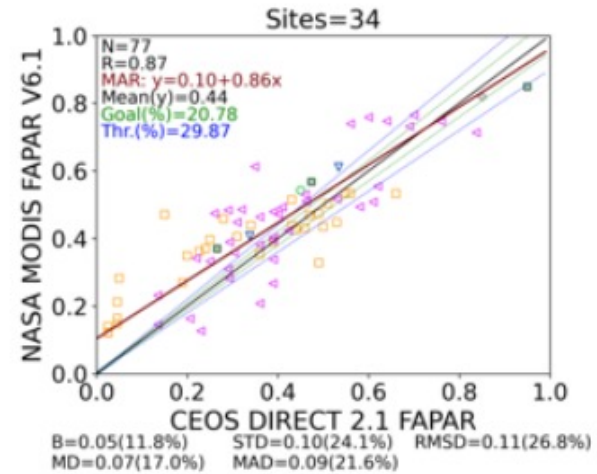
C3S: Copernicus Climate Change Service
CLMS: Copernicus Land Monitoring Service

fAPAR



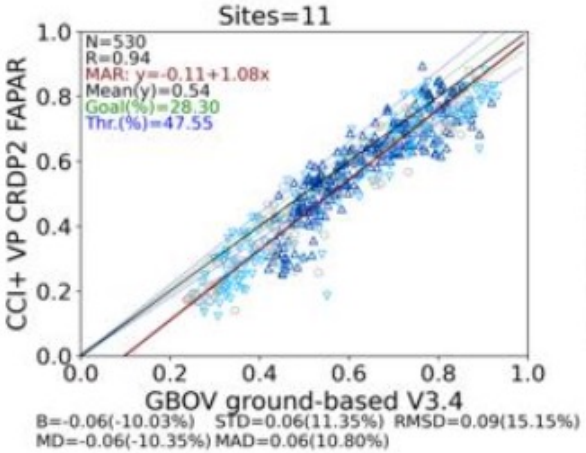


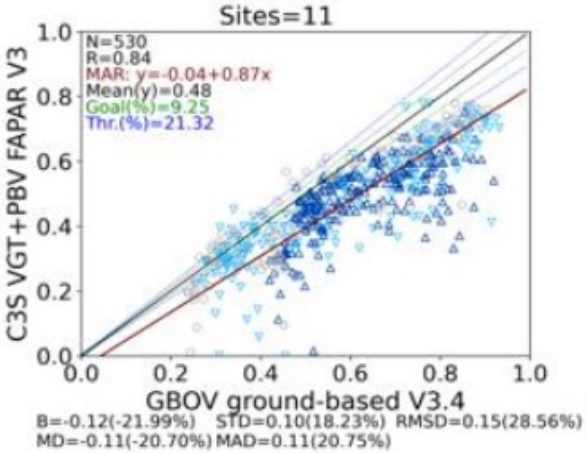


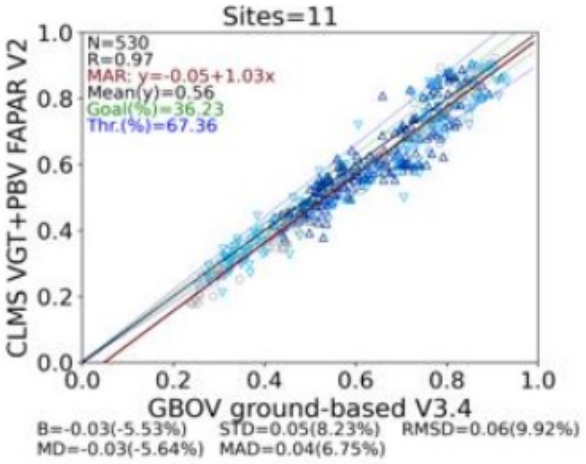


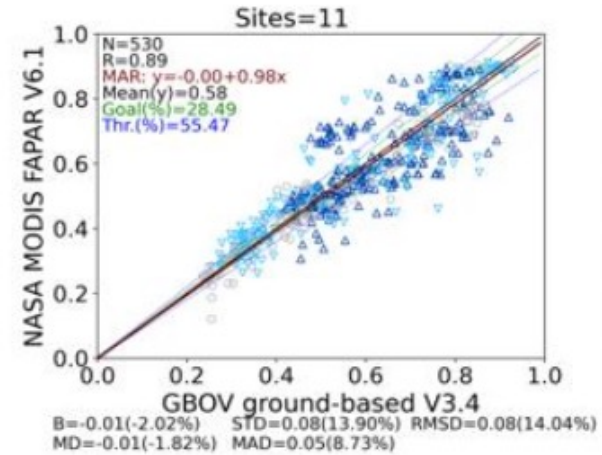
Validation vs CEOS LPV DIRECT2.1

fAPAR

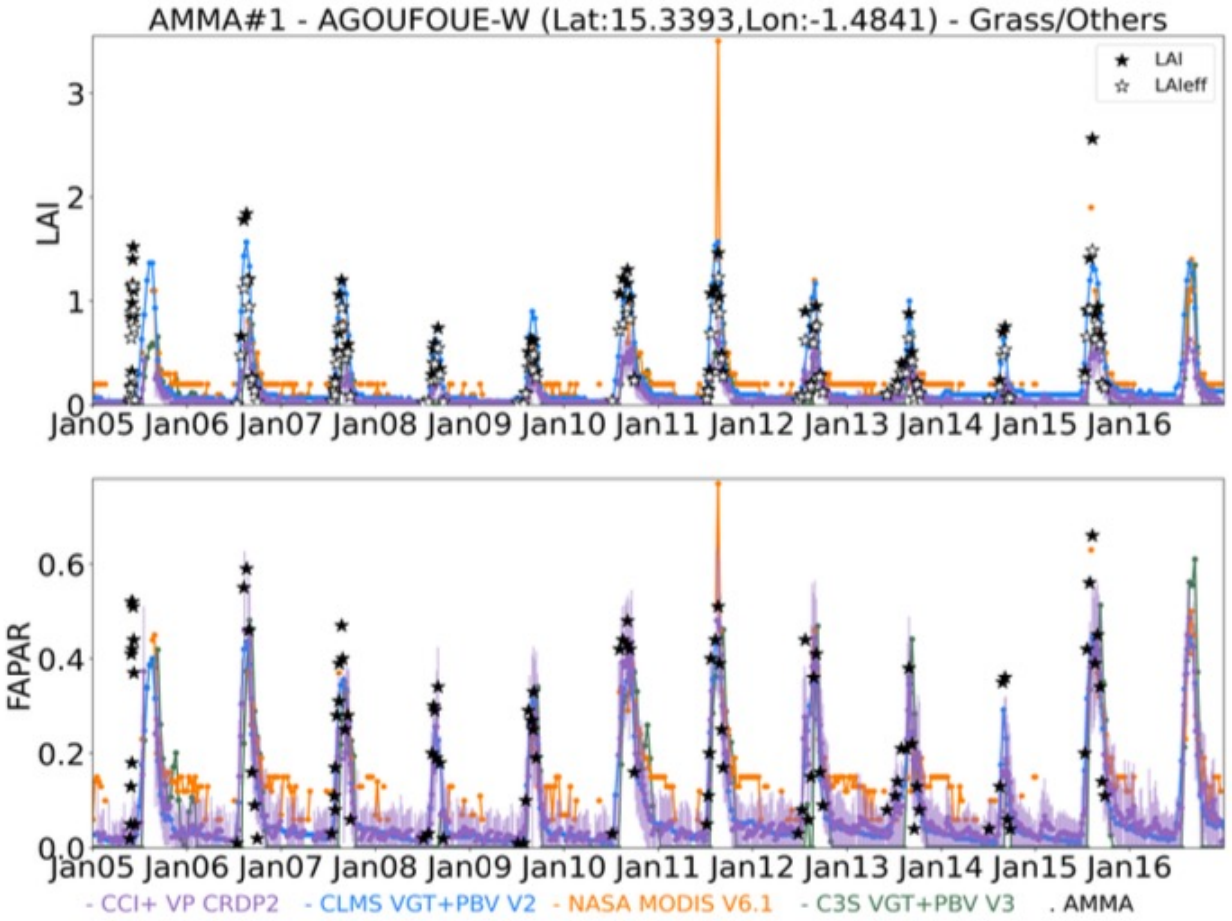


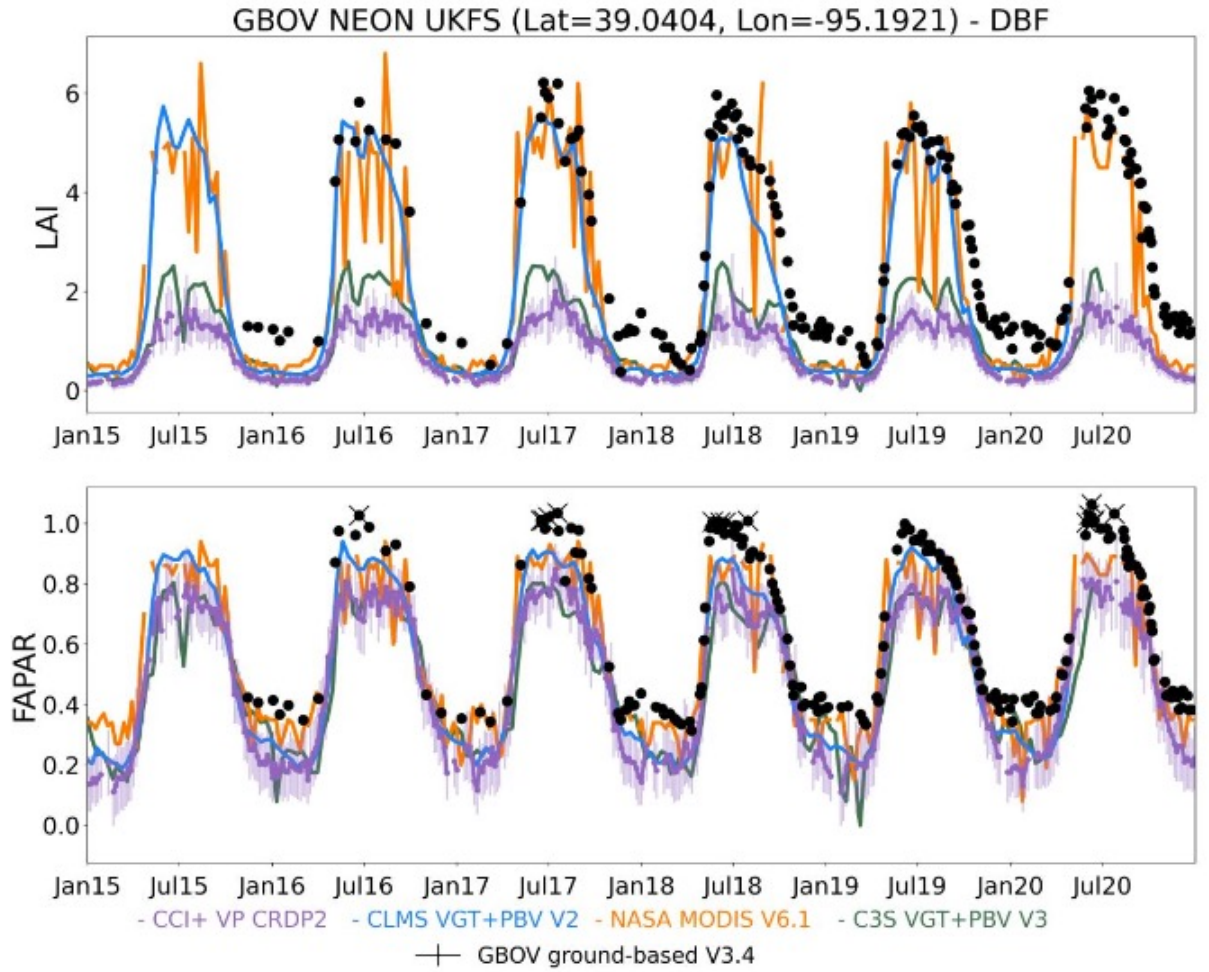






Validation vs GBOV V3.4- Best Quality
(only NEON forest sites, no bias in upscaled products)





Good temporal consistency but… CDR (>20 years) are now available.

Good practice protocols for stability assessment are needed.

Land Cover Focus Area

Alexandra (Sasha) Tyukavina (U. Maryland, USA)
Nandika Tsendbazar (Wageningen University, Netherlands)

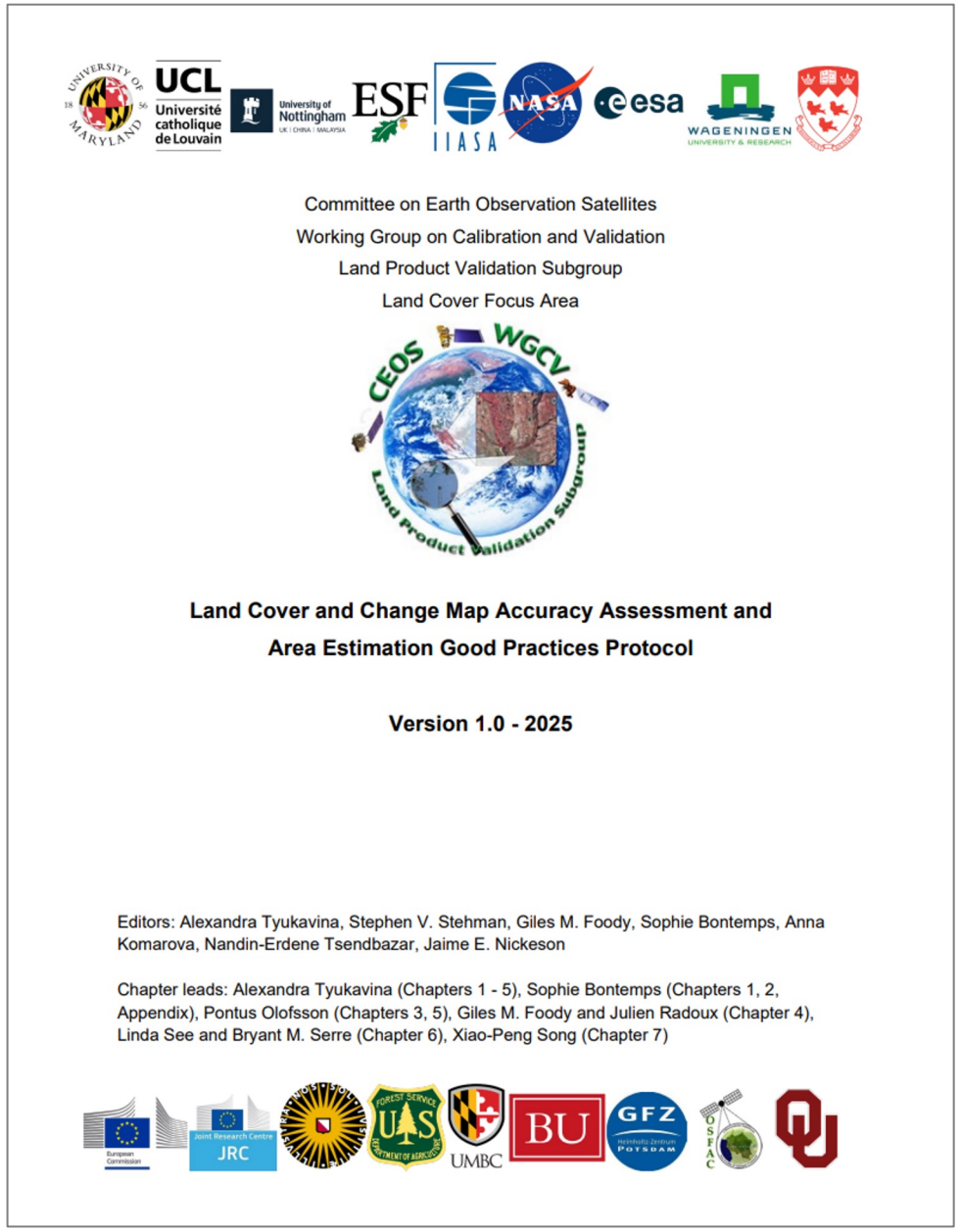
LPV telecon – October 14, 2025

Land Cover (1/3)

Version 1.0 of the LC validation guidelines was **published on September 15!**

https://doi.org/10.5067/doc/ceoswgcv/lpv/lc.001

Version 1.1, incorporating feedback from and endorsed by WGCV is planned to be published next week (October 20-24)



Committee on Earth Observation Satellites
Working Group on Calibration and Validation
Land Product Validation Subgroup
Land Cover Focus Area

Land Cover and Change Map Accuracy Assessment and Area Estimation Good Practices Protocol

Version 1.0 - 2025

Editors: Alexandra Tyukavina, Stephen V. Stehman, Giles M. Foody, Sophie Bontemps, Anna Komarova, Nandin-Erdene Tsendbazar, Jaime E. Nickeson

Chapter leads: Alexandra Tyukavina (Chapters 1 - 5), Sophie Bontemps (Chapters 1, 2, Appendix), Pontus Olofsson (Chapters 3, 5), Giles M. Foody and Julien Radoux (Chapter 4), Linda See and Bryant M. Serre (Chapter 6), Xiao-Peng Song (Chapter 7)

Land Cover (2/3)

nature communications

Article

https://doi.org/10.1038/s41467-025-64014-9

Rapid monitoring of global land change

Received: 28 October 2024

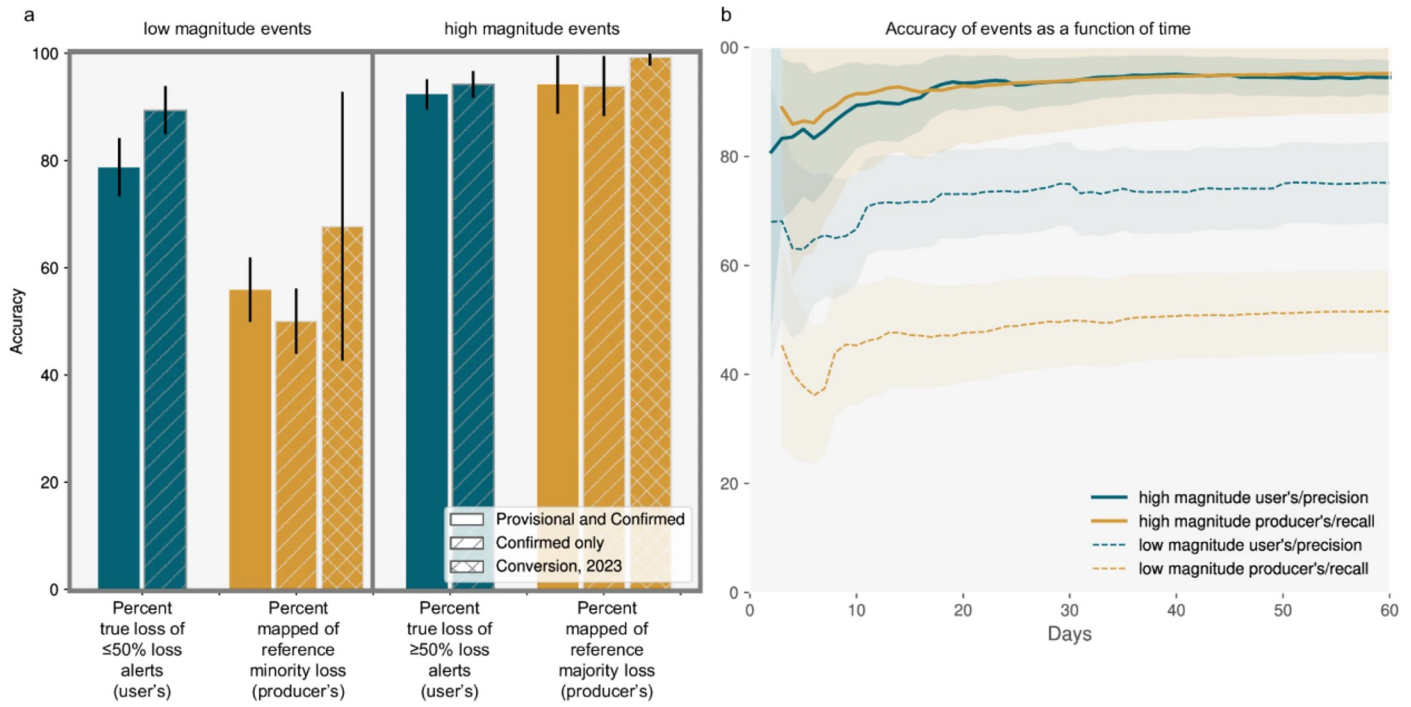
Accepted: 4 September 2025

Published online: 08 October 2025

Amy H. Pickens[1], Matthew C. Hansen[1], Zhen Song[1], Andrew Poulson[1], Anna Komarova[1], Antoine Baggett[1], Theodore Kerr[1,2], Aleksandra Mikus[1,2], Carolina Ortiz Dominguez[1,2], Alexandra Tyukavina[1] & André Lima[1]

New publication: DIST-ALERT near real-time vegetation monitoring product with validation

\+ sample-based assessment of disturbance drivers



a Accuracies of the vegetation loss alerts split by low and high magnitude events. Conversion is only labeled in the reference data and thus only producer's accuracy is calculated. **b** User's accuracy is calculated relative to the detection date and producer's accuracy relative to the reference date; both accuracies include all ongoing provisional and confirmed alerts. The black bars (**a**) and shaded area (**b**) represent one standard error.

- Stratification for sample selection using land cover type (8 types) and and the DIST-ALERT product (4 change strata) + no change stratum across land covers;
- 50 x 8 x 4 pixels sampled (+1 extra) + 48 in no change = 1649 pixels total sample size;
- Reference data collected every 5 days throughout 2023;
- High confidence ('confirmed') alerts with high vegetation loss (≥ 50%): user's accuracy 94.2 ± 2.5%, producer's accuracy 93.9 ± 5.6%;
- Accuracy of detections improves over time (when alerts are confirmed);
- Alerts with a single detection ('first') have high commission, with many errors caused by omissions of cloud and shadow masking within HLS data.

Land Cover (3/3)

nature communications

Article

https://doi.org/10.1038/s41467-025-64014-9

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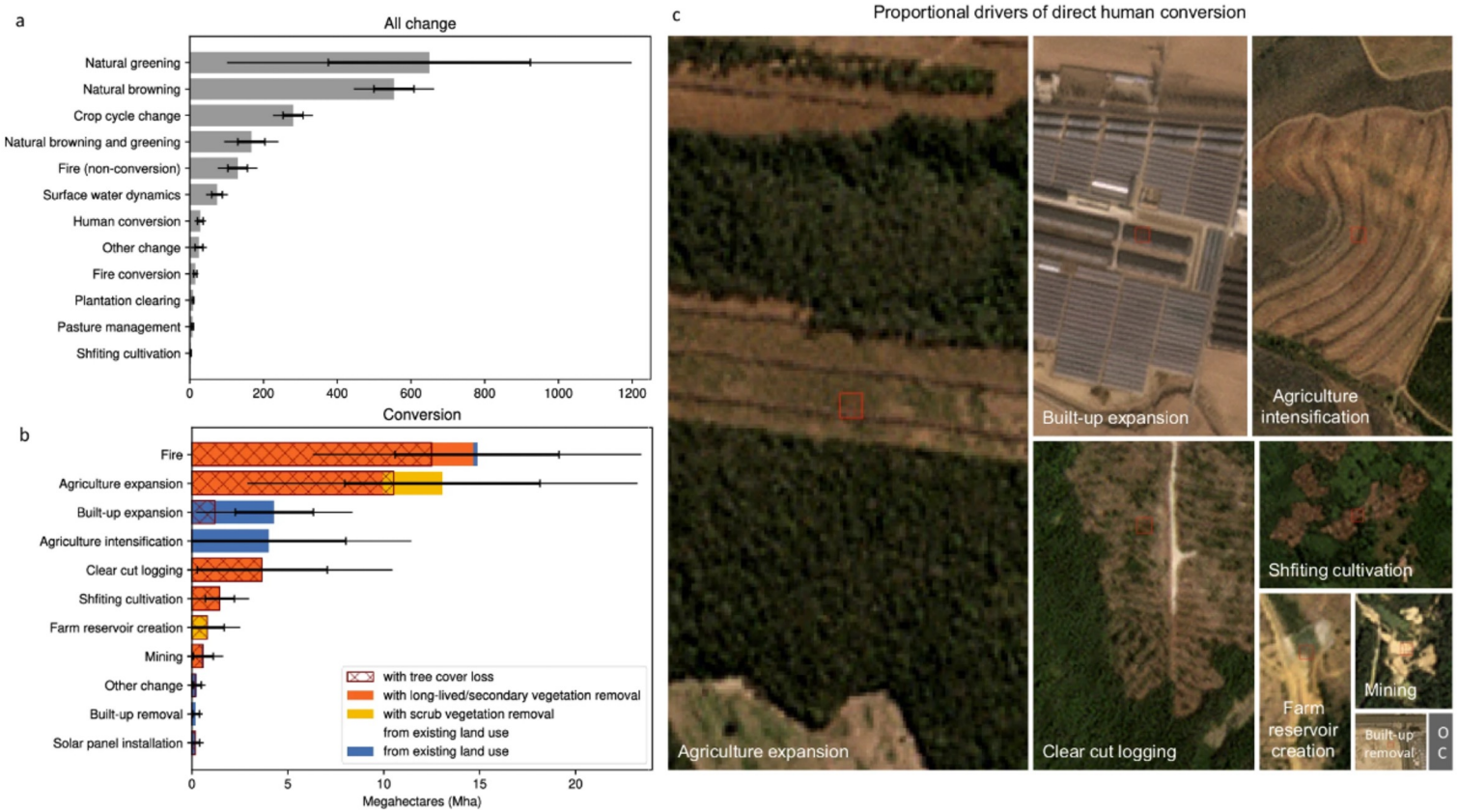
Sample-based assessment of disturbance drivers for 2023



a The estimated area of change dynamics in all land cover types. **b** The estimated areas of just conversion drivers, divided by the previous class of land cover or land use. The area estimates are based on the probability reference sample; the shorter uncertainty bars represent one standard error of the estimates, and the longer bars represent the 95% confidence interval. **c** The proportions of drivers from the total area of direct human conversion, with example sites shown with PlanetScope imagery from Planet Labs PBC. Fires without evidence of new land use are excluded from direct human conversion. O.C. stands for "Other change".

- Same sample as for validation;
- Reference information recorded:
  - the overall type/driver of land change dynamic (including 'no change');
  - whether it was a human-caused conversion, naturally caused conversion, or no conversion;
  - whether the change began in the previous year.
- Natural greening and browning - ⅔ of all change;
- Crop management - second largest contributor;
- Conversion fires (>1 year recovery) vs. non-conversion fires (<1 year)

Snow (1/3)

Mission News

- No SWE missions were selected from recent NASA Earth System Explorer call
- CSA has released an RFP for conceptual design, development plans and cost estimates for a future implementation of the Canadian SWE mission concept, TSMM
- Hydroterra+ selected in ESA Earth Explorer for Phase A study would provide snow information over Europe, [ESA - ESA selects four new Earth Explorer mission ideas]

Figure 13 Observation scenarios target coverage areas (from Concept B)

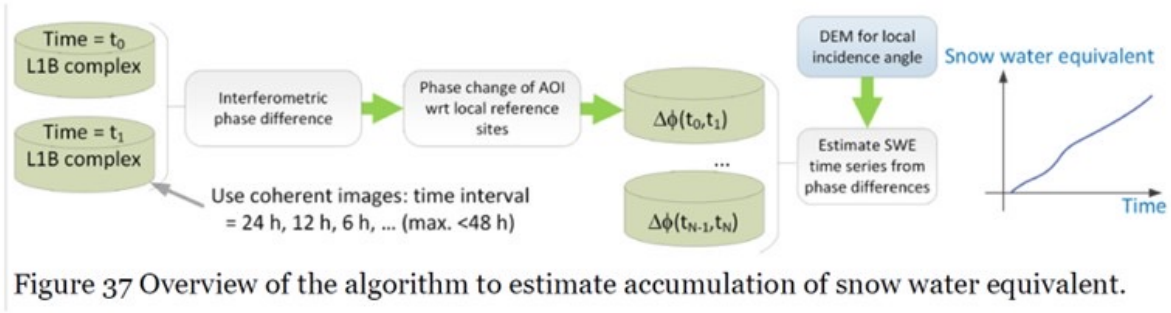


Figure 37 Overview of the algorithm to estimate accumulation of snow water equivalent.

Figures: Earth Explorer 10 candidate mission Hydroterra – Report for Assessment

Snow (2/3)

Collaboration Efforts

Global Climate Observing System program (GCOS)

- Current Essential Climate Variable (ECV) guidance for snow is being reviewed over the next ~6 months
- These requirements mainly focused on data requirements that are not currently met by any satellite mission
- The GCOS snow group has reached out to the snow community for input in the development of the requirements.
- We will work with this group to develop a validation protocol once the requirements are in place

May – December 2024

Snow ECV requirements
Special off-cycle requirements review

Snow ECV products
Reconsideration of snow products

Outcome/deliverable(s)
- Revised snow requirements
- Possible manuscript describing the process and community consensus on requirements and Snow ECV products.

Colleen Mortimer (supp. By Patricia de Rosnay & Kari Luojus)

2024-25

CEOS Land Product Validation subgroup
Snow focus area validation protocols

Outcome/deliverable(s)
- Land product validation plan for snow to assess Satellite products against GCOS ECV requirements

Carrie Vuyovich & Juha Lemmetyinen

- In the meantime the CEOS LPV Snow will point to the protocols developed by the SnowPEx satellite snow product intercomparison and evaluation exercise which focuses on existing SCE and SWE products

Snow (3/3)

Website Updates

- Updates made to the Home page and Collaboration page
- Working on References and Product table next

Land Surface Temperature and Emissivity

Upcoming Conferences

- International Workshop on High-Resolution Thermal Earth Observation. 18 – 20 November, 2025. Toulouse, France.
- Science and Cal/Val Activities at the Gobabeb Research Centre (Namibia). ESA/ESRIN, Frascati, Italy, on 24–25 November. Hybrid format.

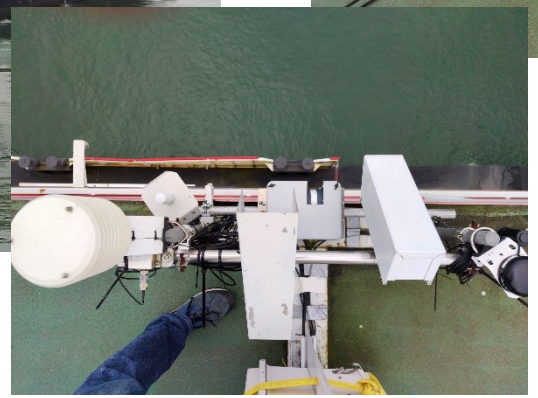
Project news

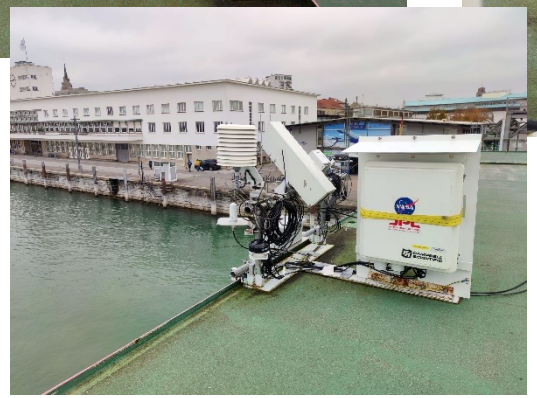
- TIRCALNet preparation study: New sites are being planned.

JPL & Heitronics KT15.85 comparison

In-situ comparison of TIR radiometers at Lake Constance

- JPL Radiometer (JPL Network)
  - Wavelength range: 8-14 µm
  - Field of view: 44°
  - Accuracy: 0.08 K
  - Self-calibrated with internal blackbody
- HEITRONICS KT15.85 (KIT Network)
  - Wavelength range: 9.6-11.5 µm
  - Field of view: 44°
  - Accuracy: 0.3 K
  - High long-term stability: <0.1 % per year





Evapotranspiration(1/3)

RS ET Product:

	ET products	ET Estimation method (ET models)	Source Type	Source	Spatial Coverage	Spatial Resolution	Temporal Coverage	Temporal Resolution	Update Frequency (Latency)	Validation	Reference Type	Data Availability	Typical Use Case (agriculture, hydrology, climate studies)	Reference
1	GLEAM	Penman-based with ML-trained stress factors	Satellite - based	MODIS sensors (Terra/Aqua), NTSG (UMT), NASA Earth Observing System	Global (land only, excl. Antarctica)	0.25° (~25 km) to 0.1°	1980-2024	daily	Annually	Yes	Flux Towers	Freely available in a public SFTP server	multidisciplinary	link
2	MOD16A2	Penman–Monteith equation	Satellite - based	TerraMODIS	Global (land only)	500m	2000 – present	8-day composite	8 days	Yes	Flux Towers	Publicly available	multidisciplinary	link
3	FLUXNET	Eddy covariance(EC) measurements	Ground - based	Eddy Covariance Flux Tower	Global network of sites	Site-specific (~1 km^2)	1990 - present	daily	Near-real-time	primary reference for other ET products	Flux Towers	Data sharing policies vary by site	multidisciplinary	https://flux
4	Sen-ET	Combines Sentinel-2 multispectral optical data with Sentinel-3 thermal infrared data, using ML	Satellite - based	Sentinel-2, Sentinel-3	Global	10 - 20 meters	2015 - present	3-5 days	Approximately every 5 days (Sentinel-2 revisit)	Yes	Flux Towers	Open Access via ESA Copernicus data portals	Agriculture monitoring, water resource management	
5	ERA5-Land	Penman-Monteith approach for potential ET with dynamic soil moisture for actual ET	Reanalysis-based	Produced by ECMWF, data distributed by Copernicus Climate Data Store (CDS)	Global land	~9 km	1950 - Present	hourly; daily	Near-real-time (2-3 months)	yes	Flux towers & satellite observations	Open Access	multidisciplinary	link

- Database of about 40 ET datasets
- Not only RS ET products
- Both limited areas and large regions
- Regularly updated and one-shot

A curate selection will be soon added to the webpage

Example of Summary Sheet


MOD16A2

MOD16A2 provides global 8-day composite estimates of ET, including transpiration, soil evaporation, and interception loss, derived from MODIS satellite data using the Penman-Monteith algorithm. The product supports global-scale land surface flux analysis and is delivered at 500 m spatial resolution from 2000 to present.

Estimation method	Penman–Monteith (MODIS inputs)
Spatial Coverage	Global (land only)
Spatial Resolution	500m
Temporal Coverage	2000 – present
Update Frequency	8-day composite
Validation	Validated using flux tower data (FLUXNET)
Data Availability	Free via NASA LP DAAC
Use Cases	Agriculture, drought monitoring, water cycle

Methodology:
- Based on the Penman–Monteith equation, integrating MODIS land products (LAI/FPAR, albedo, land cover) with daily meteorological reanalysis data.
- Produces composite 8-day ET, PET, latent heat flux (LE), and quality control layers.
- Accounts for both transpiration and evaporation from soil/canopy.

Rationale:
To provide consistent, high-resolution global ET data for climate, agricultural, drought, and water management applications.

Limitations/Considerations:
Uncertainties remain in arid/semi-arid zones and under complex canopies.
Annual updates; not near real-time.
Dependent on MODIS data and reanalysis quality.

Primary output:
- ET (Evapotranspiration, mm/8 days)
- PET (Potential Evapotranspiration, mm/8 days)
- LE (Latent Heat Flux, W/m²)
- PLE (Potential Latent Heat Flux, W/m²)

Validation & Performance:
- Validated using FLUXNET and other ground-based flux data.
- Typical RMSE for 8-day ET: ~8–15 mm/8d (varies by region/crop).
- Generally good agreement for forests/cropland, with some overestimation in arid environments.

References:
https://developers.google.com/earth-engine/datasets/catalog/MODIS_NTSG_MOD16A2_105

North America Average Annual ET over 2000 - 2006.

Evapotranspiration(2/3)

Good Practices Protocol:

First draft of the Extended Outlies is (almost) ready to be shared with the community.

- Get feedback from the community: before the end of 2025.
- Define chapter leaders and main contributors: early 2026.
- Full first draft: second half of 2026.

Table of Contents

Evapotranspiration(3/3)

Events:

AGU Chapman Conference - **Energy Balance Closure Problem**

Boulder (CO), September 15-19, 2025

Workshop - **Advances in Thermal RS for the Management of Agricultural System**

Portici (Italy), May 6-9 2026