Land Product Validation (LPV)
Sub-group Meeting

Michael Cosh – (USDA) –Chair

Fabrizio Niro – (ESA/ESRIN) – Vice Chair

Subgroup meeting
10 Sep 2024

NEXT LPV TELECON NOV 5, 2024 ???

	First Name	Last Name	Institution	Institution	End of Term
Admin	Michael	Cosh	USDA	USA	Apr 2025
	Fabrizio	Niro	ESA	Italy	Apr 2025 (promotion to Chair)
	Jaime	Nickeson	GSFC	USA	
Land Cover	Alexandra	Tyukavina	University of Maryland	USA	March 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 (last term)
	Hao	Tang	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	UMass Boston	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)
	Alex	Gruber	TU Wien	Austria	Sept 2026 (1st term)
LST	Glynn	Hulley	NASA/JPL	USA	July 2024 (2nd 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)
Snow Cover	Carrie	Vuyovich	NASA GSFC	USA	Jan 2026 (1st term)
	Juha	Lemmetyinen	FMI	Finland	Sept 2026 (1st term)
Veg Index	Simon	Kraatz	USDA	USA	Apr 2027 1st term
	Tomoaki	Miura	University of Hawai'i	USA	Ex-officio
Biomass	Laura	Duncanson	UMD/GSFC	USA	ex-officio
	Kim	Calders	Ghent University	Belgium	Feb 2026 (1st term)
	Neha	Hunka	UMD	USA	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)
	TBD				

WORKING GROUP ON CALIBRATION & VALIDATION

WCGV and LPV Plenary

Upcoming WGCV Plenary

- *WGCV-54, Oct 15-18, 2024   USGS, Sioux Falls, South Dakota*

Upcoming LPV Meeting

- American Geophysical Union Fall Meeting, Washington, DC   ½ day in person meeting
- Living Planet Symposium, Vienna, Austria, June 23-27, 2025

Other sessions

- American Geophysical Union Session, 25 abstracts
- European Geophyscial Union Session...

Past LPV Plenary Meetings

- March 2018, ESA LPVE, Frascati, Italy
- April 2019, ESA LPS, Milan Italy
- May 2021, Virtual
- Sep 2022 Virtual
- June 2023, ESA Frascati

Protocols Status – Updates or Still on Track?

Focus Area	Protocol
Biophysical	LAI(2014)
Fire/Burn Area	Burned Area Targeting 2024 Active Fire next
Phenology	Targeting 2024 (?%)
Vegetation Index	Targeting 2024 (60%)
Land Cover	Targeting 2024 (95%)
Snow Cover	
Surface Radiation	Albedo(2019) Global Downward Radiation Product Validation Best Practices (80%)
Soil Moisture	SM(2020)
LST and Emissivity	LST (2019)
Aboveground Biomass	AGWB(2021)
Evapotranspiration	
GPP/NPP	

WORKING GROUP ON CALIBRATION & VALIDATION

CEOS

FA Web Status

The Home and Collaboration pages have been placed in your GoogleDoc folders to markup for any updates.

Will focus on Biophysical, Veg Index, and Phenology to get them out of the red.

Updates can be made at any time, just edit your GD files w track changes (suggestions).

Focus Area	Home Page	Product table	Collaboration Page	References	Listserv	Letters to Community
Land Cover	May 2024	Dec 2023	May 2024	May 2024	Sep 2024	Oct 2022
Biophysical LAI/Fpar	Nov 2021	Nov 2021	Nov 2021	Aug 2022	Oct 2019	Sept 2019
Surface Rad/Albedo	Jan 2024	Jan 2023	Mar 2021	Oct 2022	Dec 2023	Draft Jan 2024
LST/Emissivity	Jan 2024	Mar 2024	Mar 2024	Jan 2024	Aug 2024	
Fire/Burn Area	May 2021	Feb 2024	Mar 2020	Aug 2022	Dec 2023	
Soil Moisture	Apr 2024	Feb 2019	Apr 2024	Sep 2022	Dec 2020	Dec 2020
Phenology	Apr 2021	July 2020	Apr 2021	Oct 2022	Dec 2023	
Snow Cover	May 2024	Jan 2021	May 2024	Oct 2021	Oct 2019	
Vegetation Index	May 2021	Nov 2021	May 2021	May 2021	May 2019	
Biomass	Mar 2024	Oct 2021	Mar 2024	Dec 2023	Dec 2023	Sept 2020

Focus Area Reports

- Vegetation Indices
- Land Cover
- Fire/Disturbance
- LST&E
- Surface Radiation
- Evapotranspiration
- Land Surface Phenology
- Biophysical (LAI/FAPAR)
- Snow
- Biomass
- Soil Moisture

Vegetation Indices 1/2

Protocol Development

- Formed a small group of VI experts to review the outline (November 2022)
  - Carolien Toté (VITO, Belgium)
  - Kamel Didan (University of Arizona, USA)
  - Molly Brown (University of Maryland, USA)
  - ~~Michele Meroni (JRC, Italy)~~
  - Kazuhito Ichii (Chiba University, Japan)
- Held a kick-off meeting with the expert group (December 15, 2022)
- Held a 2nd meeting to the group's review comments/suggestions (Jan 2023)
- Revised the outline and shared the revised outline with them (March 2023)
- Completed the first complete draft (December 3, 2023)
- Had the group review one more time (December 2023 - January 2024)
- Reviewed and updated the VI listserv list (May 2024)
- Plan to send the draft protocol document for the community feedback (August 2024)

Vegetation Indices 2/2

2nd GEO Workshop, 28-29 June 2024, Seoul, South Korea

- Follow up of the initial workshop in Hawaii in 2023
- Objectives:
  - To strengthen collaborations among geostationary satellite communities across continents
  - To monitor global land surfaces at hyper-temporal scales
- Participants from US, Japan, South Korea, China, Singapore, and Australia
- Several presentations on VI algorithm validation and VI temporal profile validation (Himawari, GOES-R, MODIS, and VIIRS)

Guideline document update:

Version 0.1 is ready, sent out for community review on August 30th, 2024

Next steps:

Revisions due on October 1st, 2024

Expected completion of Version 1.0: Winter 2024 – 2025

Editors and chapter leads will address reviewers' comments

One round of revisions is planned (no re-review)

Authors: Tyukavina, A.[1], Bontemps, S.[2], Foody, G.[3], Stephen V. Stehman[4], See, L.[5], Olofsson, P.[6], Tsendbazar, N.[7], Radoux, J.[2], Komarova, A.[1], Serre, B.[8], Song, X-P.[1], d'Andrimont, R.[9], Koren, G.[10], Potapov. P.[1], Bullock, E.[11], Campbell., P.[12,13], de Bruin, S.[7], Defourny, P.[2], Friedl., M.A.[14], Fritz., S.[5], Hansen, M.[1], Herold, M.[7, 15], Lamarche, C.[2], Lesiv, M.[5], Mané, L.[16], Meroni, M.[9], Nickeson, J.[12], Pelletier, F.[8], Pickens, A.[1], Reiche, J.[7], Shchepashchenko, D.[5], Tarrio, K.[14], Verhegghen, A.[9], Woodcock, C.[14], Xiao, X.[17]

[1] Department of Geographical Sciences, University of Maryland, College Park, MD, USA
[2] Earth and Life Institute, Université catholique de Louvain, Louvain-la-Neuve, Belgium
[3] School of Geography, University of Nottingham, Nottingham, UK
[4] College of Environmental Science and Forestry, State University of New York, Syracuse, NY, USA
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[6] NASA Marshall Space Flight Center, Huntsville, AL, USA
[7] Laboratory of Geo-Information Science and Remote Sensing, Wageningen University & Research, Wageningen, the Netherlands
[8] Department of Natural Resource Sciences, McGill University, Montreal, Canada
[9] European Commission, Joint Research Centre (JRC), Ispra, Italy
[10] Copernicus Institute of Sustainable Development, Utrecht University, Utrecht, the Netherlands
[11] Rocky Mountain Research Station, U.S. Forest Service, Riverdate, UT, USA
[12] NASA Goddard Space Flight Center, Greenbelt, MD, USA
[13] Goddard Earth Sciences Technology and Research (GESTAR) II, University of Maryland Baltimore County, Baltimore, MD, USA
[14] Department of Earth and Environment, Boston University, Boston, MA, USA
[15] Helmholtz GFZ German Research Centre for Geoscience, Remote Sensing and Geoinformatics Section, Telegrafenberg, Potsdam, Germany
[16] Observatoire Satellital des Forêts d'Afrique Centrale (OSFAC), Kinshasa, Democratic Republic of the Congo
[17] Department of Microbiology and Plant Biology, Center for Earth Observation and Modeling, University of Oklahoma, Norman, OK, USA

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 0.1 - 2024

Editors: Alexandra Tyukavina, Sophie Bontemps, Giles Foody, Stephen V. Stehman, Anna Komarova, Jaime Nickeson

Chapter leads: Alexandra Tyukavina (Chapters 1 - 5), Sophie Bontemps (Chapters 1, 2, Appendix), Pontus Olofsson (Chapters 3, 5), Giles Foody and Julien Radoux (Chapter 4), Linda See and Bryant Serre (Chapter 6), Xiao-Peng Song (Chapter 7)
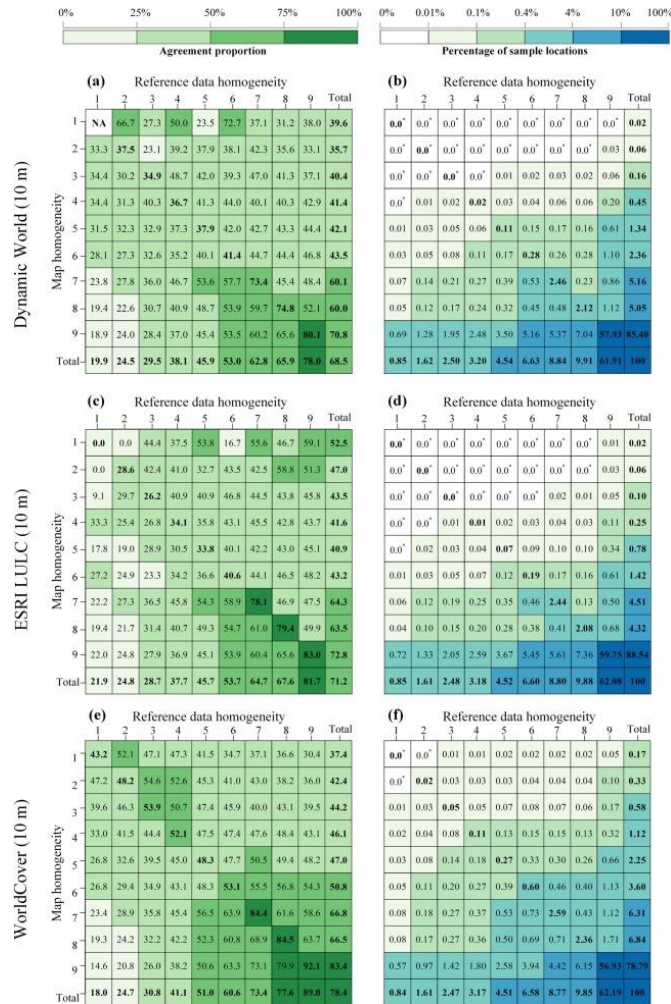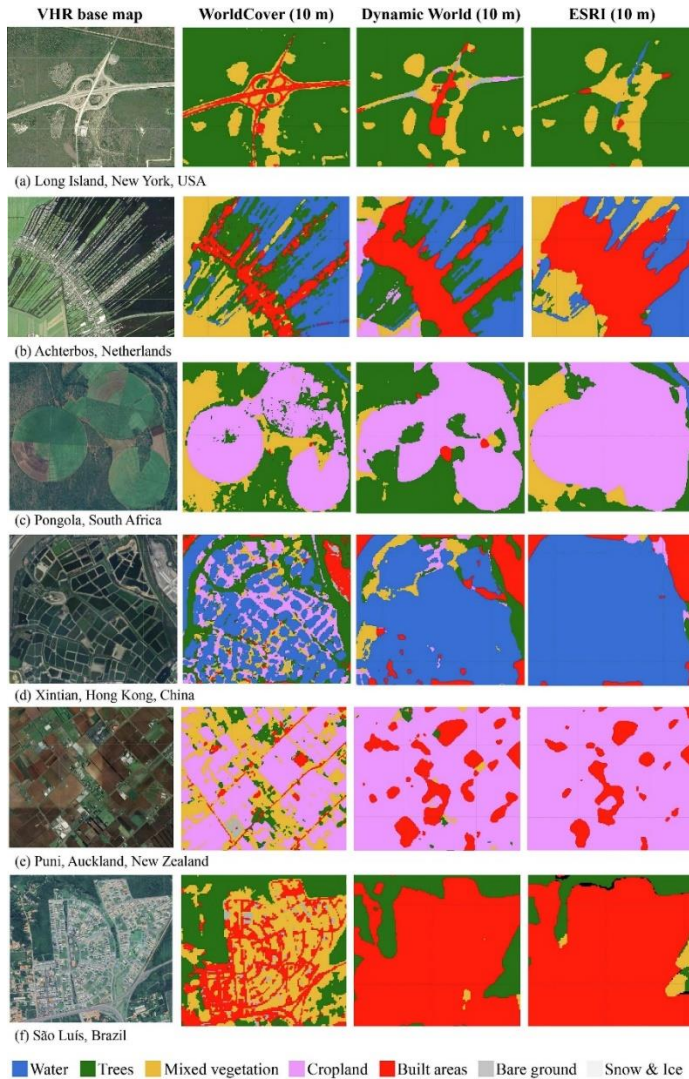
Comparative validation of recent 10m-resolution global land cover maps

Panpan Xu [a], Nandin-Erdene Tsendbazar [a] ✉, Martin Herold [a, b], Sytze de Bruin [a], Myke Koopmans [a], Tanya Birch [c], Sarah Carter [d], Steffen Fritz [e], Myroslava Lesiv [e], Elise Mazur [d], Amy Pickens [f], Peter Potapov [f], Fred Stolle [d], Alexandra Tyukavina [f], Ruben Van De Kerchove [g], Daniele Zanaga [g]

Show more ∨

+ Add to Mendeley   ⁂ Share   " Cite
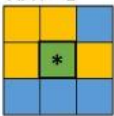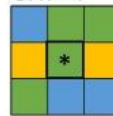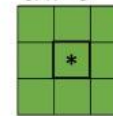
- Comparative validation of recent high-resolution global land cover maps
- Accuracy comparison – global, continental, and for 47 countries
- Assessing spatial details
- Integrating reference data uncertainty to map validation
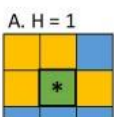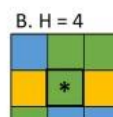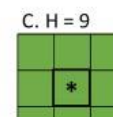
Validation data is error-free

Using landscape context to account for validation data error.

the more homogeneous the landscape, the less the validation data error
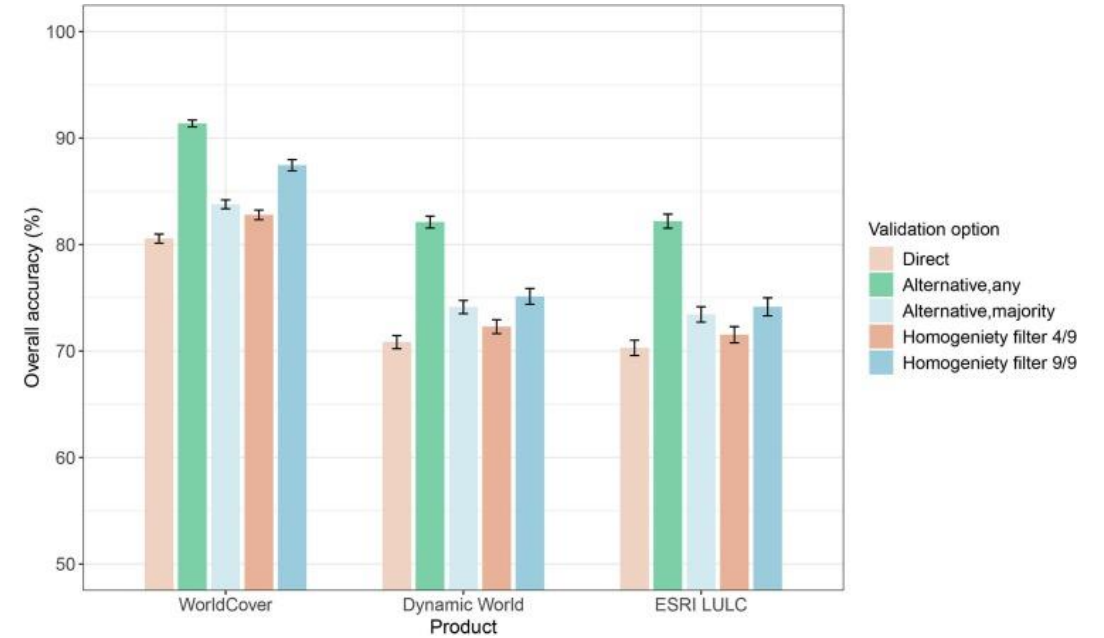
- Comparative validation of recent high-resolution global land cover maps
- Accuracy comparison – global, continental and for 47 countries
- Assessing spatial details
- Integrating reference data uncertainty to map validation

Fire Disturbance

Validation Protocol Status

- Update of 11-page 2010 draft burned area validation protocol ongoing
- Currently 34 pages
- Engaged additional section authors
- Discussion-ready draft for GOFC Fire Implementation Team meeting (17-18 Sep.) and 13th EARSeL Workshop on Forest Fires (19-20 Sep.) in Milan
- Active Fire protocol to follow

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 10.0 – June 2024

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

Satellite-Derived Global Burned Area Product Validation Best Practices Protocol
Draft v10.1 – June 2024

Table of Contents

2

Upcoming Conferences

- 7th International Symposium on Recent Advances in Quantitative Remote Sensing (RAQRS'VII), Valencia, Sep 23-27
- EUMETSAT Meteorological Satellite Conference 2024. Würzburg, Germany, 30 Sep – 4 Oct.
- ECOSTRESS Science and Applications Team meeting, Pasadena, CA, 30 Sep – 2 Oct.
- EARSeL Thermal Remote Sensing Workshop. 2-4 December 2024, Leicester, UK.
- LST CCI 2024 User Workshop. 5-6 December 2024, Leicester, UK.

Project news

- TIRCALNet preparation study, coordination meeting in June 2024.
- Validation of ECOSTRESS Collection 2 LSTE products is underway.
- Analyses of thermal camera in situ measurement intercomparison campaign available.
- International science workshop on High resolution Thermal remote sensing expected in India during November 2024

TIRCalNet Preparation Study

- Goal: Prepare the roadmap for the TIRCalNet operations.

- Cooperation between TIRCalNet Preparation Study team (Uni. Leicester, KIT, RAL Space), CNES and JPL.

- Study at La Crau site:
  - Characterization of site uncertainties: Emissivity measurements + drone flights.
  - Characterization of instruments uncertainties.
  - Characterization of atmospheric propagation approach: common methodo

Continuity between MODIS Aqua and VIIRS Land Surface Temperature
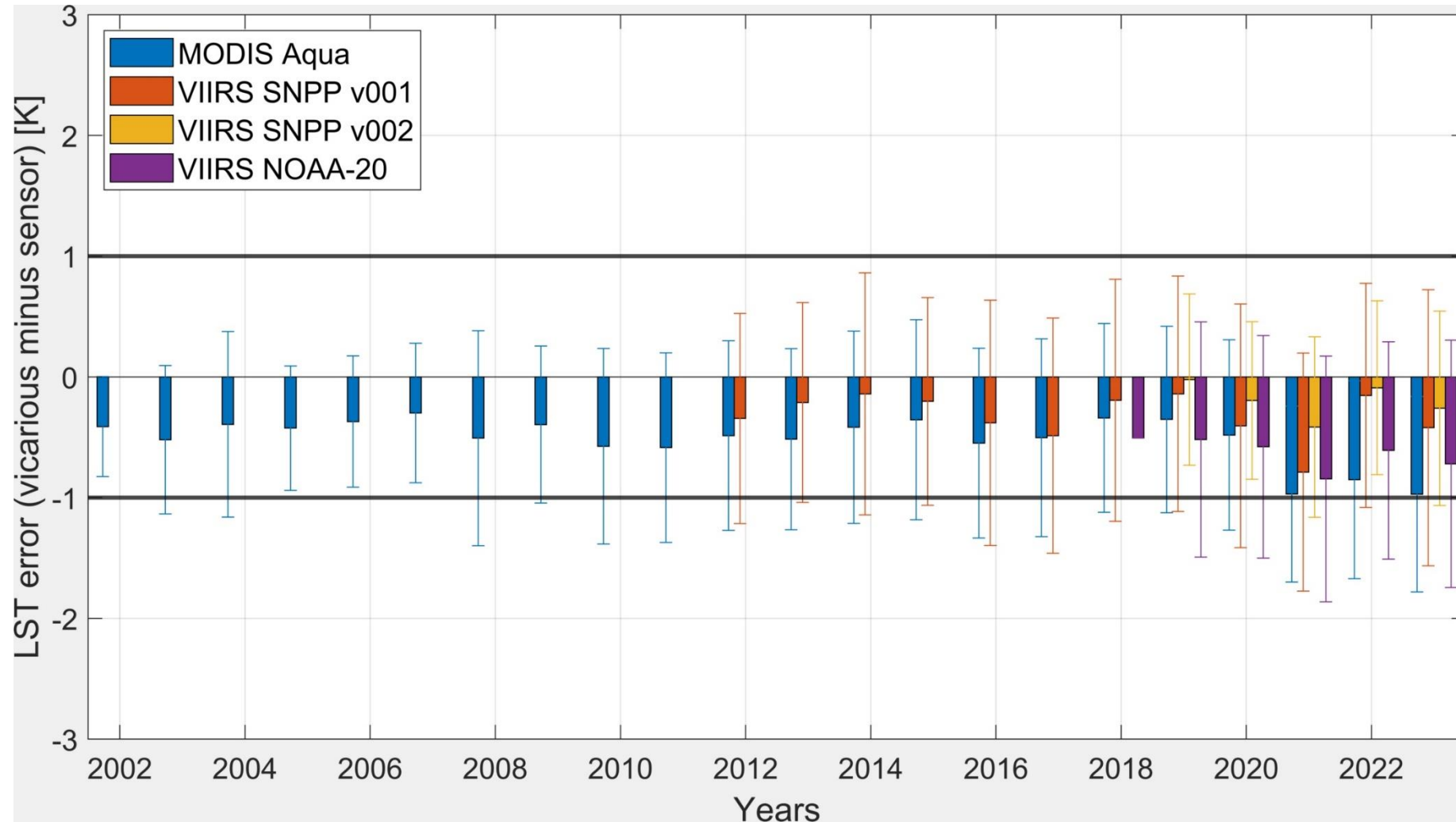
Surface Radiation

LP DAAC to Release Gap Filled MODIS Version 6.1 Albedo, BRDF, and NBAR Data Product

- Expected in Fall 2024
- The LP DAAC will announce the availability of the Terra+Aqua Combined MODIS Version 6.1 Bidirectional Reflectance Distribution Function and Albedo (BRDF/Albedo) Gap-Filled Snow-Free Daily L3 Global 30ArcSec Climate Modelling Grid (CMG) data product (MCD43GF).
- The data product includes Albedo, Bidirectional Reflectance Distribution Function (BRDF), and Nadir BRDF-Adjusted Reflectance (NBAR) data. Currently, the collection only contains data from **2013 through 2021**. The remaining historic data will be added at a later date.
- The older MCD43GF Version 6 data product will remain available until the complete MCD43GF Version 6.1 data record is available.

Surface radiation: **Angela Erb, Jorge Sánchez-Zapero**, **Zhuosen Wang**

- **SALVAL:**
  - ○ 2024 annual update has started (inclusion updated values for ground data and satellite products).
  - ○ New sampling LANDVAL-V2 for product intercomparison will be tested in the tool: from 720 to 2000 samples.

LAND VALidation (LANDVAL) V2: Representative global sampling for satellite product intercomparison and calibration
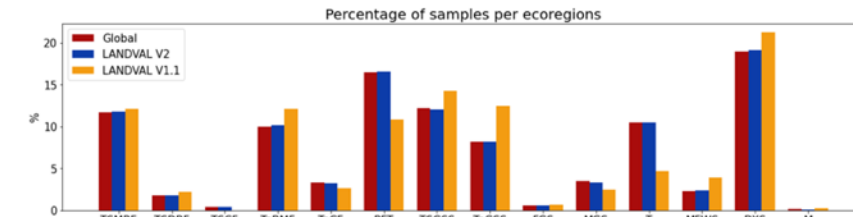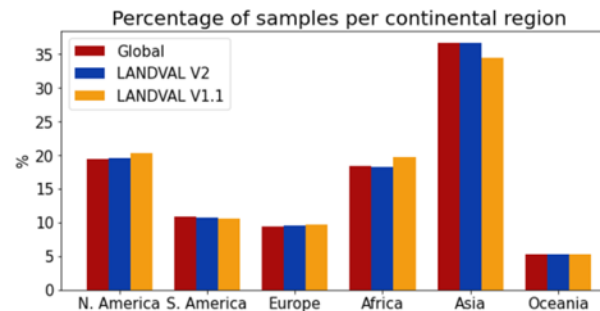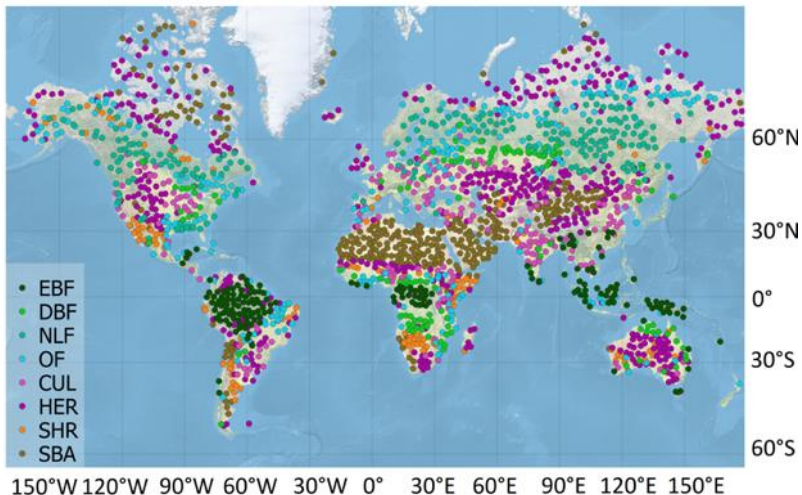
Martínez-Sánchez, Enrique[1]; Sánchez-Zapero, Jorge[1] (iD); Camacho, Fernando[1]

DOI 10.5281/zenodo.10559900

https://zenodo.org/records/10559901

LANDVAL V2

Percentage of samples per continental region

Percentage of samples per ecoregions

- TSMBF – Tropical & Subtropical Moist Broadleaf Forest
- TSDBF – Tropical & Subtropical Dry Broadleaf Forest
- TSCF – Tropical & Subtropical Coniferous Forest
- TeBMF – Temperate Broadleaf & Mixed Forest
- TeCF – Temperate Conifer Forest
- BFT – Boreal Forest/ Taiga
- TSGSS – Tropical & Subtropical Grasslands, Savannas & Shrublans

- TeGSS – Temperate Grasslands, Savannas & Shrublands
- FGS – Flooded Grasslands & Savannas
- MGS – Montane Grasslands % Shrublands
- T – Tundra
- MFWS – Mediterranen Forest, Woodlands & Scrub
- DXS – Desert & Xeric Shrublands
- M - Mangroves

Percentage of samples per biome type
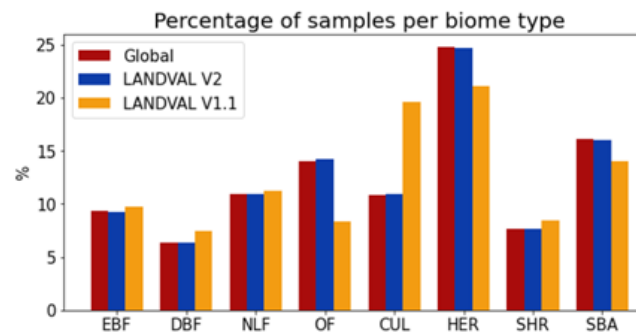
EBF – Evergreen Broadleaf Forest
DBF – Deciduous Broadleaf Forest
NLF – Needle-leaf Forest
OF – Other Forest
CUL – Cultivated
HER – Herbaceous
SHR – Shrublands
SBA – Sparse and Bare Areas

17

Evapotranspiration(1/3)

Initiation status:

- LPV website for ET focus area is ready to go live.

- AGU abstract submitted about ET product evaluation, including authors from US., Europe, Australia, Brazil, and China

Workshops:

- AGU Chapman conference:

  - The Energy Balance Closure Problem: Causes, Corrections, and Implications (Sep 14-19, 2025 Boulder)

- International Science Workshop on High-Resolution Thermal Earth Observation (Nov. 19-21, 2024 India, abstract and registration due 9/30)

- ECOSTRESS Science Team meeting (Sep 30-Oct 2, 2024 Pasadena, LA)

Publications (large regional or continental product):

- Evapotranspiration and surface energy fluxes across Europe, Africa and Eastern South America throughout the operational life of the Meteosat second generation satellite (https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/gdj3.235)

- A brief history of the thermal IR-based Two-Source Energy Balance (TSEB) model – diagnosing evapotranspiration from plant to global scales (https://www.sciencedirect.com/science/article/pii/S0168192324000662)

- Spatial-temporal patterns of land surface evapotranspiration from global products (https://www.sciencedirect.com/science/article/pii/S0034425724000774#f0060)

Recent Publications:

Tang et al., 2024 RSE
https://www.sciencedirect.com/science/article/pii/S0034425724000774#f0010

Category	Name	Time Coverage	Spatial Resolution
Remote Sensing-based	EB-ET	2000-2007	5km/day
	SSEBop	2003-now	1km/month
	3T	2001-2020	0.25º/day
	GLEAM	1980-2022	0.25º/day
	PT-JPLsm	2002-2017	36km/month
	ET-Monitor	2001-2019	1km/month
	MOD16A2	2001-now	500m/8-day
	NTSG	1983-2018	0.25º/month
	BESS	2001-2015	1km/8-day
	PML-V2	2000-2020	500m/8-day
	PEW	1982-2018	0.1º/month
Reanalysis-based	CFSR	1979-2010	0.3º/sub-daily
	CFSV2	2011-now	0.2º/sub-daily
	ERA5-Land	1950-now	0.1º/sub-daily
	GLDAS V2.1	2000-2023	0.25º/sub-daily
	JRA-55	1958-now	0.56º/sub-daily
	MERRA-2	1980-now	0.5,0.625º/sub-daily
	NCEP-R2	1979-now	1.9º/sub-daily
Hybrid-based	DOLCE	1980-2018	0.25º/month
	GLASS	1982-2018	1km/8-day
	REA	1980-2017	0.25º/day
Machine Learning-based	SGAN	1982-2019	1km/month
	DLBH	2003-2019	0.25º/daily
	FLUXCOM	2001-2015	0.083º/month
Water balance-based	WB-MTE	2001-2013	0.5º/month
	TerraClimate	1958-2015	4km/month

Land-cover types (MCD12Q1, IGBP, 2018)

Legend: AmeriFlux, ChinaFLUX, EuroFlux, FLUXNET, OzFlux, TPDC; Shrublands, Savannas, Grasslands, Others, Croplands, Snow and Ice, Water, Forests

Number of years: 1–3, 4–6, 7–8, 9–11, 12–16
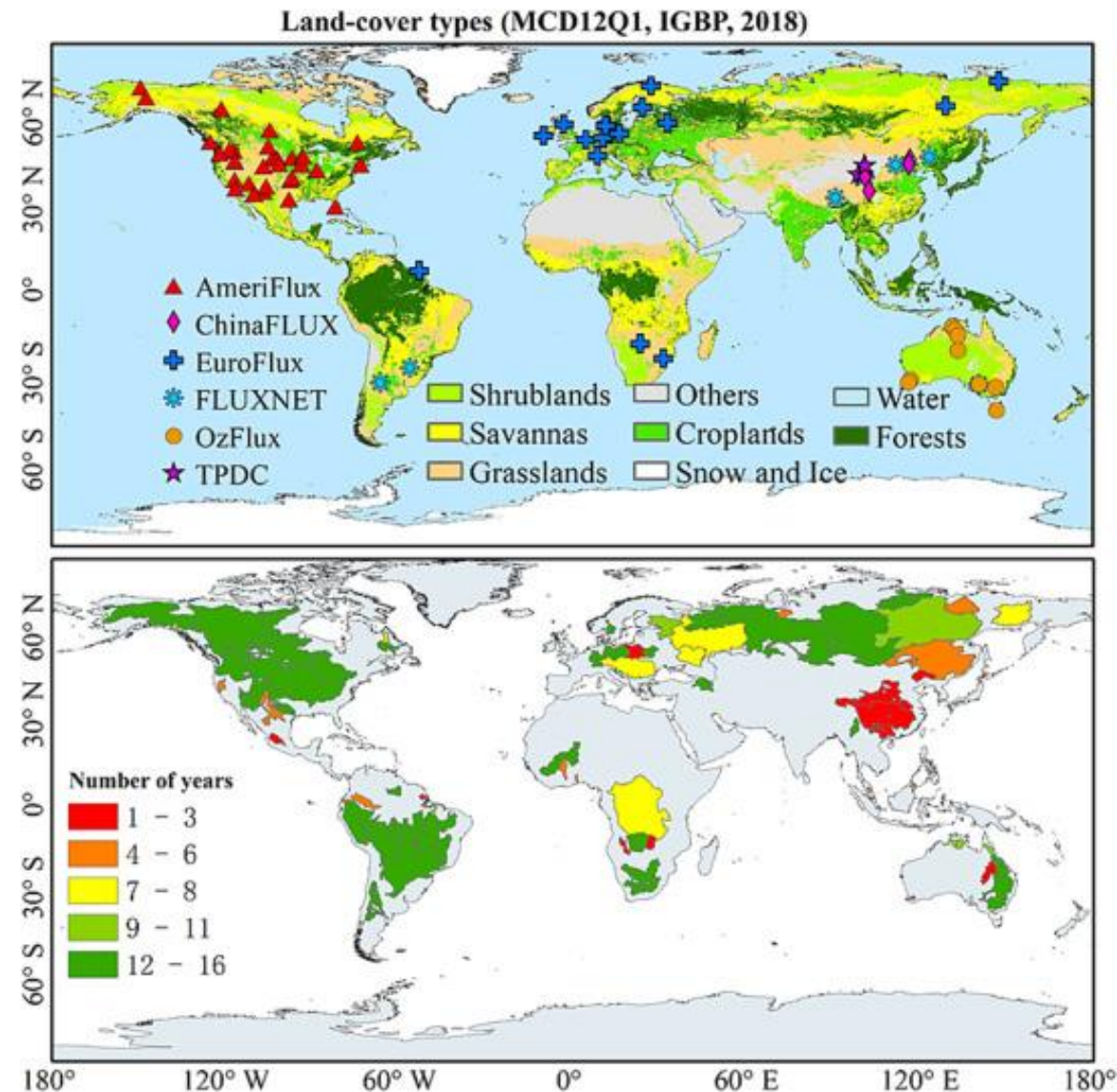
Tang et al., 2024 RSE
https://www.sciencedirect.com/science/article/pii/S0034425724000774#f0010
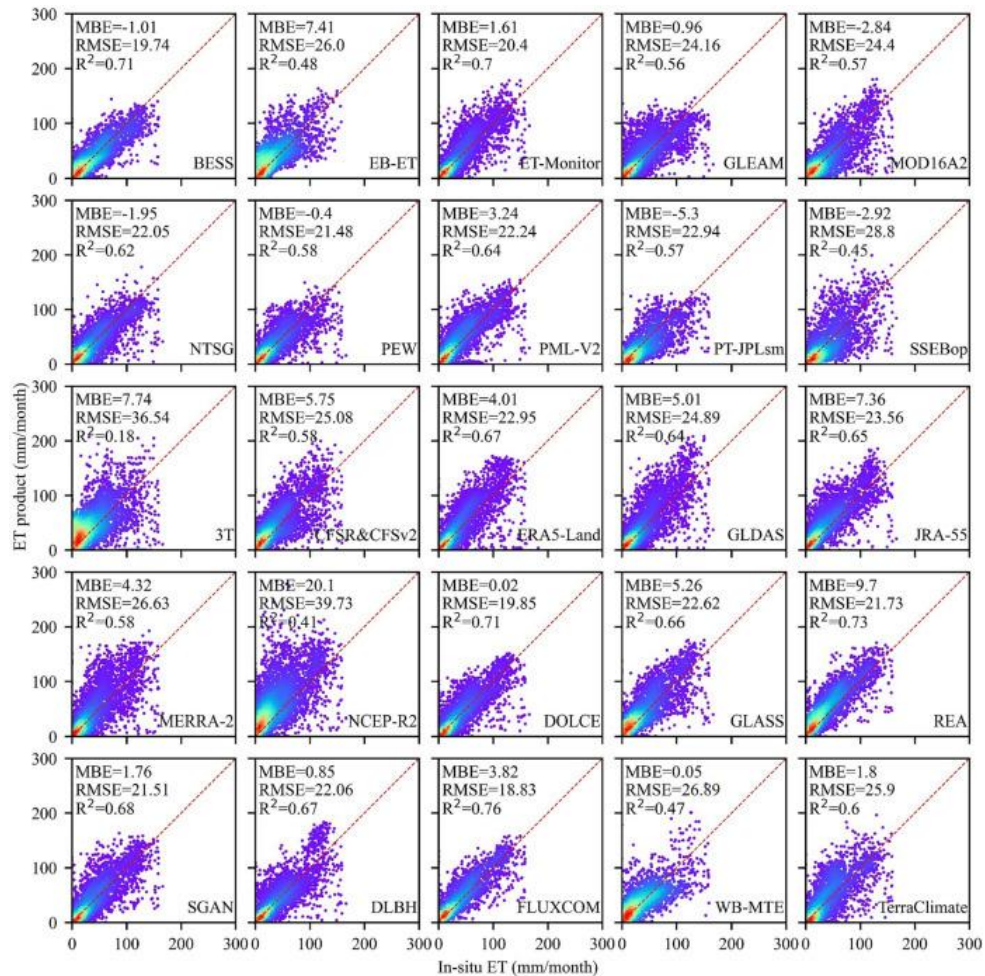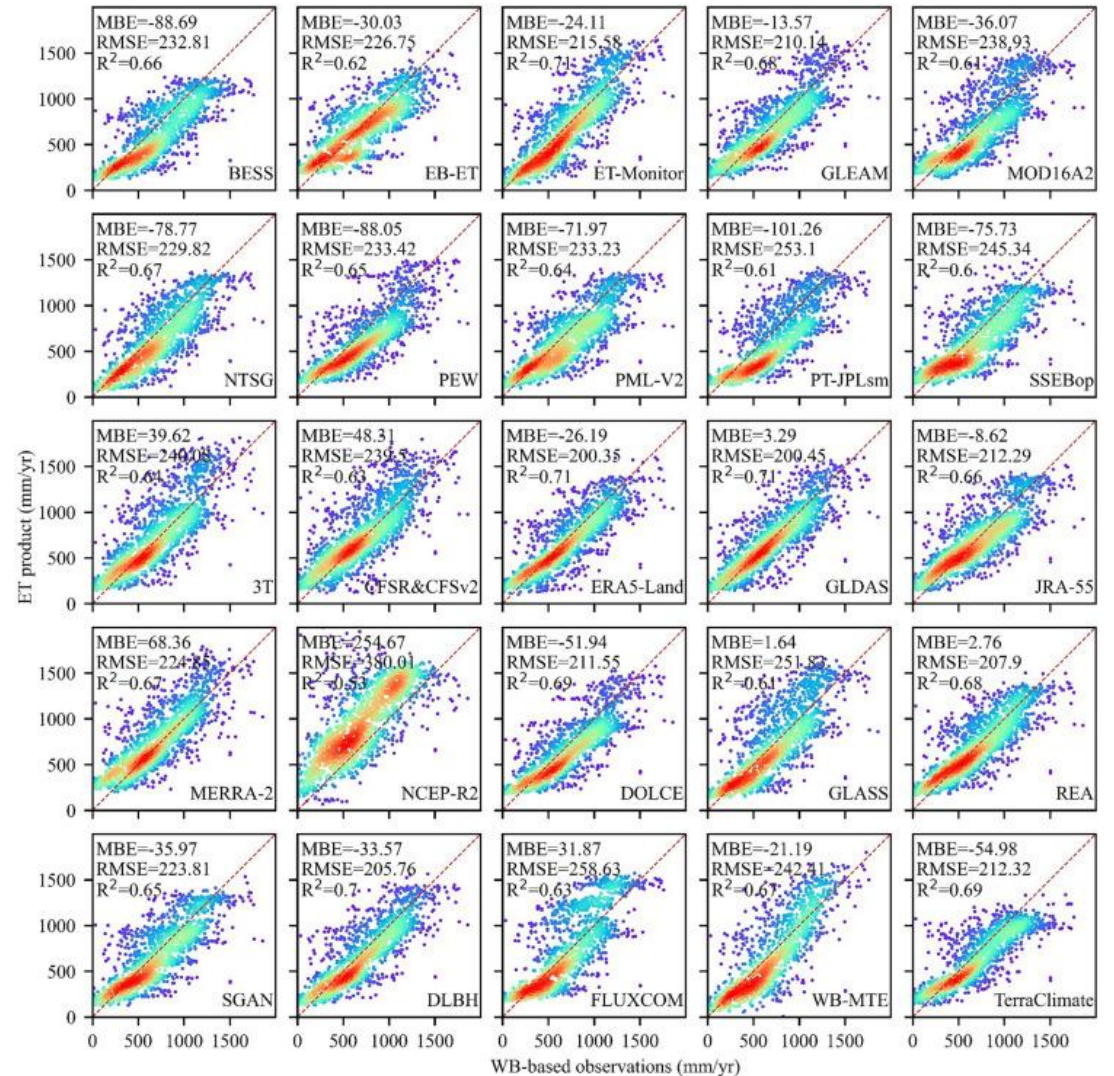

Comparison with Flux Tower Observations
~19 mm/month to ~29mm/month

Comparison with Water Balance
~200mm/year to ~260mm/year

20

Land Surface Phenology

- Copernicus Land Monitoring Service (CLMS) has signed a new contract for the continuation and evolution of the High-Resolution Vegetation Phenology and Productivity (HR-VPP) product suite:
  - Consortium comprises VITO, in partnership with Lund University, Joanneum Research, and Space4Environment.
  - Calibration report to be published in autumn 2025

- Review paper: Gong et al. Satellite remote sensing of vegetation phenology: Progress, challenges, and opportunities. ISPRS J. Photo. Rem. Sens.

- Special Issue in the journal "Forest": Vegetation and Remote Sensing Phenology in Deciduous Forests.
  - Deadline for manuscript submissions: 31 October 2025

Biophysical (1/4)

- Definitions:
  - 3 Geomatics Canada Open Files (version controlled DOI labelled)
  - Revised LAI, FAPAR to conform with current GCOS definitions.
  - Added FCOVER corresponding to FAO definition.
  - Added definition of "Related Quantities" to each definition to increase clarity in community.

- Revised Product List
  - Deleted 20 (mainly different resolutions of same products)
  - Added new products: 6 LAI, 8 FAPAR, 8 FCOVER; including 7 <100m resolution continental products.

- CEOS Validation Stage Assessment
  - Assessed validation stage by continent.
  - Geomatics Canada Open File summarizing findings
    - A total of 22 LAI products, 17 fAPAR products and 8 fCOVER products were identified and evaluated in terms of continental scale CEOS validation stage.
    - Stage 3 validated products are currently available for Europe and North America at >=250m resolution and for regions of North America above 40degrees at 20m resolution. Stage 2 validated >250m resolution products are also available for Africa and Asia and it is likely these will soon achieve Stage 3. Stage 1 validate products are available for South America and Australia/Oceania.
  - Up to LPV to decide how to update product validation stage table – suggest it be uniform across variables.

- Outline of new good practice document for medium resolution products including fCOVER.

Product Temporal Stability

- Assessment/methodology of product stability (change in bias/yr)
- L8 and S2 stability better than 0.2 LAI/yr and 0.02 fCOVER/yr and fAPAR/yr.
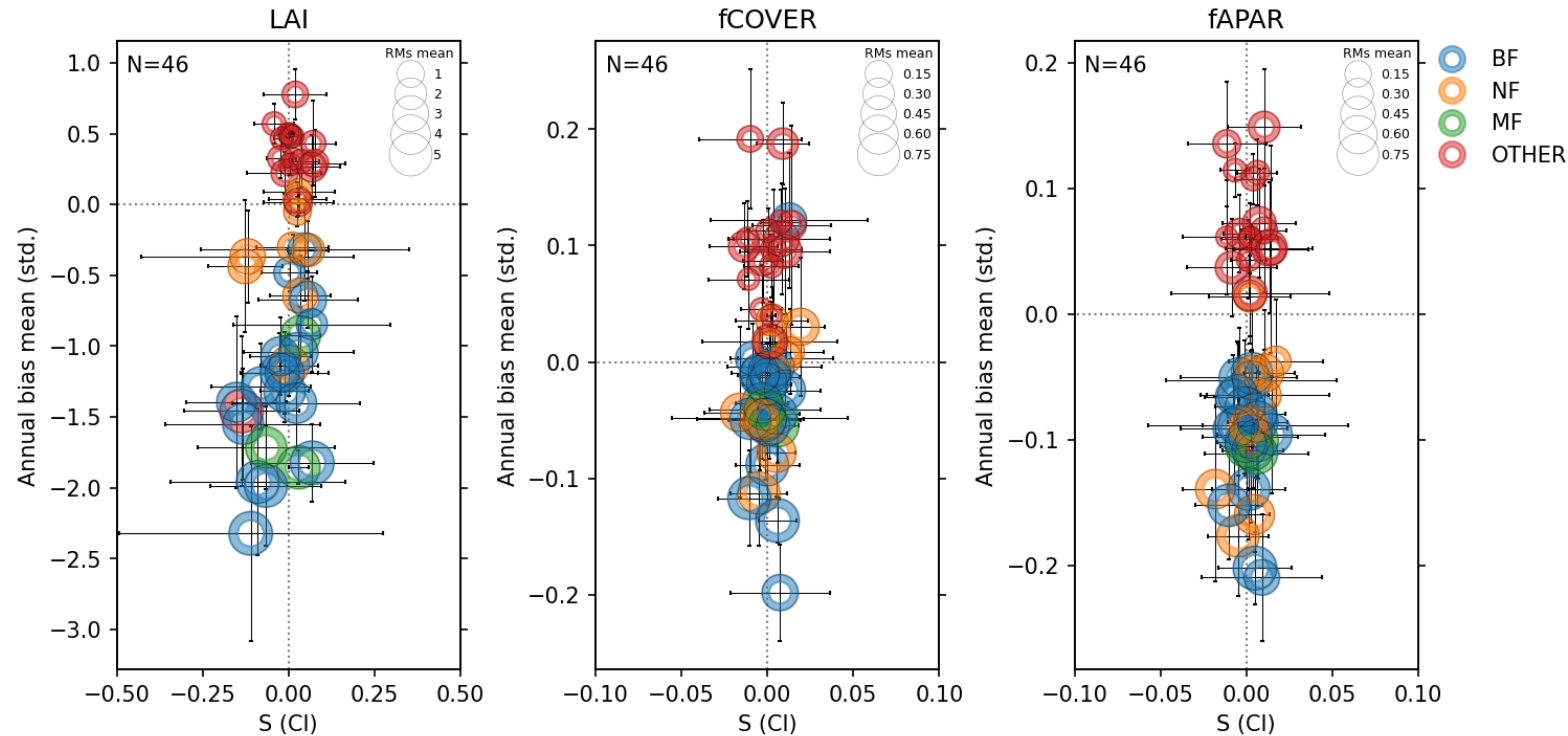
Stability (S) versus annual bias of SL2P-CCRS 30m Landsat 8/9 products over NEON reference sites with at least 5 years of >5 matchups. Djamai et al. in review.

WORKING GROUP ON CALIBRATION & VALIDATION

Good Practices Update

- Discussions on proposed new sections
    - Revise *Definitions*
        - inclusion of FAPAR, FCOVER
    - Revise *In Situ Reference Estimates*
        - include new sensor and tech development (e.g. terrestrial laser scanner)
    - Add new section on high resolution data products
        - high resolution vs. ESU
    - Add new section on 3D data products
        - lidar

WORKING GROUP ON CALIBRATION & VALIDATION

CEOS

Biophysical (4/4)

PRODUCTS

Yan, K., Wang, J., Peng, R., Yang, K., Chen, X., Yin, G., Dong, J., Weiss, M., Pu, J., and Myneni, R. B.: HiQ-LAI: a high-quality reprocessed MODIS leaf area index dataset with better spatiotemporal consistency from 2000 to 2022, Earth Syst. Sci. Data, 16, 1601–1622, https://doi.org/10.5194/essd-16-1601-2024, 2024

Brown, L. A., Morris, H., Meier, C., Knohl, A., Lanconelli, C., Gobron, N., Dash, J., … (2023). Stage 1 validation of plant area index from the Global Ecosystem Dynamics Investigation. *IEEE Geoscience and Remote Sensing Letters, 20*(3), 280-284. https://doi.org/10.1109/LGRS.2022.3190123

VALIDATION STUDIES

Camacho, F., Martínez-Sánchez, E., Brown, L. A., Morris, H., Morrone, R., … (2024). Validation and conformity testing of Sentinel-3 green instantaneous FAPAR and canopy chlorophyll content products. *Remote Sensing, 16*(15), 2698. https://doi.org/10.3390/rs16152698

Fernandes, R., Hong, G., Brown, L. A., Dash, J., Harvey, K., Kalimipalli, S., … (2024). Not just a pretty picture: Mapping leaf area index at 10 m resolution using Sentinel-2. *Remote Sensing of Environment, 311*, 114269. https://doi.org/10.1016/j.rse.2024.114269

Fernandes, R., Djamai, N., Harvey, K., Hong, G., MacDougall, C., Shah, H., & Sun, L. (2024). Evidence of a bias-variance trade off when correcting for bias in Sentinel 2 forest LAI retrievals using radiative transfer models. *Remote Sensing of Environment, 305*, Article 114060. https://doi.org/10.1016/j.rse.2024.114060

IN-SiTU METHODS

Ma, L., Yu, D., Chen, Y., Feng, K., Tang, H., Sumnall, M. J., & Zheng, G. (2024). Quantifying the plant area index of overstory and understory vegetation on sloped terrain using single-station terrestrial laser scanner. *IEEE Transactions on Geoscience and Remote Sensing, 62*, 1-19. https://doi.org/10.1109/TGRS.2024.3395584

Brown, L. A., & Leblanc, S. G. (2024). CoverPy: Automated estimates of plant area index, vegetation cover, crown cover, crown porosity, and uncertainties from digital cover photography in Python. *SoftwareX, 27*, 101767. https://doi.org/10.1016/j.softx.2024.101767
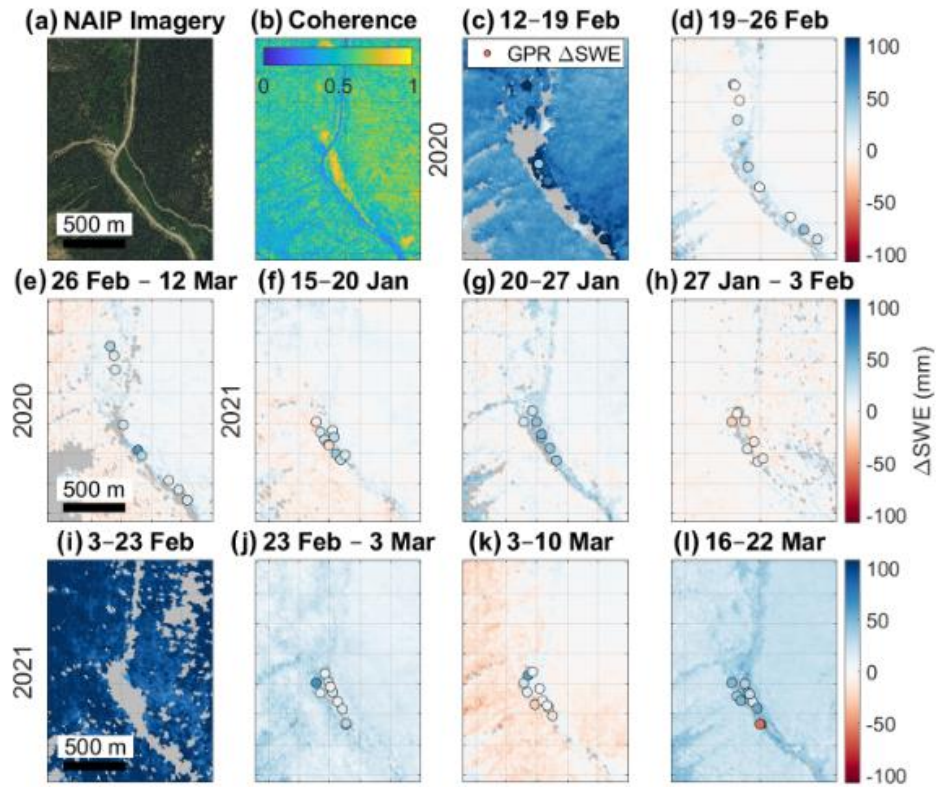
Brown, L. A., Morris, H., Morrone, R., Sinclair, M., Williams, O., Hunt, M., … (2024). Near-infrared digital hemispherical photography enables correction of plant area index for woody material during leaf-on conditions. *Ecological Informatics, 79*, 102441. https://doi.org/10.1016/j.ecoinf.2024.102441

Brown, L. A., Morris, H., Leblanc, S., Bai, G., Lanconelli, C., Gobron, N., Meier, C., … (2024). HemiPy: A Python module for automated estimation of forest biophysical variables and uncertainties from digital hemispherical photographs. *Methods in Ecology and Evolution*. Advance online publication. https://doi.org/10.1111/2041-210X.14123
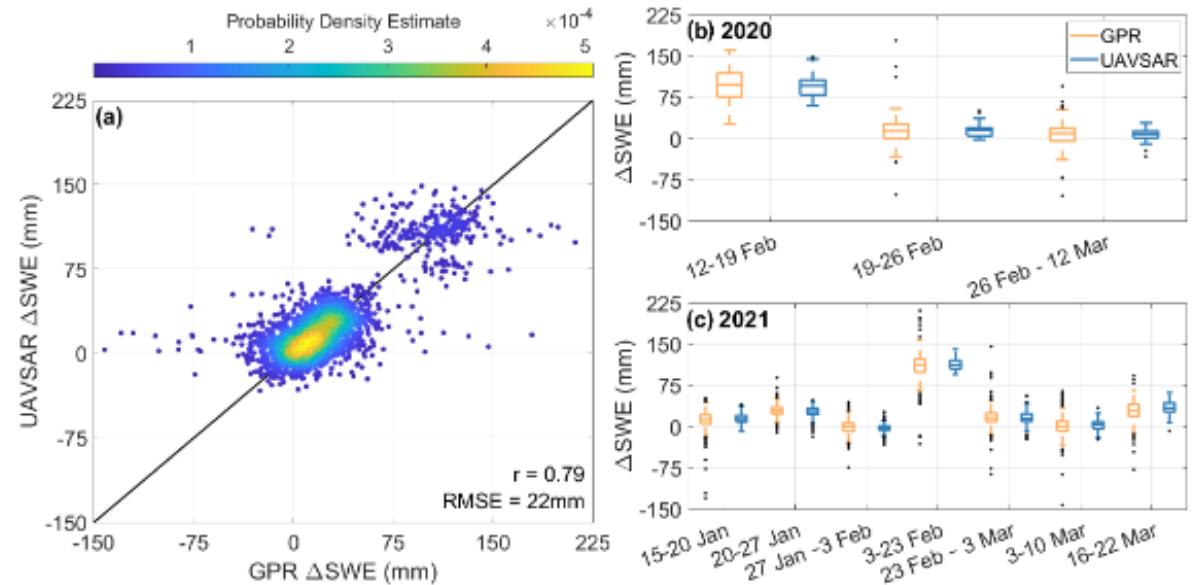
Recent papers

(a) National Agriculture Imagery Program (NAIP) imagery from summer 2023 at the MR site. (b) Median coherence across all dates. (c–l) UAVSAR ΔSWE retrievals for each 2020 and 2021 date interval at the MR field site.

Bonnell, R., McGrath, D., Tarricone, J., Marshall, H.-P., Bump, E., Duncan, C., Kampf, S., Lou, Y., Olsen-Mikitowicz, A., Sears, M., Williams, K., Zeller, L., and Zheng, Y.: Evaluating L-band InSAR snow water equivalent retrievals with repeat ground-penetrating radar and terrestrial lidar surveys in northern Colorado, The Cryosphere, 18, 3765–3785, https://doi.org/10.5194/tc-18-3765-2024, 2024.

UAVSAR ΔSWE retrievals compared with coincident GPR ΔSWE retrievals

Recent papers

Jorge Ruiz *et al.*, "Comparing InSAR Snow Water Equivalent Retrieval Using ALOS2 With In Situ Observations and SnowModel Over the Boreal Forest Area," in *IEEE Transactions on Geoscience and Remote Sensing*, vol. 62, pp. 1-14, 2024, Art no. 4302314, doi: 10.1109/TGRS.2024.3439855.
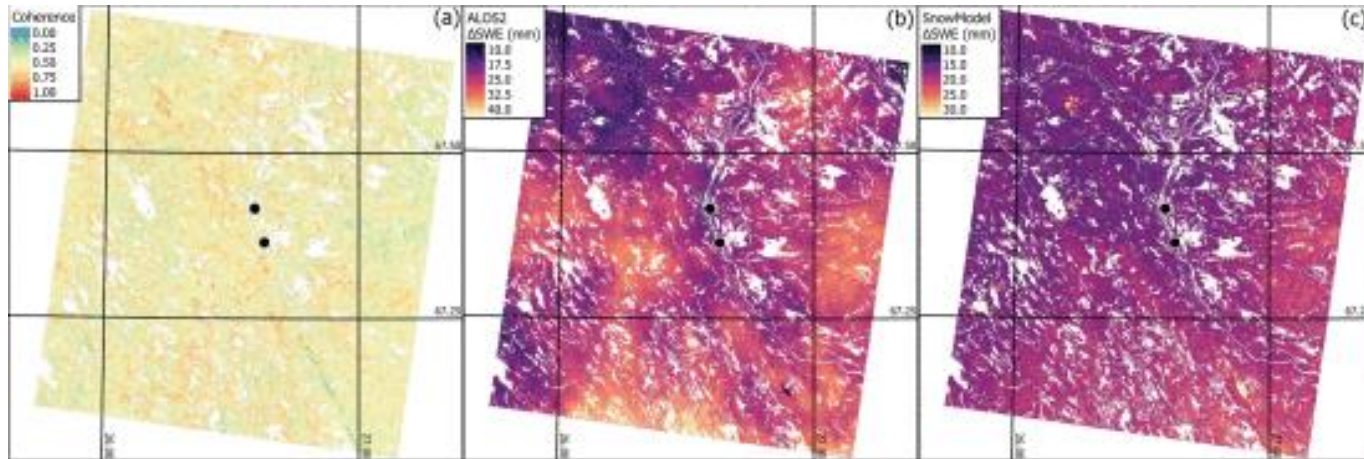
Maps of (a) coherence, (b) ALOS2 ΔSWE, c) SnowModel ΔSWE for Sodankylä area for image pair 11 (Jan 13-27, 2020).
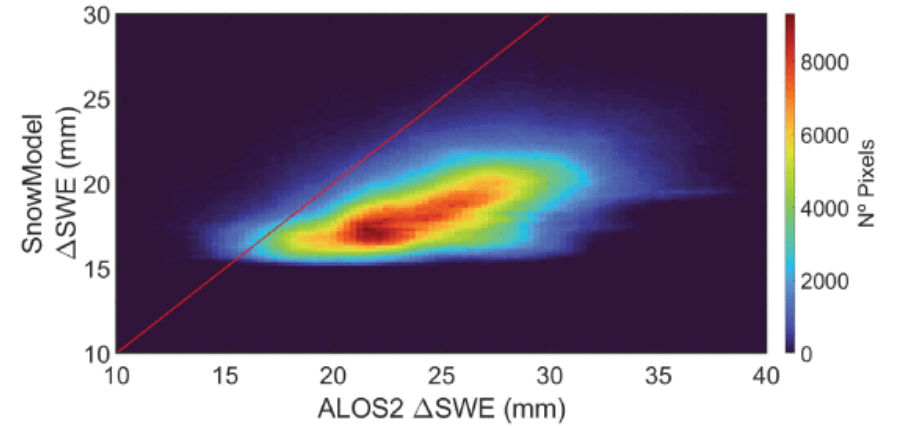
Histogram between ALOS2 and SnowModel ΔSWE
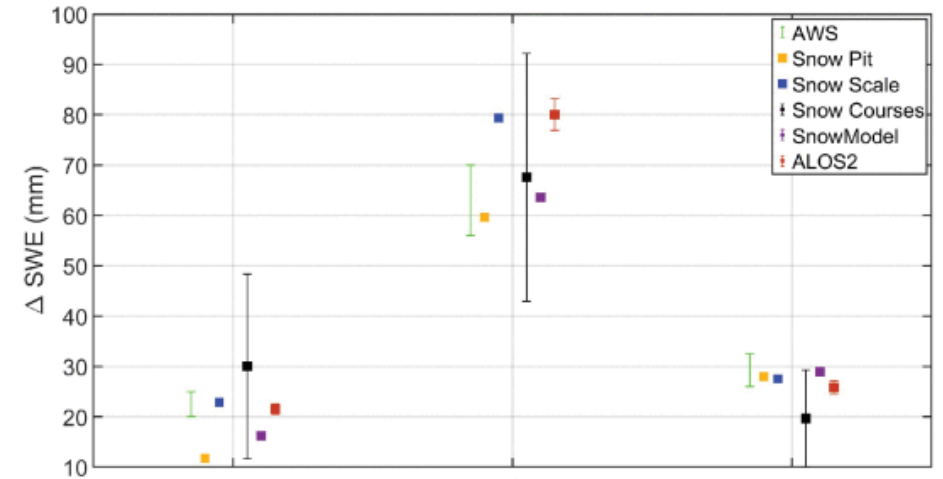
ALOS2 ΔSWE vs. in situ and SnowModel ΔSWE for three interferometric image pairs

NASA Snow Community Meeting
August 14-15, 2024, Boulder, CO

Objective: To cohesively summarize existing and ongoing snowpack monitoring efforts and identify remaining knowledge gaps and next steps for the snow community, specifically through recognition of the completion of NASA SnowEx multi-year field experiment and recent Earth System Explorers satellite mission proposals

1. Toward consensus across snow community
   - Community building
   - Snow mission requirements
   - Science questions
   - Applications
   - Next steps
2. Summarize the current state of snow sensing, modeling, and technologies
3. Outline white paper concepts for the next decadal survey

- Approximately 200 in-person and virtual attendees
- Summary report in prep now

WORKING GROUP ON CALIBRATION & VALIDATION

CEOS

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.

  Update on process:
  - Meeting July 5 to discuss review:
    - Plan to focus on the three existing snow ECV products (variables/quantities) – **Area Covered by Snow, Snow Depth, Snow Water Equivalent**.
    - As this is a GCOS initiative, it will concentrate on the GCOS requirements which are intended for **climate** monitoring
  - Preliminary requirements drafted
  - Next meeting to discuss will be scheduled for late Sept/early Oct

- We will work with this group to develop a validation protocol once the requirements are in place
- 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

CEOS

WORKING GROUP ON CALIBRATION & VALIDATION

Committee on Earth Observation Satellites
Working Group on Calibration and Validation

Land Product Validation Subgroup

Global Aboveground Biomass Product Validation

Best Practice Protocol

Version 2.0 – 2025

Editors: Kim Calders, Neha Hunka, Laura Duncanson, David Minor, Mat Disney, John Armston, Jaime Nickeson

Protocol Update Status

- V2.0 is currently being drafted
- Some authors have provided revisions to chapters.

Biomass Harmonization

Two papers that use NASA GEDI and ESA CCI forest biomass estimates are currently in review

National Forest Biomass Assessments Enhanced with Earth Observation to Aid Climate Policy Needs
- Hunka, Neha and May, Paul and Babcock, Chad and Armando Alanís de la Rosa, José and de los Ángeles Soriano-Luna, Maria and Mayorga Saucedo, Rafael and Armston, John and Santoro, Maurizio and Requena Suarez, Daniela and Herold, Martin and Málaga, Natalia and Healey, Sean P. and Kennedy, Robert and Hudak, Andrew and Duncanson, Laura. Available at SSRN: https://ssrn.com/abstract=4910141

Intergovernmental Panel on Climate Change (IPCC) Tier 1 forest biomass estimates from Earth Observation
- Neha Hunka, Laura Duncanson, John Armston, et al. *Authorea.* March 04, 2024.
  DOI: 10.22541/au.170958900.06861359/v1

- Results to be submitted to the IPCC Emission Factors Database in October 2024

Soil Moisture (1/2)

Relevant projects:

- Fiducial Reference Measurements for Soil Moisture (FRM4SM)
  - Direct negotiations w. ESA for a Phase 2 (2025-2026)
  - Dedicated budget to update the CEOS LPV validation good practice protocol
  - Exchange w. Copernicus Evaluation and Quality Control (EQC) framework to integrate QA4SM activities

- ESA Climate Change Initiative (CCI)
  - New satellite-only root zone soil moisture products provided in the next release
  - Proposal for new CCI AWU in preparation, important open questions regarding the validation of high-res soil moisture
  - Proposal for new CCI ET in discussion, joint forces w. ESA CCI soil moisture team
  - Potential of expanding QA4SM to validate other variables

- EURAMET Green Deal Call 2024
  - Proposal in development: "Metrology for ground-based reference measurements for satellite soil moisture validation"
  - ~3 M€ project, led by the German National Metrology Institute (Miroslav Zboril)
  - Focus: Development of soil moisture "super sites", transferring SI-traceability from the lab into the field, aiming to get long-term funding for the operation via meteorological institutes, WMO, etc.
  - **Letter of support from CEOS LPV / NCSMMN?**

Upcoming workshops:

- BIPM-WMO Metrology for Climate Action Workshop 2024
  - 16-18 September @ BIPM headquarters, Sevres, France.
  - Free online attendance possible: https://bipm-cenv2024.org/

- EGU General Assembly 2025
  - 27 April-2 May, Vienna, Austria
  - Several Cal/Val sessions proposed (incl. Soil Moisture)

- ESA Living Planet Symposium 2025
  - 23-27 June, Vienna, Austria
  - Several Cal/Val sessions proposed (incl. Soil Moisture)

WORKING GROUP ON CALIBRATION & VALIDATION