WGCV-56

Land Product Validation (LPV) sub-group report

Committee on Earth Observation Satellites

Fabrizio Niro (Serco/ESA)

WGCV-56

USGS-EROS, 20-24 April 2026

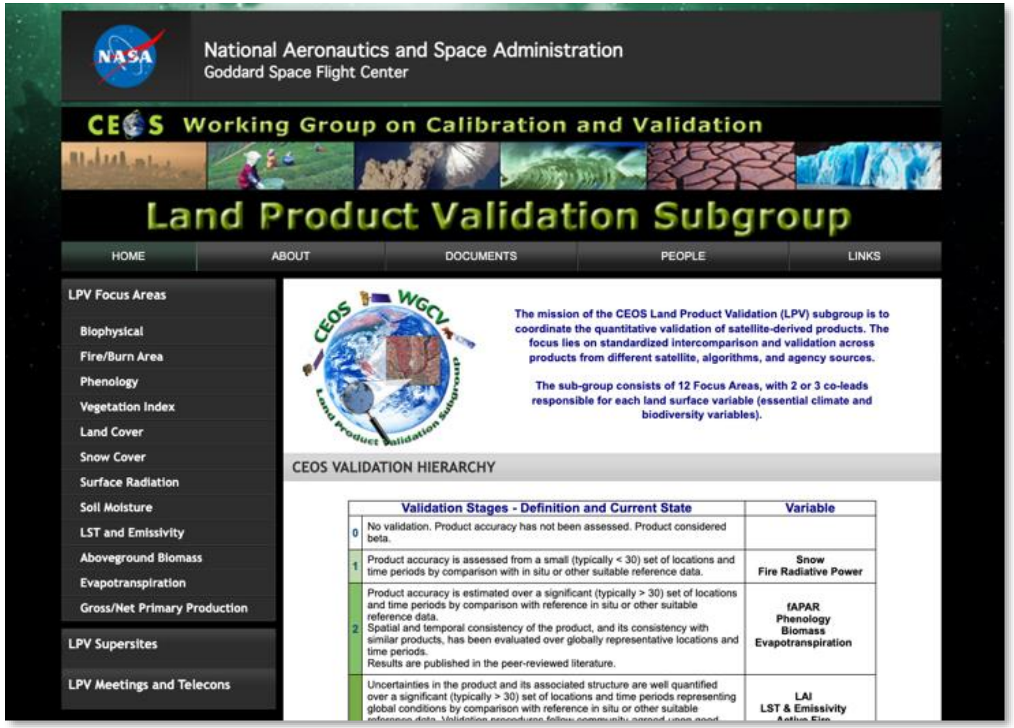
Outline

- Overview
    - Mission and Objectives
    - Validation framework
    - Protocols, datasets and Tools
- LPV Supersites
- FA status report
- Summary and Outlook
- Recent updates on ACIX-IV Land

Mission and Objectives

- ❖ The mission is to **coordinate** the **quantitative validation** of satellite-derived land products
- ❖ The main objective is to **develop standardized validation practices** and a common **validation framework** to enhance **comparability** and interoperability across products
- ❖ The sub-group consists of **12 Focus Areas**, with **2-3 co-leads** responsible for each land variable (ECVs, EBVs, EAVs,)

https://lpvs.gsfc.nasa.gov/



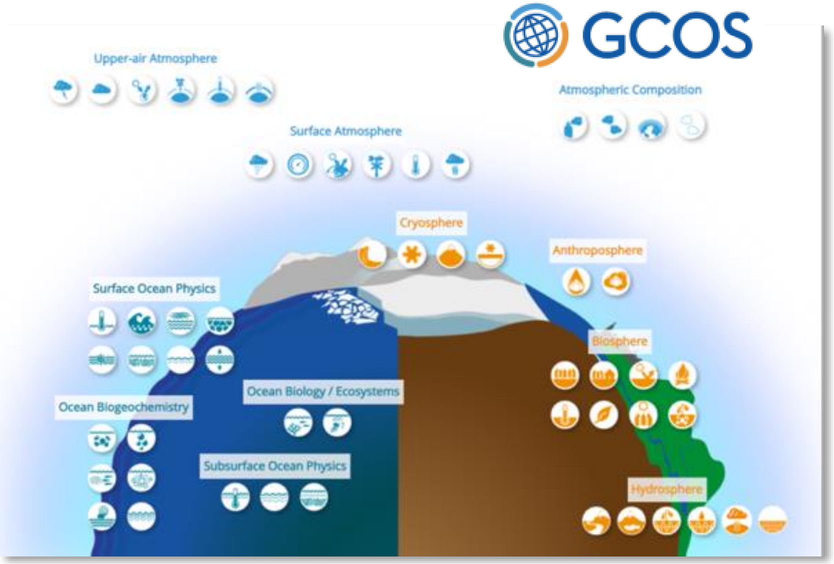
LPV team

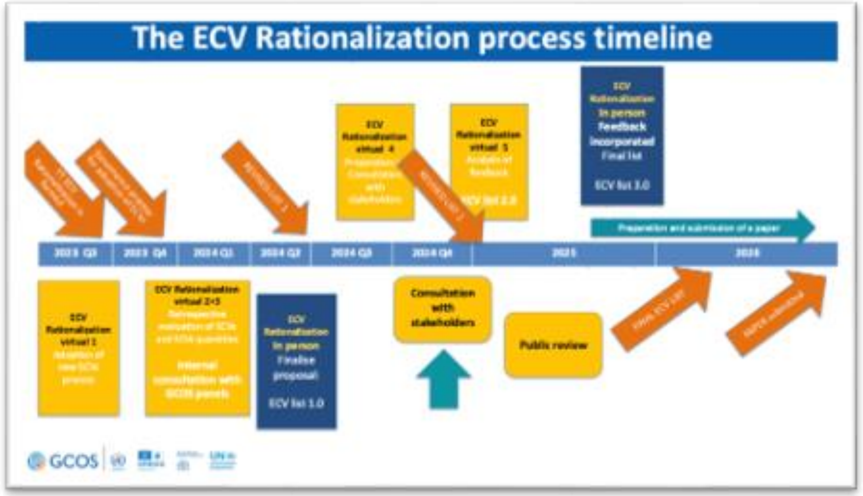
Ex-officio
NEW

	First Name	Last Name	Institution	Country	End of Term
	Fabrizio	Niro	ESA	Italy	Apr 2028
Lead team	Vice-chair				
	Jaime	Nickeson	GSFC	USA	
	Alexandra	Tyukavina	University of Maryland	USA	Mar 2027 (2nd term)
Land Cover	Nandika	Tsendbazar	Wageningen University	Netherlands	April 2027 (1st term)
	Sophie	Bontemps	Université Catholique de Louvain	Belgium	**ex-officio**
	Richard	Fernandes	Natural Resources Canada	Canada	Apr 2027 (one term)
Biophysical	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 Laboratory	UK	Jan 2026 (1st term)
	Zhuosen	Wang	NASA GSFC	USA	**ex-officio**
Surface Rad	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	Technical University Wien (TUW)	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)
	Joshua	Gray	North Carolina State University	USA	Jan 2025 (2nd term)
Phenology	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)
	Tomoaki	Miura	University of Hawaii	USA	**ex-officio**
Veg Index	Simon	Kraatz	USDA	USA	Apr 2027 (1st term)
	Sarah	**Gebruers**	**VITO**	**Belgium**	**Sep 2028 (1st term)**
	Laura	Duncanson	University of Maryland	USA	**ex-officio**
Biomass	**Mikhail**	**Urbazaev**	**GFZ**	**Germany**	**Jan 2029 (1st term)**
	KC	**Cushman**	**ORNL**	**USA**	**Jan 2029 (1st term)**
ET	Yun	Yang	Cornell University	USA	Jan 2027 (1st term)
	Carmelo	Cammalleri	Polytechnic of 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)

User requirements

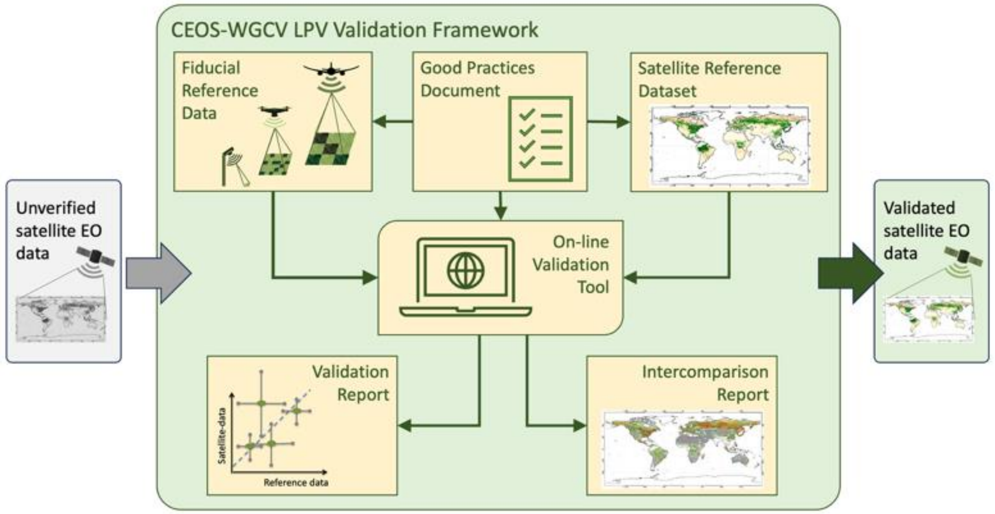
- **GCOS ECVs** requirements for climate applications have been historically the main driver for defining LPV validation framework
- More recently, GEOBON, GEOGLAM started to formulate their needs for **EBVs**, **EAVs**, although their uncertainty requirements are not yet mature
- Collaborations with user groups:
  - Active participation to the public review within the GCOS **ECVs rationalization** process (Jul-Sep 2025)
  - Future cooperation with GCOS is foreseen for defining updated **ECVs uncertainty** requirements (2028)
  - Close cooperation with **GEOGLAM** for crop mapping and LC protocol, now on-going for ET protocol





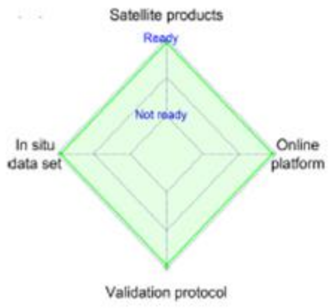
LPV Validation Framework

- Core **elements**:
  - Fiducial Reference Measurements
  - Validation Good Practices Protocol
  - Reference satellite products
  - On-line validation tool
- LPV Validation **stage**
  - **Readiness** of the four core elements essential to reach Stage 4
  - Maturity increases as reference data becomes more **representative** across biomes and ecoclimatic conditions
  - Validation methods and results should undergo rigorous **peer-review**



Niro et al. 2024

	Validation Stages - Definition and Current State	Variable
0	No validation. Product accuracy has not been assessed. Product considered beta.	
1	Product accuracy is assessed from a small (typically < 30) set of locations and time periods by comparison with in situ or other suitable reference data.	Snow Fire Radiative Power
2	Product accuracy is estimated over a significant (typically > 30) set of locations and time periods by comparison with reference in situ or other suitable reference data. Spatial and temporal consistency of the product, and its consistency with similar products, has been evaluated over globally representative locations and time periods. Results are published in the peer-reviewed literature.	fAPAR Phenology Biomass
3	Uncertainties in the product and its associated structure are well quantified over a significant (typically > 30) set of locations and time periods representing global conditions by comparison with reference in situ or other suitable reference data. Validation procedures follow community-agreed-upon good practices. Spatial and temporal consistency of the product, and its consistency with similar products, has been evaluated over globally representative locations and time periods. Results are published in the peer-reviewed literature.	LAI LST & Emissivity Active Fire Burned Area Vegetation Indices
4	Validation results for stage 3 are systematically updated when new product versions are released or as the interannual time series expands. When appropriate for the product, uncertainties in the product are quantified using fiducial reference measurements over a global network of sites and time periods (if available).	Land Cover Albedo Soil Moisture



Bayat et al. 2020

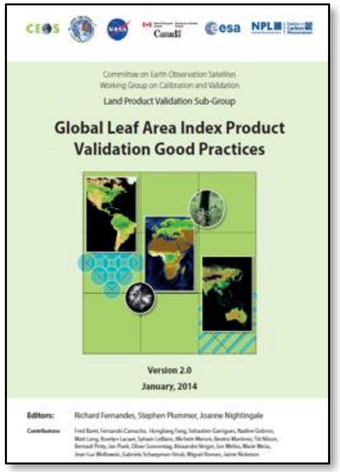
LPV Protocols

- Key outcome of LPV sub-group:
  - **Guidelines** for measurements, comparison to satellite, uncertainty evaluation, metrics
  - **Community-driven** effort, lengthy process
  - Need **regular update** as requirements evolve, new sensors and methods emerge

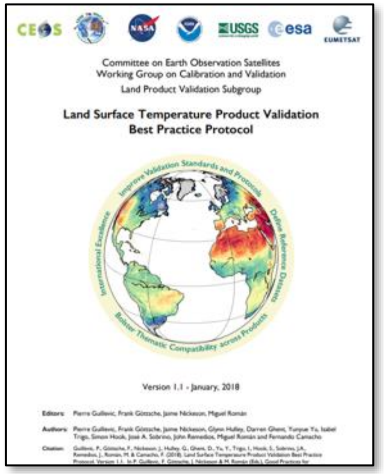
Statistics of **download** from LPV web site demonstrate the strong uptake of the protocols within the community with the most recent LC protocol rapidly becoming one of the most popular

Summary - Annual Downloads

Year	LC	AGB	SM	Alb	LST	LAI*
2016						53
2017					17	58
2018					104	142
2019				126	79	95
2020			102	122	106	134
2021		445	126	90	81	129
2022		188	55	48	52	93
2023		239	77	60	79	104
2024	263	369	88	61	90	110
2025	485	303	82	44	85	130
2026^	135	77	31	11	26	29
Totals	883	1621	561	562	719	1077

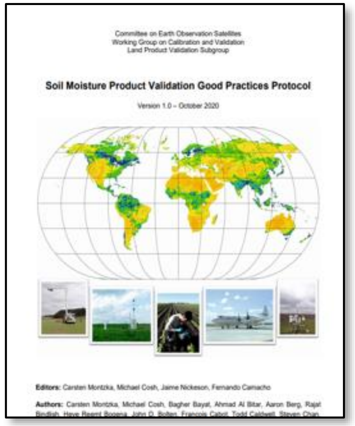


2014 - LAI



2018 - LST

2019 - Albedo



2020 - SM

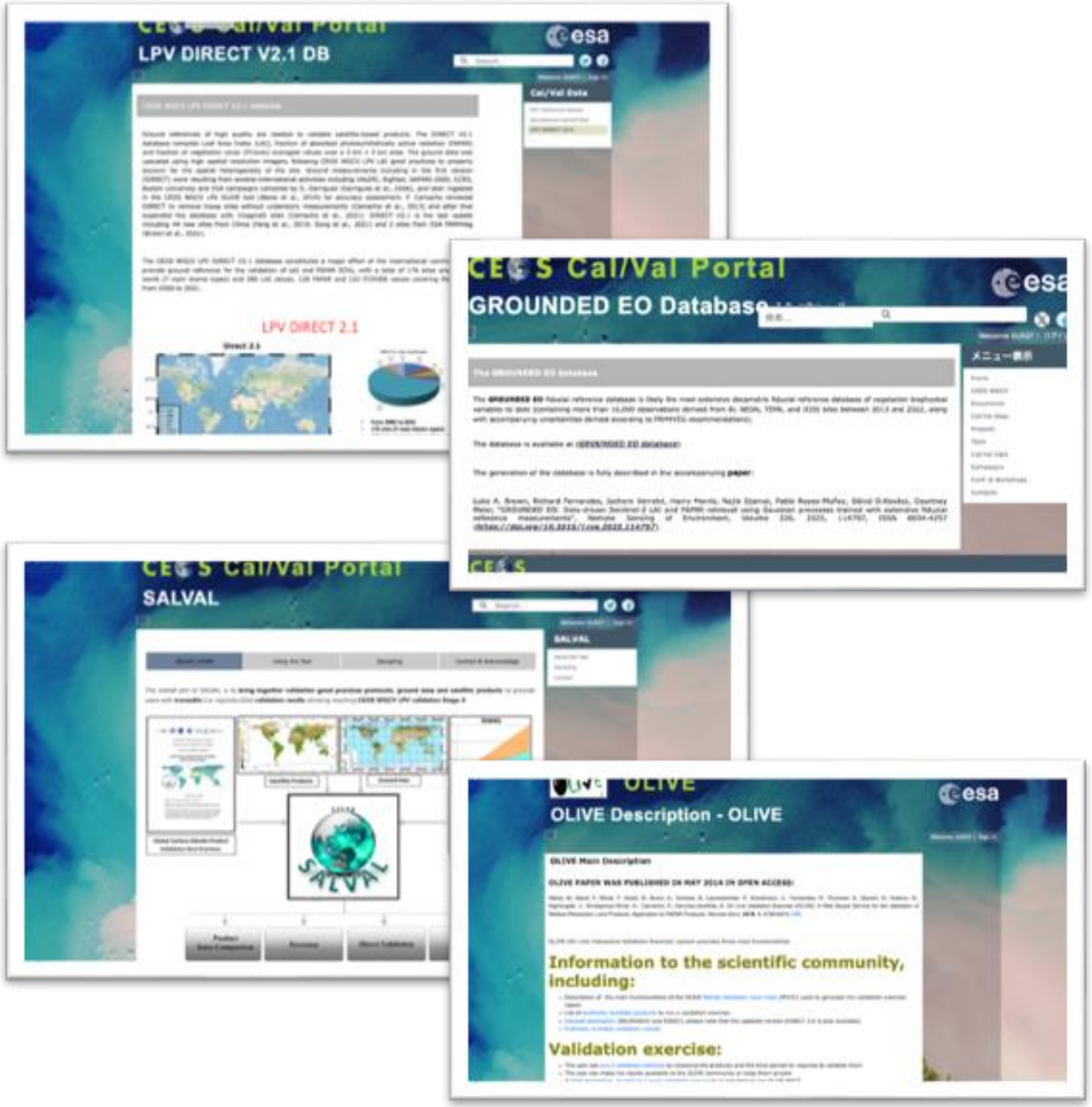
2021 - AGB

2026 - LC

LPV Datasets and Tools

❖ Available in CEOS Cal/Val portal:

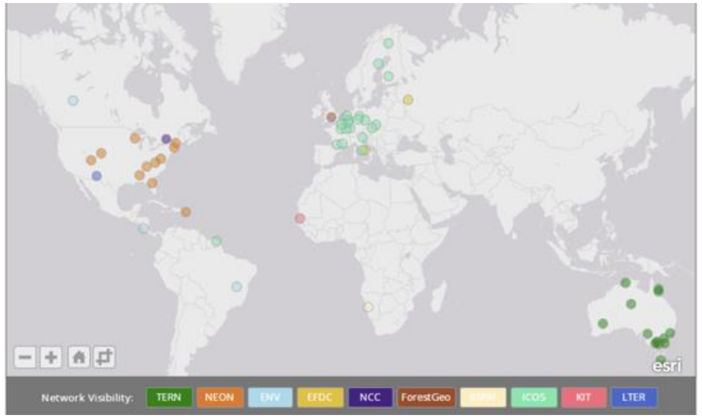
- **LPV Direct 2.1 dataset** for LAI, fAPAR, fCover coarse resolution
- **GROUNDED EO** most extensive decametric resolution dataset for LAI/FAPAR following FRM4VEG
- **SALVAL Tool** for broadband albedo coarse resolution using ground-based data and reference satellite products
- **OLIVE Tool** for LAI/fAPAR outdated (long-standing action) → ESA project to update the tool, starting on April 2026

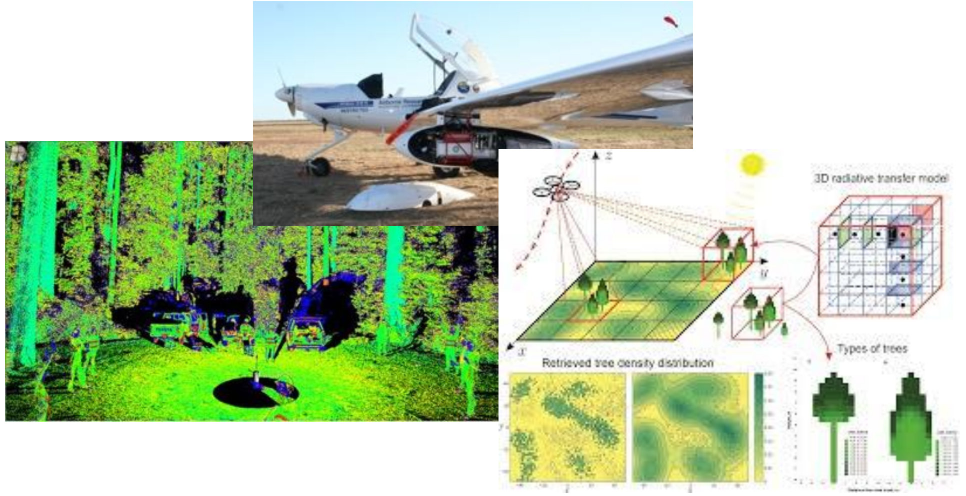


LPV Supersites V1

- **Objective:** evaluate most suitable sites to support satellite land products validation
- First defined in **2016** in response to CEOS action:
  - **Well characterised** site including 3D canopy structure and key land variables → Enabling **RTM-based** validation
  - Useful for validating **3+ ECVs** → Cross ECVs physical **consistency** (GCOS IP 20222)
  - Long term sustained **operations**, part of established networks
  - Follow community-agreed **protocols**
  - Ideally supported by **airborne** acquisitions

GCOS 2022 IP: *"Currently satellite-based products developed separately with different processing streams despite several ECVs being closely inter-related (e.g., albedo, Fire, FAPAR and LAI). Consistency between these products needs to be ensured so that data from multiple sources can be used together."*



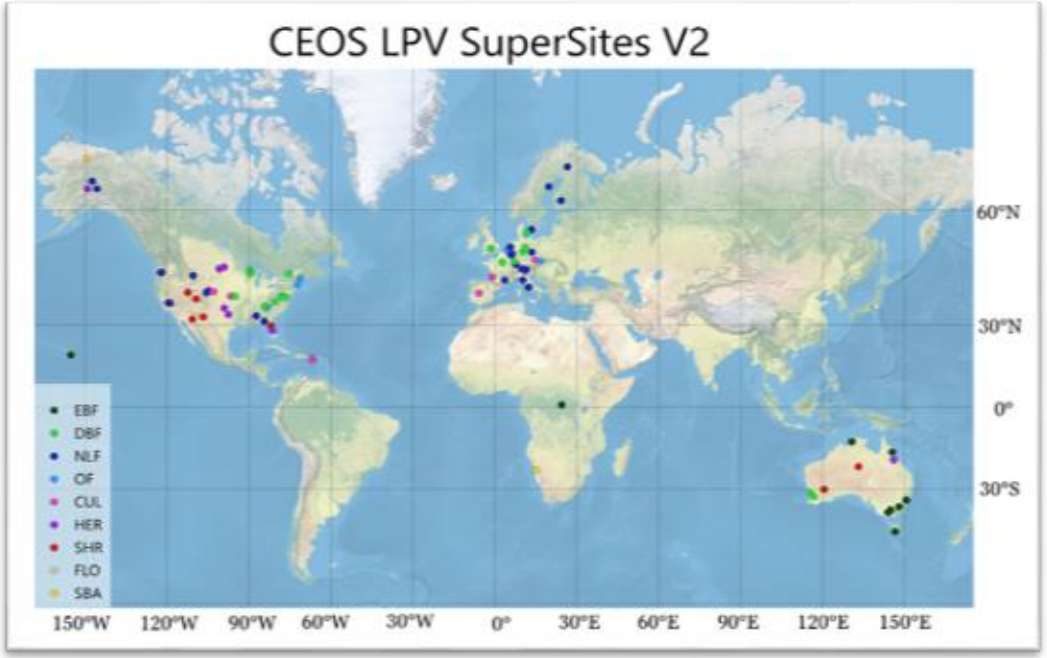


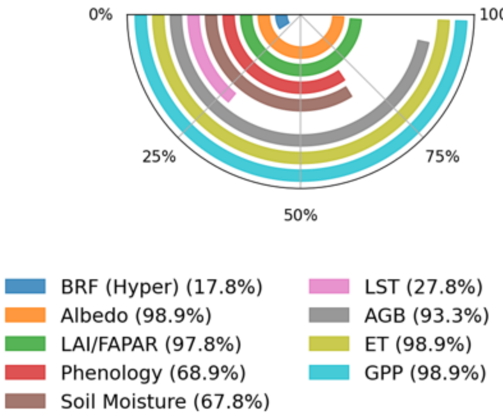
LPV Supersites V2 review

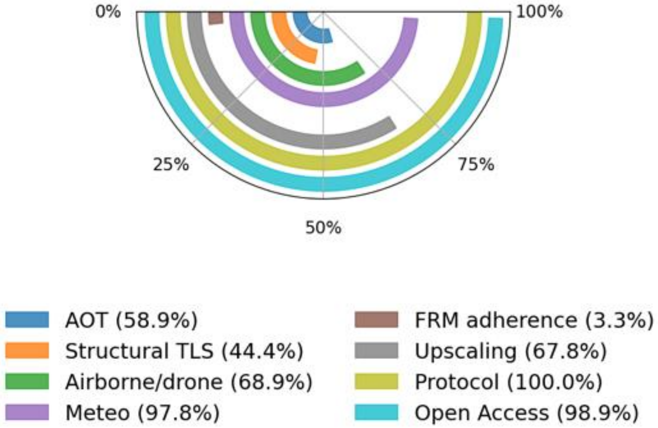
- Since 2016 landscape has **evolved**: new networks, new sites and projects, new variables and missions
- Review **definition**
  - Expand variables: **ET**, **GPP/NPP**, **SIF, BRF (hyp)**
  - For validation of **3+ family** of ECVs (**multi-themes**, e.g., not only FAPAR/LAI/FCover, but also albedo, LST, SM)
  - Airborne + **UAV** Hyperspectral / Lidar (ideal)
  - Adherence (ideal) to **CEOS-FRM** principles
- Review **selection** (220+ candidate)
  - Include **recent** networks /project/sites
  - Refine **ranking:** ancillary data, spatial homogeneity, biomes and geographical relevance

LPV Supersites 2.0

- Status
  - Internal LPV review completed
  - Final version **published** in LPV website
  - **90 sites** + 64 candidate sites
  - **Spreadsheet** + **TN** delivered
  - It should be regularly updated (every 5 years)
- Remaining **gaps**
  - Geographical gaps
  - Some biomes under sampled
  - Limited adherence to FRM
  - LST and Spectrally-resolved BRF







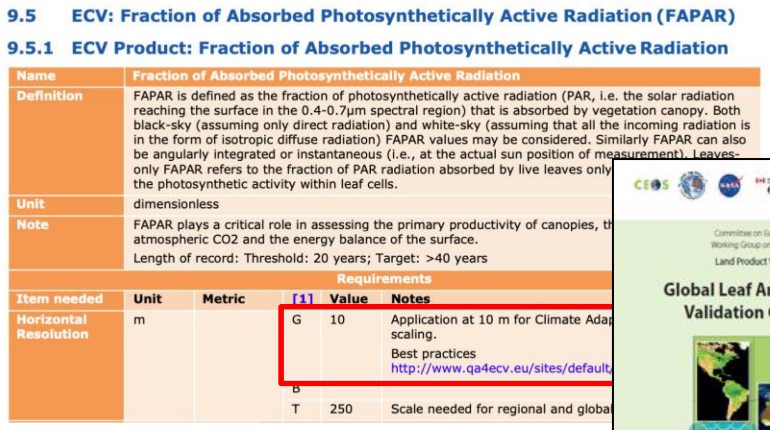
FA status report

Biophysical	Fires	Phenology	Vegetation Index
Land Cover	Snow	Surface Radiation	Soil Moisture
LST / LSE	Biomass	Evapotranspiration	GPP/NPP

- Protocol Ready
- Update on going
- Draft ready
- Draft on going

Biophysical

- LAI 2014 protocol revision
  - Add new variable: **FCover**, **FAPAR**
  - More stringent **GCOS** 2022 requirements (FAPAR **Res G=10m**, U G=5%) for climate adaptation
  - Better align to **CEOS-FRM** principles
  - Recent technological **advances** (e.g., UAV, automated)
  - **Draft paper** sent to co-authors, 15+ comments
  - Submission in Q2 2026 to new **EGU EO Journal**
- Better use of **ICOS** for Cal/Val (NUBICOS EU)
  - Long-standing **action** within LPV
  - Align **protocol** to FRM4VEG and LPV (e.g., understory)
  - Progressively updating across **all ICOS sites**

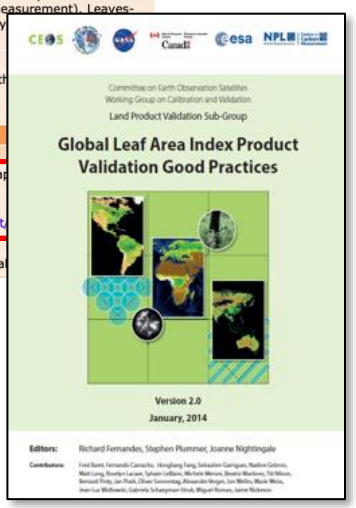

9.5 ECV: Fraction of Absorbed Photosynthetically Active Radiation (FAPAR)

9.5.1 ECV Product: Fraction of Absorbed Photosynthetically Active Radiation

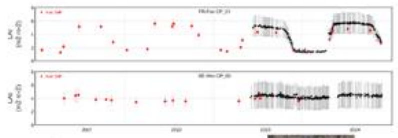
Name	Fraction of Absorbed Photosynthetically Active Radiation
Definition	FAPAR is defined as the fraction of photosynthetically active radiation (PAR, i.e. the solar radiation reaching the surface in the 0.4-0.7µm spectral region) that is absorbed by vegetation canopy. Both black-sky (assuming only direct radiation) and white-sky (assuming that all the incoming radiation is in the form of isotropic diffuse radiation) FAPAR values may be considered. Similarly FAPAR can also be angularly integrated or instantaneous (i.e., at the actual sun position of measurement). Leaves-only FAPAR refers to the fraction of PAR radiation absorbed by live leaves only the photosynthetic activity within leaf cells.
Unit	dimensionless
Note	FAPAR plays a critical role in assessing the primary productivity of canopies, th atmospheric CO2 and the energy balance of the surface. Length of record: Threshold: 20 years; Target: >40 years

Item needed	Unit	Metric	[1]	Value	Notes
Horizontal Resolution	m		G	10	Application at 10 m for Climate Adap scaling. Best practices http://www.qa4ecv.eu/sites/default/
			B		
			T	250	Scale needed for regional and global

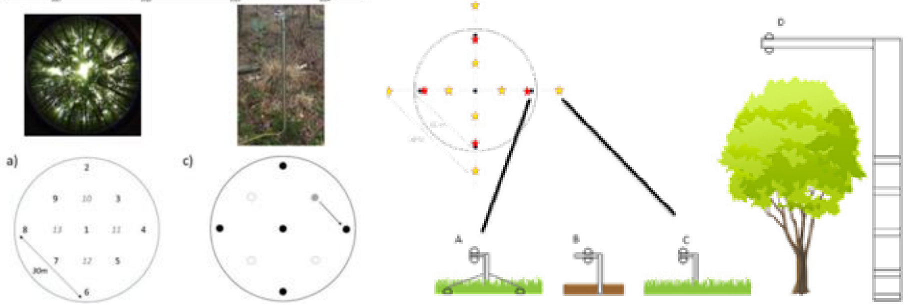
GCOS



fiducial reference measurements for vegetation



ICOS | NUBICOS



Fires

- **Burned Area (BA)**
  - Updated **GCOS** requirements (Goal=10 m)
  - Consolidated **draft** UMD and NPL lead authors
  - Still some **disagreement** within the community regarding required sample sizes, metrics
- **Fire Radiative Power (FRP)**
  - Still at **validation stage 1**
  - **Scarcity** of campaign data remain the main constraint
  - **FRM4Fires** aiming at enhancing maturity by developing FRP traceability / uncertainty tree
  - Recent use of triple collocation to assess FRP (MODIS, VIIRS, SLSTR) consistency

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4	Validation results for stage 3 are systematically updated when new product versions are released or as the interannual time series expands. When appropriate for the product, uncertainties in the product are quantified using fiducial reference measurements over a global network of sites and time periods (if available).	Land Cover Albedo Soil Moisture

UNIVERSITY OF MARYLAND NPL National Physical Laboratory

DRAFT

Committee on Earth Observation Satellites

Working Group on Calibration and Validation
Land Product Validation Subgroup

Satellite-Derived Global Burned Area Product Validation Best Practices Protocol

Version 10.1 – June 2025

Editors: *

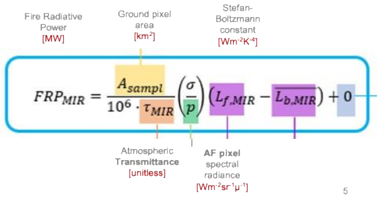
Authors: B. Mota, L. Giglio, L. Boschetti, D. P. Roy, S. V. Stehman, J. V. Hall, M. Humber, K. Vadrevu, M. Padilla, M. Zubkova.

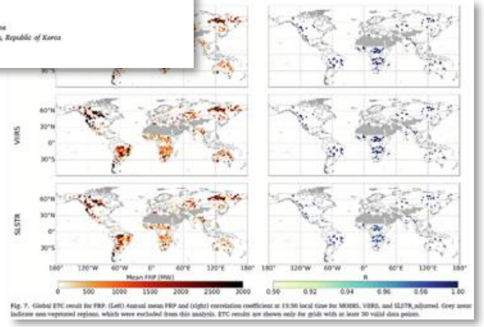
Citation: *, 2024, Satellite-Derived Global Burned Area Product Validation Best Practices Protocol

Contents lists available at ScienceDirect
Remote Sensing of Environment
journal homepage: www.elsevier.com/locate/rse
ELSEVIER

Comprehensive global fire radiative power evaluation by minimizing detection bias with intercomparison and extended triple collocation analysis

Yoojin Kang[a], Jaese Lee[b], Jungho Im[c,d,e,*]





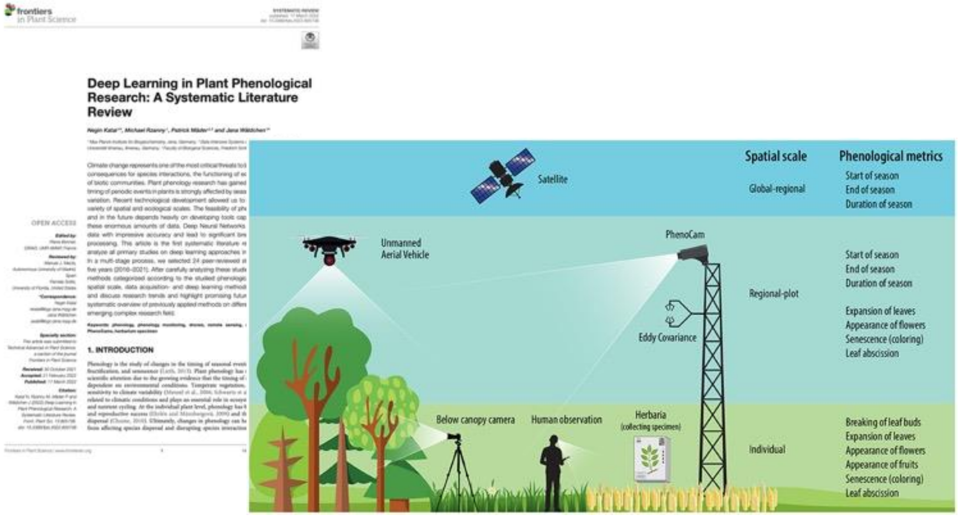
Phenology and VI

❖ Land surface phenology (LSP)

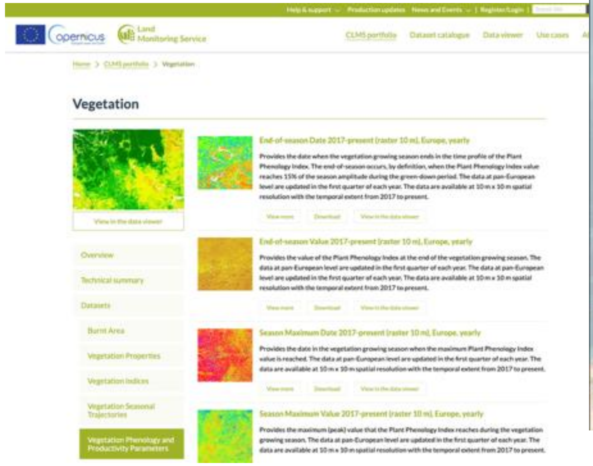
- **Consolidated draft** ready under review
- Focus on **HR**, Copernicus HR-VPP (10m)
- Large **variety** of Cal/Val sources and different spatiotemporal scale sampled
- Emerging use of **UAV**: review paper being prepared
- Systematic use of Ground-based networks (PhenoCam, Flux Towers)

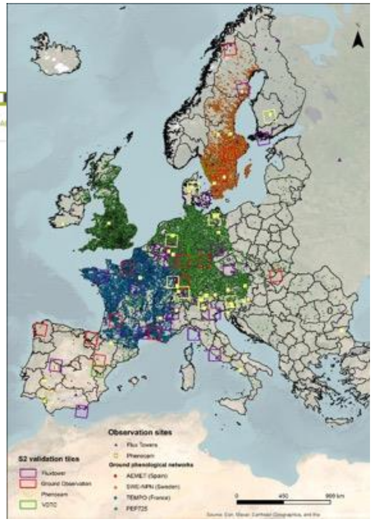
❖ Vegetation Indices

- Q2 2026: release of **consolidated draft V2** to the community for collecting feedback



Katal et al. 2022





Land Cover

- **Status and Challenge**
  - Ever **increasing** number of HR (10m) maps
  - Large **discrepancies** in quality assessment methods still hampers the comparability across products
- **LC Protocol**
  - Updating Straheler et al. 2006 guidelines
  - **V1.1** published in **Nov 2025** (WGCV comments)
  - Strong **community** effort
  - **35 co-authors**, 18 Institutions/agencies
  - **~200** pages, **300+** references
  - **GCOS** and **GEOGLAM** requirements considered
  - Recently presented at **CEOS SIT**


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

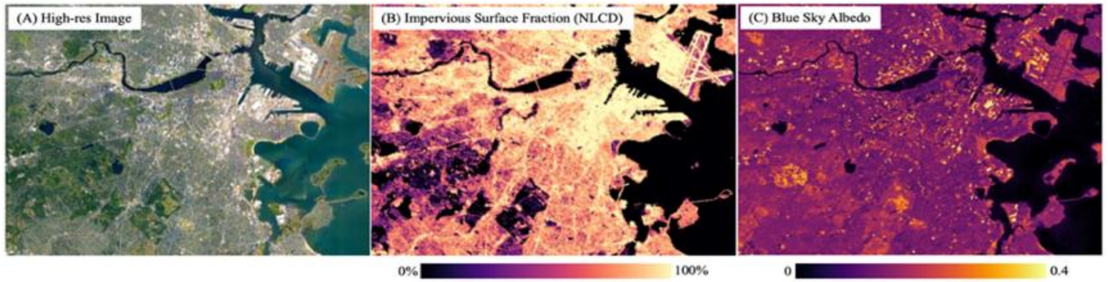
Version 1.1 - 2025

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)

Surface Radiation

- Status and Challenges
  - Emerging focus on **HR (G=10m)** products for urban monitoring (GCOS 2022)
  - Requirement for **spectral** + broadband **DHR** and **BHR** + **BRDF** parameters
  - Need to improve accuracy of albedo over **ice/snowy** surfaces (GCOS 2022 IP)
- Status within LPV
  - Existing protocol (**2019**) and tool (SALVAL) focus on **coarse** resolution and broadband
  - Need to update to move to HR and include **BRDF** parameters and **spectral albedo**
  - Plan to have an initial draft in 2027



GCOS 2022 IP: "There is a need to improve the accuracy and consistency of observations of albedo for ice and snowy surfaces across domains (terrestrial snow, land ice, ..)"

GCOS

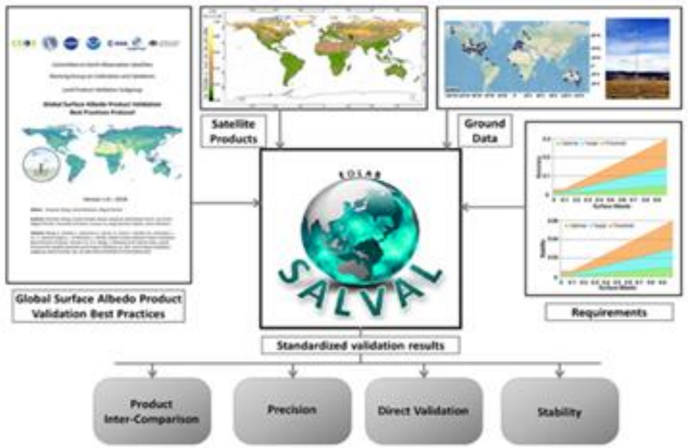
9.2 ECV: Albedo

9.2.1 ECV Product: Spectral and Broadband (Visible, Near Infrared and Shortwave) DHR & BHR[6] with Associated Spectral Bidirectional Reflectance Distribution Function (BRDF) Parameters

Name	**Spectral and Broadband (visible, near infrared and shortwave) DHR & BHR with Associated Spectral Bidirectional Reflectance Distribution Function (BRDF) parameters (required to derive albedo from reflectance)**
Definition	The land surface albedo is the ratio of the radiant flux reflected from Earth's surface to the incident flux. Each spectral/broadband value depends on natural variations and is highly variable in space and time as a result of terrestrial properties changes, and with illumination conditions.
Unit	Dimensionless
Note	Length of record: Threshold: 20 years; Target: > 40 years

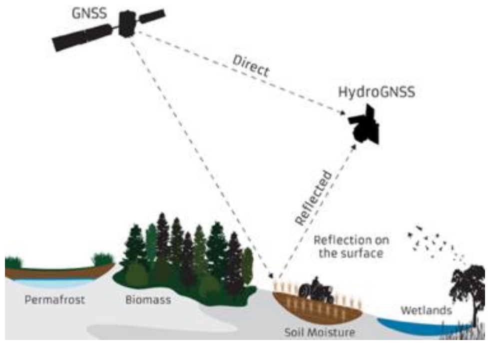
Requirements					
Item needed	**Unit**	**Metric**	[1]	**Value**	**Notes**
Horizontal Resolution	m		G	10	Due to the hete having surface for further assi
			B		
			T	250	Enable assimila
Vertical Resolution			G	-	N/A
			B	-	
			T	-	
Temporal Resolution	day		G	1	For climate cha (including geos data for BRDF
			B		
			T	10	For assimilation Same as above
Timeliness	day		G	1	For climate cha
			B		
			T	5	For NRT reanal

https://eolab.es/salval/

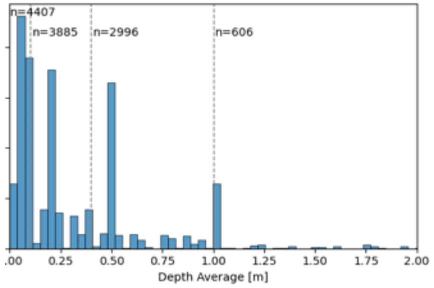


Soil Moisture

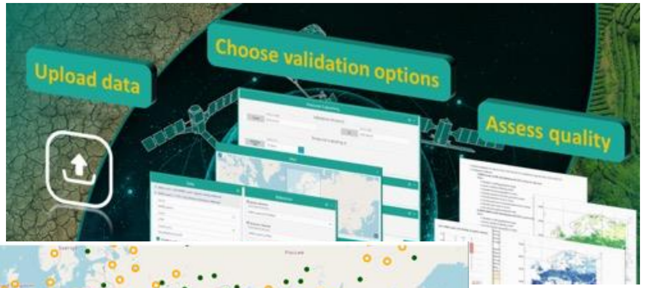
- Evolving requirements
  - Moving towards **HR** products (<1km)
  - Need **below-ground SM**
  - New technology (**GNSS**), missions, e.g., CIMR
- Need to update 2020 LPV protocol:
  - Maintain / improve **ISMN** + **QA4SM**
  - **Higher spatial resolution** and support to root zone soil moisture (**RZSM**) validation
  - Assess adherence to **CEOS-FRM → FRM assessment of ISMN** on-going
  - Aiming at first consolidated draft in Q2 2026, final update in 2027



https://ismn.earth/en/



ISMN measuring depths



https://qa4sm.eu/

LST / LSE

- Contribute to TIRCalNet
  - Intercomparison of 3 radiometers (JPL, KIT15, CIMEL) at **La Crau**
  - Since Nov 2024, long-term intercomparison between JPL and KT15 at **Lake Constance**
- Field campaign
  - Planned in **Oct 2026** in **Gobabeb**
  - Long-term dataset acquired by KIT including in-situ emissivity spectra
  - Plan to deploy two radiometers
  - Evaluate different **RTM simulations** at **TOA** to characterise uncertainties







Biomass

- **GEO-TREES** a Global Forest Biomass Reference System
  - Stems from **LPV AGB protocol** recommendations
  - 100 **core** sites (60 Tropical, 40 Temperate)
  - **Open data** policy, long-term commitment
- Updates
  - TLS field **campaign** in Ghana (Jan-Feb 2026) to support **ESA-BIOMASS** validation
  - **GEO-TREES WS** in Panama (March 2026), the new LPV FA leads present, maintaining **LPV-GEO-TREES link**
  - Integrate and **harmonize** the inventory, TLS, and ALS processing pipelines


Committee on Earth Observation Satellites

CEOS Working Group on Calibration and Validation Land Product Validation Subgroup

Aboveground Woody Biomass Product Validation Good Practices Protocol

Version 1.0 – 2021

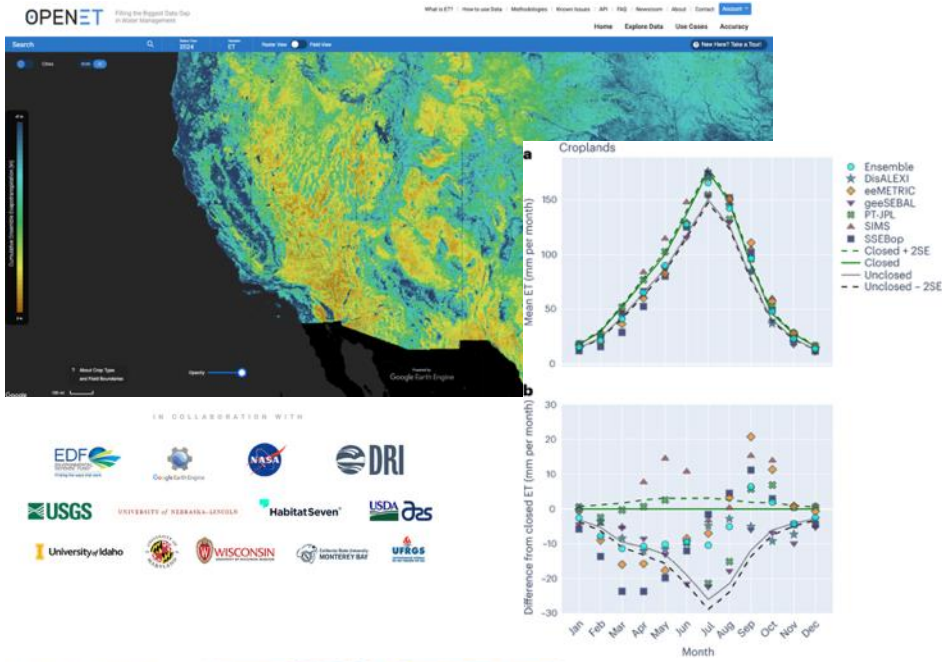
Hundreds of sites are therefore desirable, but in practice, we have to start from the current situation with sites that already meet or come close to meeting our criteria. There are currently about 170 of these. This suggests that at least 100 'high-intensity' BRM sites (following protocol recommendations including field, TLS and airborne lidar collection) are an achievable target to implement the core of the proposed long-term Forest Biomass Reference System.

It is therefore recommended to include 210 additional, distributed BRM sites within the proposed Forest Biomass Reference System. This will allow for optimal filling of large gaps between tropical BRMs, and achieve an overall tripling of the tropical site sampling intensity

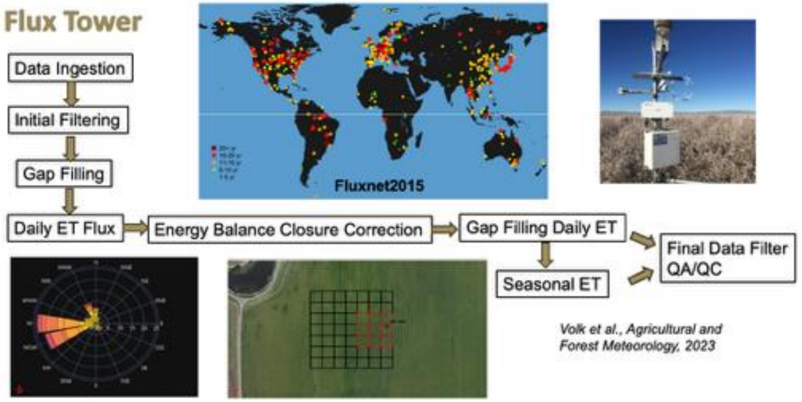
https://geo-trees.org/

Evapotranspiration

https://etdata.org/

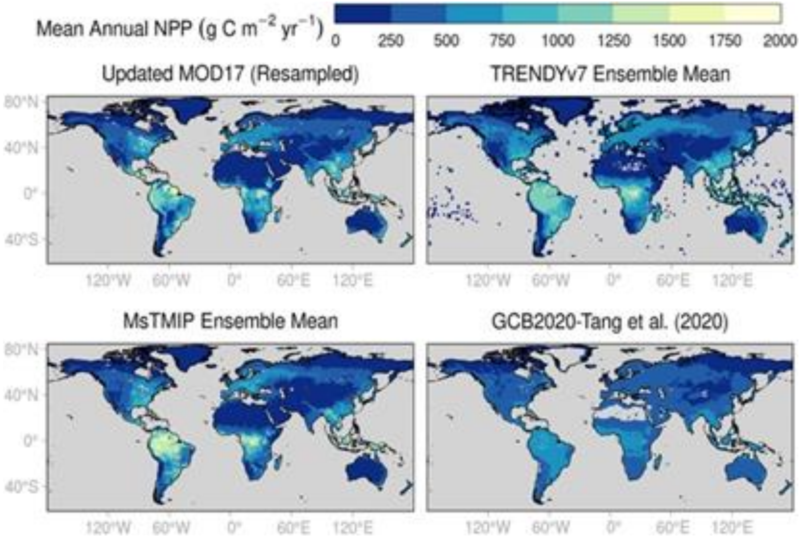


- ❖ Status and challenges (**New FA**)
  - Strong relevance for land **applications**: agriculture, water management, …
  - Growing number of **ET products**, also driven by upcoming HR TIR missions (TRISHNA, LSTM)
  - **Discrepancies** between models / validation methods
- ❖ Urgent need for community protocol
  - First draft of outline LPV protocol being prepared
  - **LPV-GEOGLAM WS** (22-24 Jun 2026, **FAO**), draft protocol will be presented / discussed
  - Consolidated **agenda** for the WS agreed



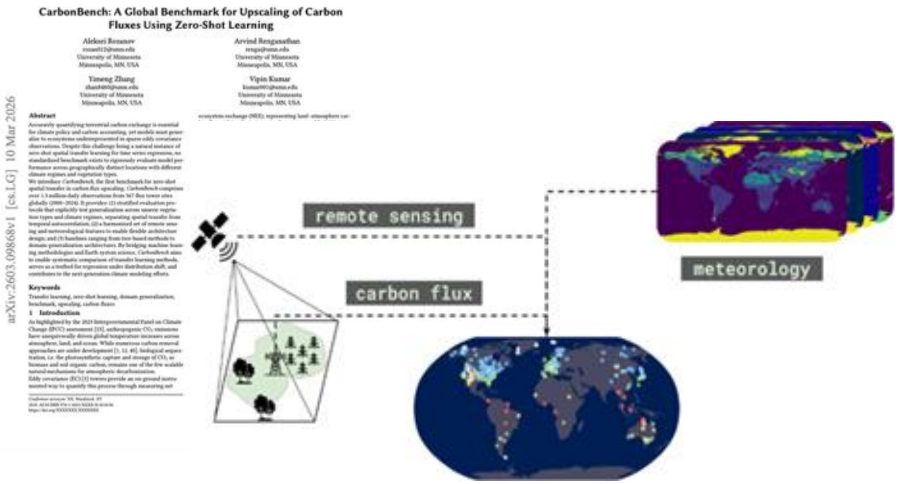
GPP / NPP

- Status and challenges
  - GPP recently proposed as **new ECV** quantity in the "Vegetation properties and productivity" group
  - Growing **interest** and **availability** of GPP/NPP global satellite products, e.g., MODIS, VIIRS, Copernicus
  - Large Variety of models and input data, persistent **inconsistencies** across products / validation methods



Endsley et al. (*JGR: Biogeosciences*)

- Recent updates: **CarbonBench**
  - **Benchmark** exercise to systematically evaluate models that estimate GPP at global scale.
  - It compiles a large dataset from **FLUXNET** sites (567 sites, 2020-2024) allowing to test models' ability to generalize to ecosystems and regions



Summary and Outlook

- Working along the lines of the LPV 2026-29 Action Plan
  - Develop and evolve validation practices and tools → LAI, FAPAR, albedo, SM, BA, LSP
  - Enhance representativeness and coverage of reference data → LPV Supersites V2
  - Strengthen collaboration with user community → GCOS, GEOGLAM, GEO-TREES
  - Reinforce focus on CEOS-FRM → FRM embedded in upcoming protocols: FAPAR, SM, FRP
  - Enhance awareness and communication → LC protocol at CEOS-SIT, LPV web site
- Outlook
  - Work towards filling long-standing gaps: OLIVE, ICOS for Cal/Val
  - Further strengthen collaboration with GEOGLAM for ET protocol (WS in June)
  - Cooperate with GCOS in the definition of uncertainty requirements for new ECVs
  - Enhance readiness for upcoming missions (hyperspectral, HR TIR)

Recent updates on ACIX-III and ACIX-IV Land

Committee on
Earth Observation Satellites

ACIX framework

- **Goal →** Understand strengths/limitations and enhance harmonisation of AC algorithms
- Generic "**X**" approach
  - Engage the **community**
  - Agree on **protocol,** references and **metrics**
  - Run the **inter-comparison** exercise
  - **Review/discuss** the results
  - **Publish** the paper
- ACIX Started in 2016, 10 years coordinated by ESA-NASA under CEOS-WGCV auspices, initial focus on L8/S2 → **4 highly cited papers**
- Since ACIX-II, 3 groups focusing on **Land, Water** and Cloud Mask (**CMIX**)

ACIX-III Land and Aqua

❖ Status

- Focus on **hyperspectral**: EnMAP, PRISMA in preparation to **CHIME**
- Validation of **AOD** and TCWV over a set of AERONET sites
- Validation of **SR** using data from **networks** (RadCalNet, HYPERNETS, AERONET-OC) and field **campaigns** for CHIME/SBG
- Use similar methods and metrics (**APU**) as in previous ACIX
- **2 papers** published in 2025

	ACIX-III Land	ACIX-III Aqua
# processor	7	7
EO data	PRISMA, EnMAP	PRISMA
Reference	RadCalNet, HYPERNETS, ad-hoc campaigns, AERONET	AERONET-OC, HYPERNETS, ad-hoc campaigns

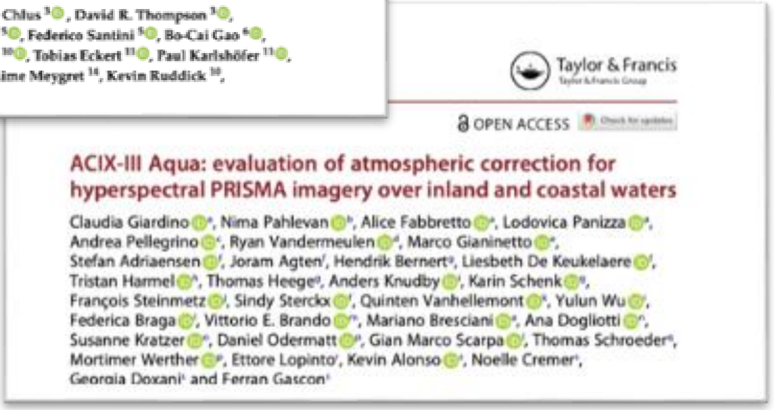
remote sensing MDPI

Article

Atmospheric Correction Inter-Comparison eXercise, ACIX-III Land: An Assessment of Atmospheric Correction Processors for EnMAP and PRISMA over Land

Noelle Cremer[1,*], Kevin Alonso[2], Georgia Doxani[1], Adam Chlus[3], David R. Thompson[3], Philip Brodrick[3], Philip A. Townsend[3,4], Angelo Palombo[5], Federico Santini[5], Bo-Cai Gao[6], Feng Yin[7,8], Jorge Vicent Servera[9], Quinten Vanhellemont[10], Tobias Eckert[11], Paul Karlshöfer[11], Raquel de los Reyes[11], Weile Wang[12], Maximilian Brell[13], Aime Meygret[14], Kevin Ruddick[10], Agnieszka Bialek[15], Pieter De Vis[15] and Ferran Gascon[2]

Cremer et al. 2025



Taylor & Francis

OPEN ACCESS

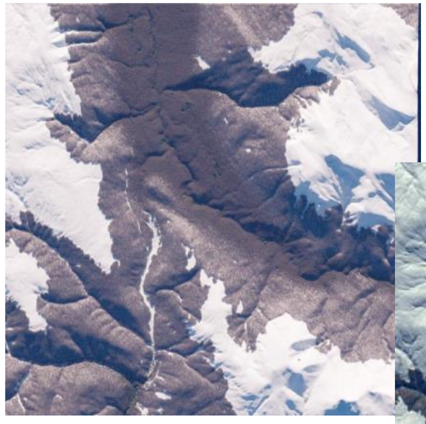
ACIX-III Aqua: evaluation of atmospheric correction for hyperspectral PRISMA imagery over inland and coastal waters

Claudia Giardino, Nima Pahlevan, Alice Fabbretto, Lodovica Panizza, Andrea Pellegrino, Ryan Vandermeulen, Marco Gianinetto, Stefan Adriaensen, Joram Agten, Hendrik Bernert, Liesbeth De Keukelaere, Tristan Harmel, Thomas Heege, Anders Knudby, Karin Schenk, François Steinmetz, Sindy Sterckx, Quinten Vanhellemont, Yulun Wu, Federica Braga, Vittorio E. Brando, Mariano Bresciani, Ana Dogliotti, Susanne Kratzer, Daniel Odermatt, Gian Marco Scarpa, Thomas Schroeder, Mortimer Werther, Ettore Lopinto, Kevin Alonso, Noelle Cremer, Georgia Doxani and Ferran Gascon

Gilardino et al. 2025

ACIX-IV Land

- ACIX-III shows strong impact of spatial **heterogeneity** and adjacency effects for field campaign data
- Reliable results mostly obtained over **RadCalNet** and HYPERNETS Gobabeb bright and homogeneous sites
- ACIX-IV will use data from networks, HYPERNETS, complemented with **RTM simulations** to better characterize uncertainty sources



Simulated MSI RGB image

Simulated CHIME RGB image

Image credit: Rayference

ACIX-IV Land Proposal

- Simulated realistic TOA scenes (S2, CHIME) over different land cover types, seasons (summer/winter) and atmospheric conditions (atmospheric vertical profile, aerosol properties) based on the ESA-**Rayference** Digital Twin Earth Synthetic Scene Generator (**DTE-S2GOS**) project
- Simulations of satellite (L8, S2) SR using the **6SV** RTM based on aerosol ground measurements.

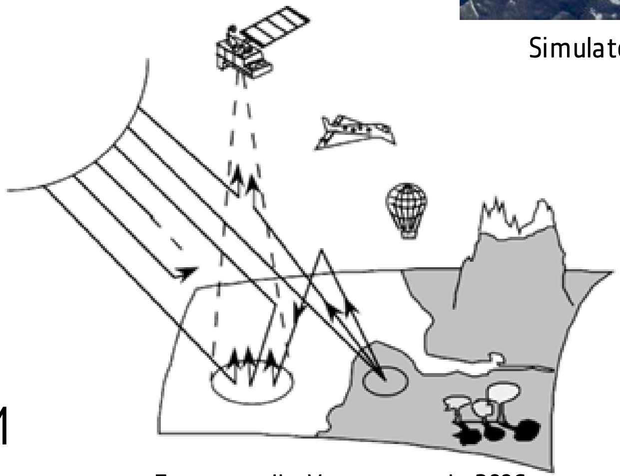
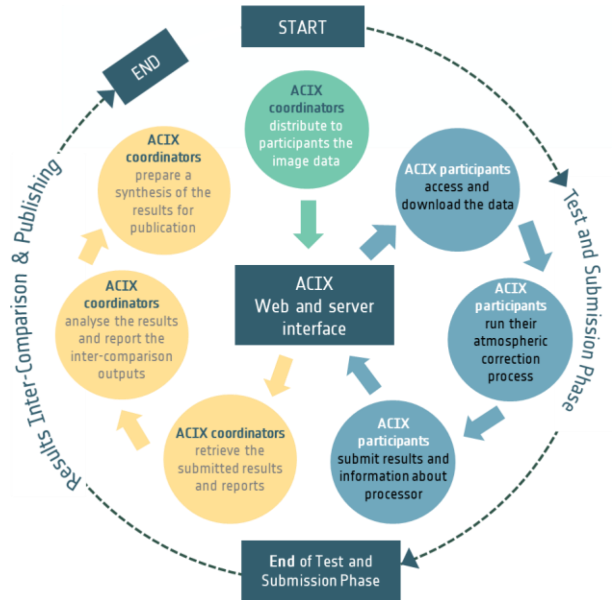


Image credit: Vermote et al., 2006

ACIX-IV Land

How

The approach would be to maintain it under CEOS-WGCV auspices as in previous ACIX



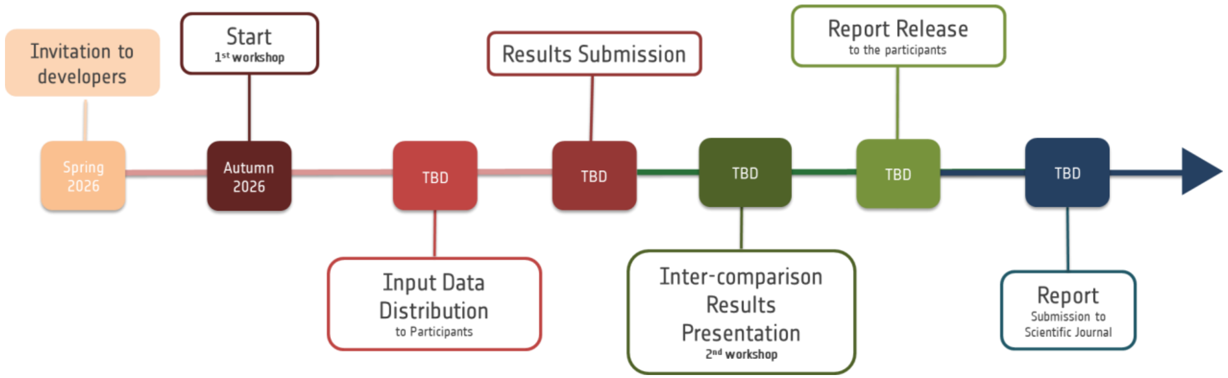
Who

Developer Teams from various Space Agencies, R&D Companies, Research Institutes and Universities (tentative list)

Processor/Model	Organisation/Affiliation	Processor/Model	Organisation/Affiliation
PACO	DLR	CHRIS/PROBA	University Valencia/Brockmann
HYPER SIAC	University College London	COCHISE	ONERA
MAGAC	MAGELLIUM	SIERRA	ONERA
GeoNEX-AC	NASA Ames Research Center	ICARE	ONERA
ACOLITE DSF	RBINS	HATCH	University of Colorado
ImaACor	CNR IMAA	FLAASH	Air Force Research Laboratory, Hanscom AFB and Spectral Sciences, Inc.
ATREM	Naval Research Lab, Washington DC USA	ACORN	Spectral Information Technology Applications Ctr.
ATCOR	ReSe Applications		
iCOR	VITO Remote Sensing	HISUI	METI
IsoFIT	NASA JPL	QUAC	Spectral Sciences
PRISMA	ASI	ISDAS	Canada Center for Remote Sensing

When

1st WS in Autumn 2026



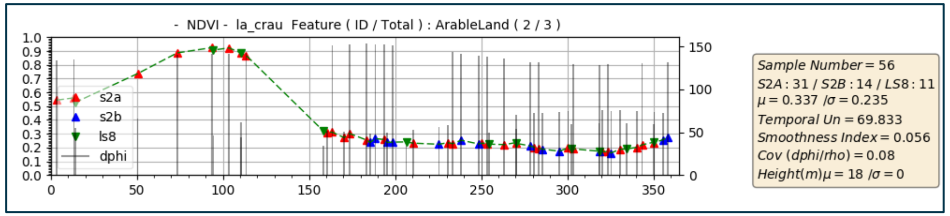
HARMONIX

- New international initiative being defined on intercomparing different approaches for BRDF normalization and data fusion for S2/L8-9, such as:
  - HLS (NASA)
  - Sen2Like (ESA)
  - NN-based data fusion (CNES)
  - … Open call for others
- Initial definition of a comparison protocol and associated quality metrics being explored, e.g., TSI

$$TSI = \sqrt{\frac{\sum_{i=1}^{n-2}\left(y_{i+1} - \frac{(y_{i+2} - y_i)}{day_{i+2} - day_i} * (day_{i+1} - day_i) - y_i\right)^2}{N-2}}$$

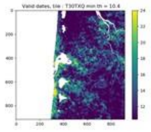
Where:

- y_i is the reflectance measurement at day_i i
- N is the total number of observations during the period.

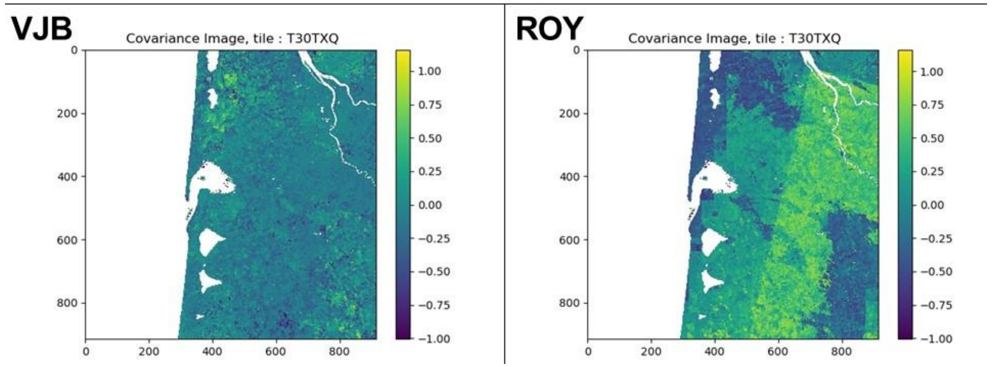


NBAR Processing & Temporal Smoothness Index (TSI)

Generally, TSI residual errors correlated with Observation Geometry (DPHI, VZA – VAA) & Land Cover surface.
NBAR ROY Processing partially correct this dependency (right), situation is better with NBAR VJB processing.



Covariance Image: Covariance between DPHI, TSI Res Variable over temporal period – Here Band 8A



Thanks !

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