Land Product Validation (LPV) Sub-group Meeting

Michael Cosh – (USDA) –Chair
Fabrizio Niro – (ESA/ESRIN) – Vice Chair

Subgroup meeting
6 Feb 2024

NEXT LPV TELECON APR 2, 2024

2024 Focus Area Leads

	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 2024 (1st term)
	Sophie	Bontemps	Université Catholique de Louvain	Belgium	Oct 2023 (2nd term)
Biophysical	Marie	Weiss	INRA	France	Sep 2023 (2nd term)
	Sylvain	Leblanc	Natural Resources Canada	Canada	Sep 2023 (2nd 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	UMass Boston	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	Tomoaki	Miura	University of Hawai'i	USA	Dec 2022 (2nd term)
	Else	Swinnen	VITO	Belgium	Apr 2023 (2nd term)
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	Mississippi State	USA	~Jan 2027 (1st term)
	Carmelo	Cammalleri	Politecnico di Milano	Italy	~Jan 2027 (1st term)
GPP/NPP	TBD				
	TBD				

Seeking FA co-leads

Land Cover Nominations

Sophie Bontemps rotating off, reaching out to Nandika Tsendbazar (Wageningen)

Biophysical Nominations (LAI, FAPAR)

Richard Fernandes, Natural Resources Canada (1 term)

Kai Yan, Beijing Normal University

Bert Gielen, University of Antwerpen

Hao Teng, University of Maryland

Vegetation Indices (NDVI, EVI, …)

Gross and Net Primary Productivity (GPP/NPP):

Reaching out to Arthur Endsley, Univ. of Montana

WCGV and LPV Plenary

Upcoming WGCV Plenary

- *WGCV-53, March 5-8, 2024* *CONAE, Cordoba, Argentina*
- *WGCV-54, Late 2024* *USGS, Sioux Falls, South Dakota*

LPV Town Hall, American Geophysical Union Fall Meeting, San Francisco, California

Past LPV Plenary Meetings

- May 2016, ESA LPS, Prague, Czech Republic
- March 2018, ESA LPVE, Frascati, Italy
- April 2019, ESA LPS, Milan Italy
- May 2021, Virtual
- Sep 2022 Virtual
- June 2023, ESA Frascati
- 2024 ???

Townhall Recap

IEEE Seminar Recap

Good Practices for Land Product Validation - GRSS-IEEE

Validation Stages

	Validation Stage - 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** **Biomass**
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** **LAI**
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.	**Vegetation Indicies** **LST & Emissivity** **Active Fire** **Burned Area**
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**

Need supporting publications on the references page to move this

Protocols Status – Updates Needed or Still on Track?

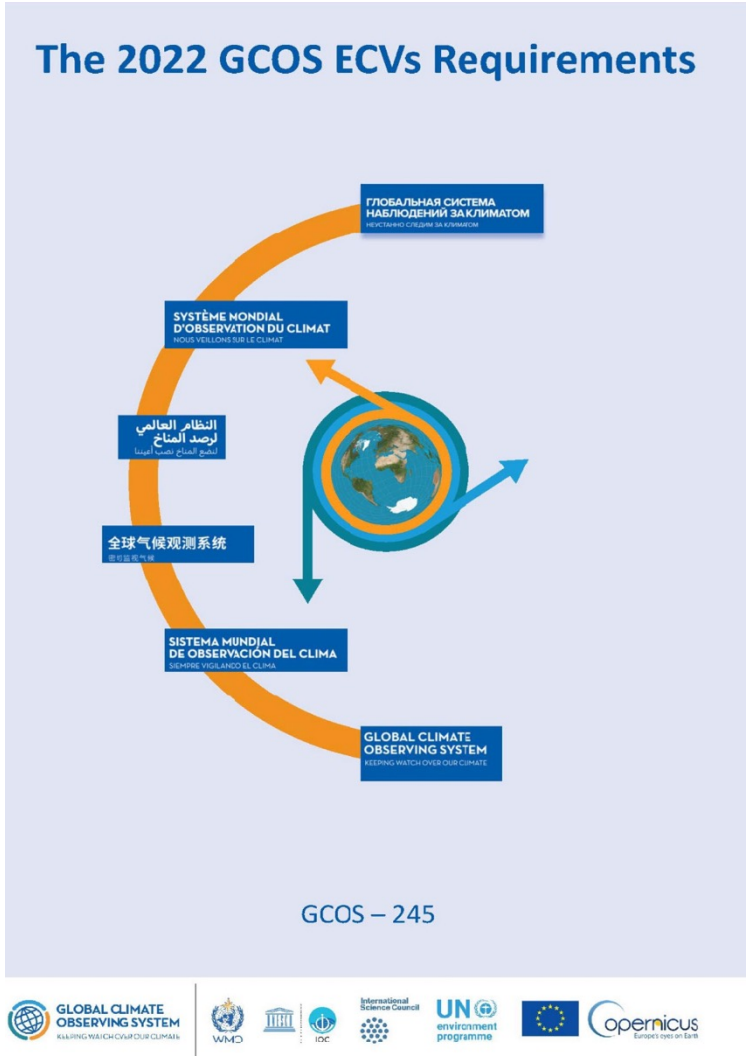
Focus Area	Protocol Timeline
Biophysical	LAI (2014), Needs update
Fire/Burn Area	Burned Area Targeting 2023 Active Fire (?)
Phenology	Targeting 2023
Vegetation Index	Targeting 2023 (60%)
Land Cover	Targeting 2023 (95%)
Snow Cover	(?)
Surface Radiation	Albedo (2019) Downwelling surface solar radiation (80%)
Soil Moisture	SM (2020)
LST and Emissivity	LST (2019)
Aboveground Biomass	AGWB (2021)

ECV updated

The latest WMO GCOS requirements from the latest version for each LPV ECV have been placed in your GoogleDrive folders.

Requirements have changed and the target, goal, and threshold requirements has changed. For instance, instead of Accuracy they have Required Measurement Uncertainty.

The changes affect the Collaboration page where we display the GCOS requirements. We need to review and decide what to include on the page.



https://library.wmo.int/records/item/58111-the-2022-gcos-ecvs-requirements-gcos-245#.ZFzCd6VBxjs

BIPM Metrology

https://www.bipm.org/en/doi/10.59161/Rapport202303

New LPV priority from WGCV

nature ecology & evolution

Explore content | About the journal | Publish with us | Subscribe

nature > nature ecology & evolution > perspectives > article

Perspective | Published: 13 May 2021

Priority list of biodiversity metrics to observe from space

Andrew K. Skidmore, Nicholas C. Coops, Elnaz Neinavaz, Abebe Ali, Michael E. Schaepman, Marc Paganini, W. Daniel Kissling, Petteri Vihervaara, Roshanak Darvishzadeh, Hannes Feilhauer, Miguel Fernandez, Néstor Fernández, Noel Gorelick, Ilse Geijzendorffer, Uta Heiden, Marco Heurich, Donald Hobern, Stefanie Holzwarth, Frank E. Muller-Karger, Ruben Van De Kerchove, Angela Lausch, Pedro J. Leitão, Marcelle C. Lock, Caspar A. Mücher, ... Vladimir Wingate + Show authors

Nature Ecology & Evolution **5**, 896–906 (2021) | Cite this article

9575 Accesses | **89** Citations | **148** Altmetric | Metrics

https://www.nature.com/articles/s41559-021-01451-x

FA Web Status

The Home and Collaboration pages have been placed in your GoogleDoc folders for markup updates/reviews

Had a goal to update these by this call and many have not done so.

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

Focus Area Reports

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

Evapotranspiration

Please welcome our new focus area leads,

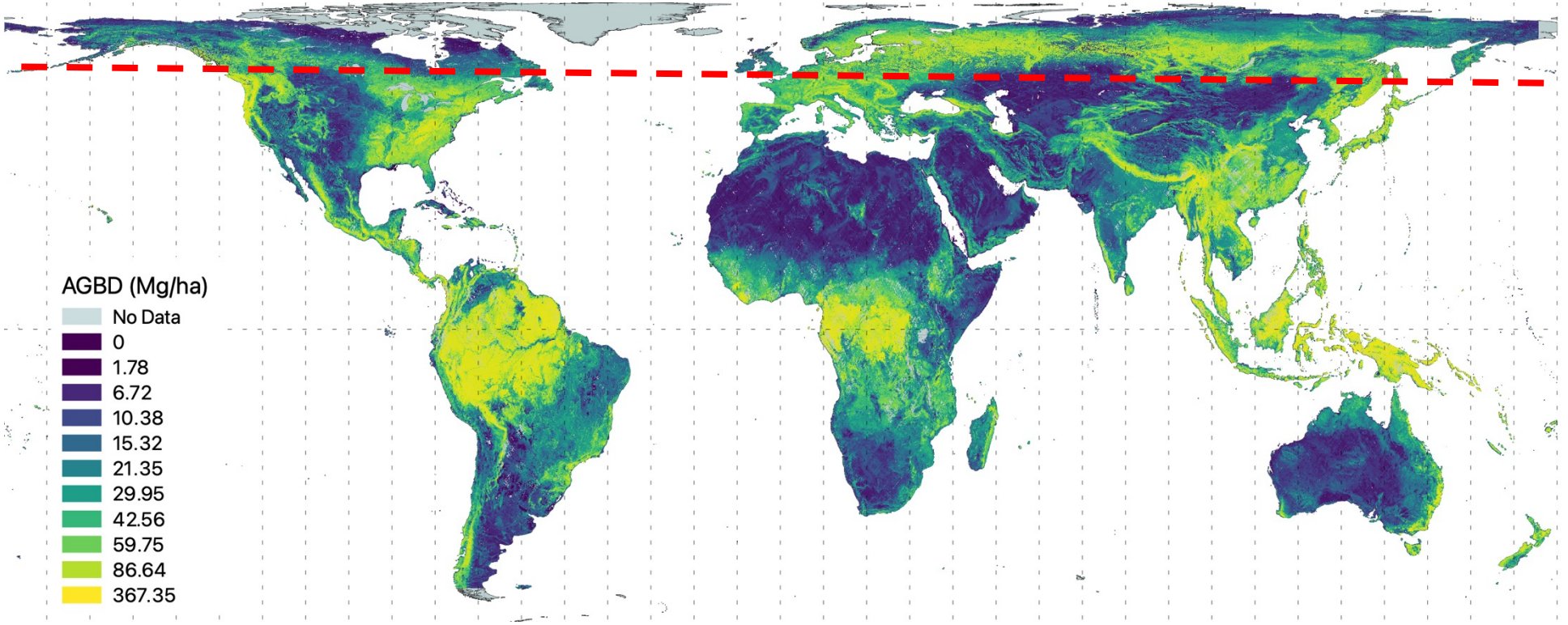
Yun Yang (Mississippi State University)

and

Carmelo Cammalleri (Polytechnic University of Milan)

Aboveground Biomass (1/5)

ICESat-2 data fill GEDI's northern data gap for global lidar mapping



ICESat-2 Boreal: 94 Pg

GEDI: 506 Pg

Global NASA Lidar AGB Estimate: ~600 Pg for 2020

Equivalent to ~ 1,100 billion tons of CO_2 – about 30 years of global emissions

Duncanson et al., in prep

Aboveground Biomass (2/5)

Biomass Harmonization: IPCC Tier 1 estimates

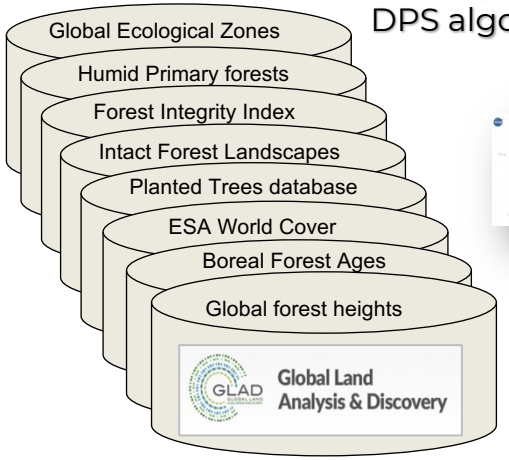
Ecological Zone (GEZ) + Continent + Forest Status/Condition

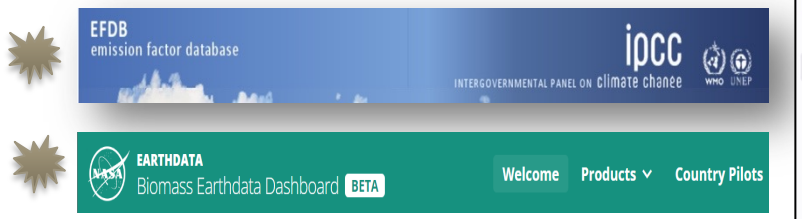
TABLE 4.7 (UPDATED)
ABOVE-GROUND BIOMASS IN NATURAL FORESTS (TONNES D.M. HA^{-1})

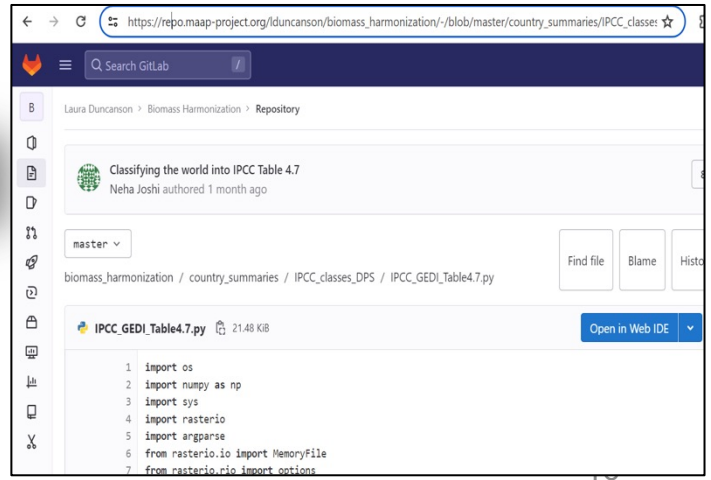
Domain	Ecological zone [1]	Continent	Status/condition[2]	Above-ground biomass [tonnes d.m. ha^{-1}]	Uncertainty	Uncertainty type	References
	Tropical rainforest	Africa	Primary	404.2	120.4	SD	1-12
			Secondary >20 years	212.9	143.1	SD	5-7, 11, 13-16
			Secondary ≤20 years	52.8	35.6	SD	9-11, 14, 15, 17
		North and South America	Primary	307.1	104.9	SD	3, 4, 9, 10, 18-21
			Secondary >20 years	206.4	80.4	SD	9, 10, 22-28
			Secondary ≤20 years	75.7	34.5	SD	9, 10, 14, 22, 23, 28-32
Tropical			Secondary ≤20 years				
	Tropical dry forest	Africa	Primary				
			Secondary >20 years	69.6	47.5	SD	1, 2, 43, 44, 51-53
			Secondary ≤20 years				
		North and South America	Primary	127.5	72.6	SD	18-21
			Secondary >20 years	118.9	81.3	SD	9, 10, 22, 23, 54
			Secondary ≤20 years	32.2	24.2	SD	9, 10, 22, 23, 54, 55
		Asia	Primary				
			Secondary >20 years	184.6	144.5	SD	9, 10, 35, 48, 56
			Secondary ≤20 years				
	Tropical shrublands	Africa	Primary				
			Secondary >20 years	48.4	45.8	SD	44, 57, 58
			Secondary ≤20 years				
		North and South America	Primary				
			Secondary >20 years	71.5	46.4	SD	59
			Secondary ≤20 years				
		Asia	Primary				
			Secondary >20 years	38.3	33.0	SD	59
			Secondary ≤20 years				

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
(https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html)

DPS algorithm 1: 20 mins
DPS algorithm 2: 10 mins



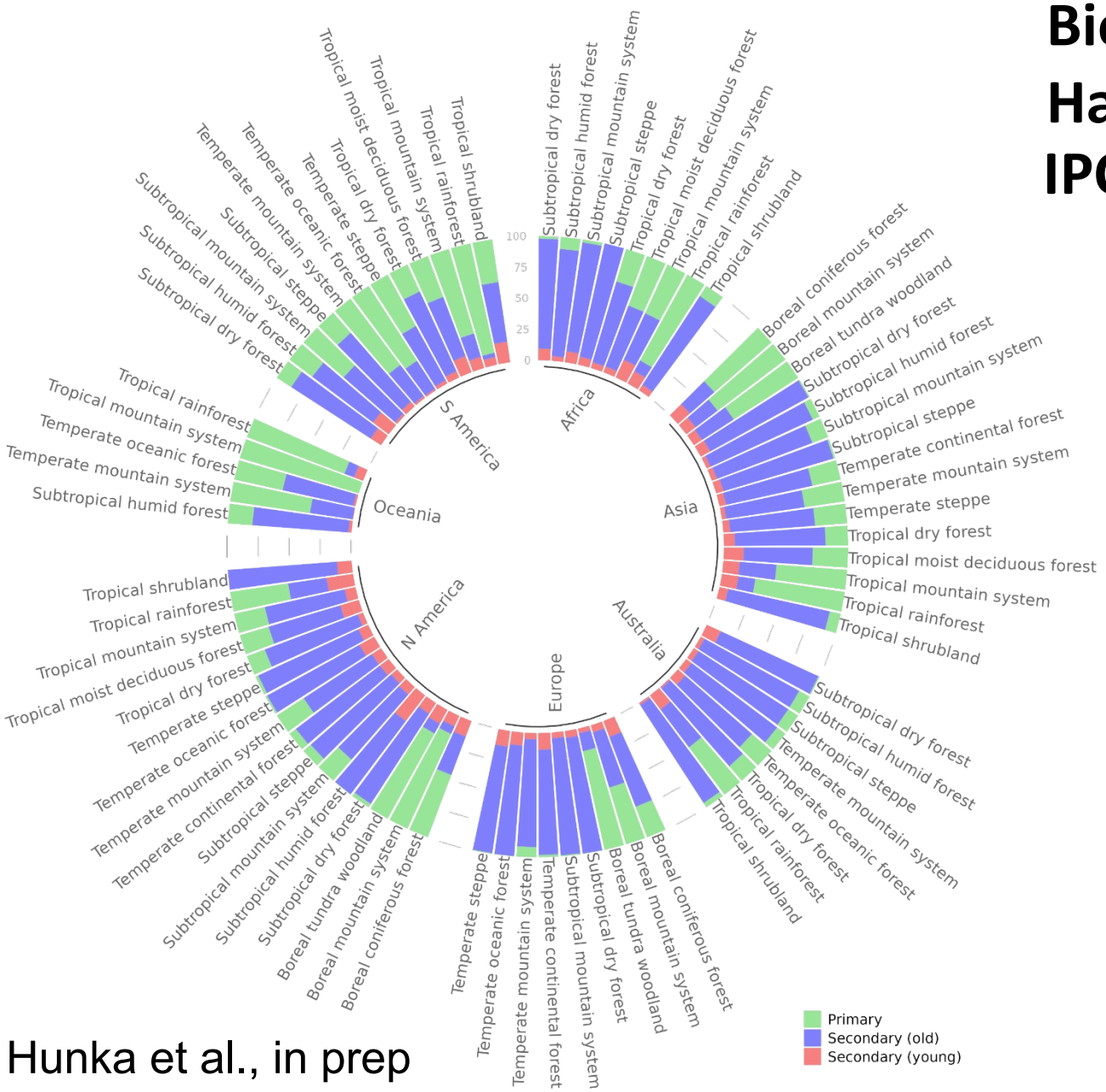




Aboveground Biomass (3/5)

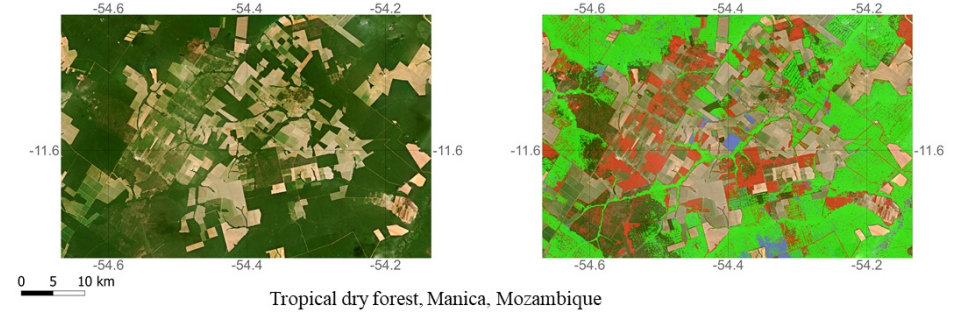
Biomass Harmonization: IPCC Tier1 estimates

Global: 3.17 billion hectares
Primary: 1613 Mha
O. Sec: 1250 Mha
Y. Sec: 310 Mha

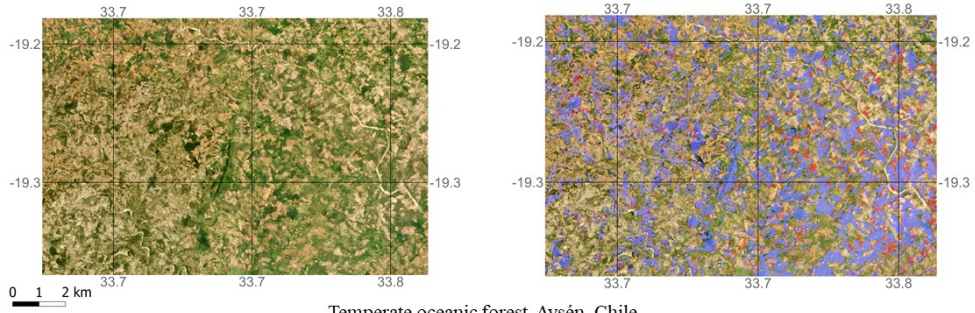


Hunka et al., in prep

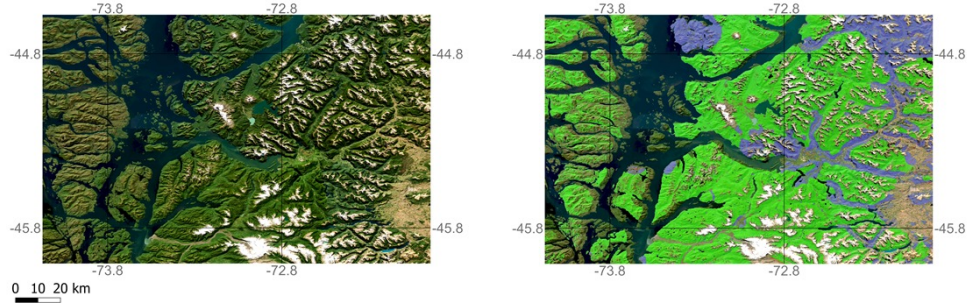
Tropical rainforest, Mato Grosso, Brazil



Tropical dry forest, Manica, Mozambique



Temperate oceanic forest, Aysén, Chile



Aboveground Biomass (4/5)

Biomass Harmonization: Upcoming work

Workshop: Use of space-based biomass maps for policy reporting 20-22 March 2024, USGS, Reston, VA

University of Maryland, the USGS SilvaCarbon program, and the GFOI R&D Component

Objectives:

- Receive an update from map developers on **current methods and approaches to estimating biomass** and associated uncertainty, as well as clarify what the current requirements for reporting on the policy side are.

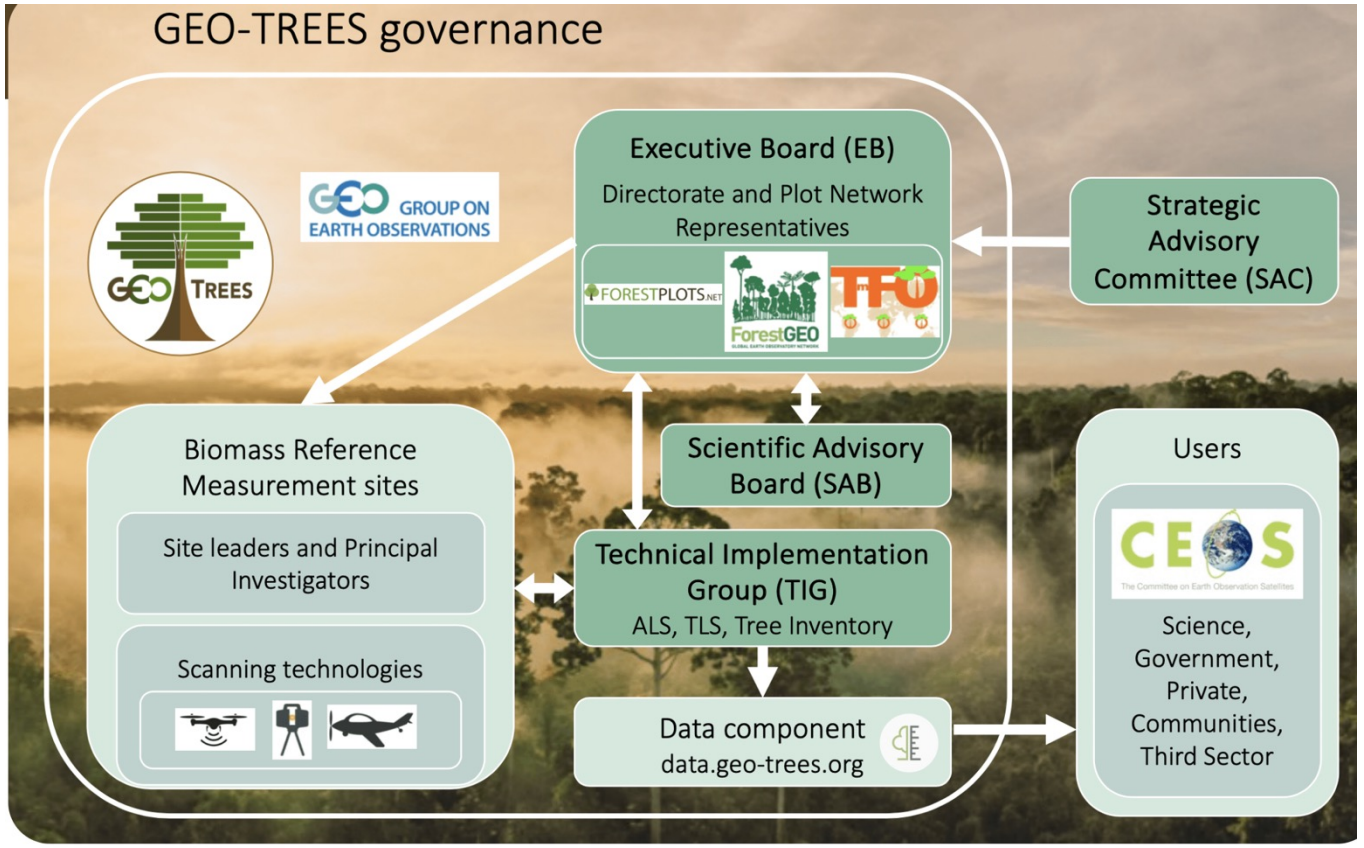
- **Collaboratively develop example codes and/or a guidance protocol** to assist countries in improving biomass stock estimates by integrating EO data. Data from three countries (Mexico, Colombia and Mozambique) will be used for this exercise, with the aim of creating tangible codes/modules on the NASA MAAP Platform.

- **Showcase how EO-based estimates can be used to fill gaps in current guidance in the policy domain**, such as biomass estimates in lands outside 'forests' and EO-based estimates for refining IPCC Tier 1 defaults.

Aboveground Biomass (5/5)

GEO-TREES updates:

- BCI Panama TLS processing as “showcase” (processing + capacity building)
- TIGs being set up now
- First/launch workshop of the GEO-TREES initiative on May 15-17. The workshop will take place at the Smithsonian Institution in Washington, DC (invitation only)

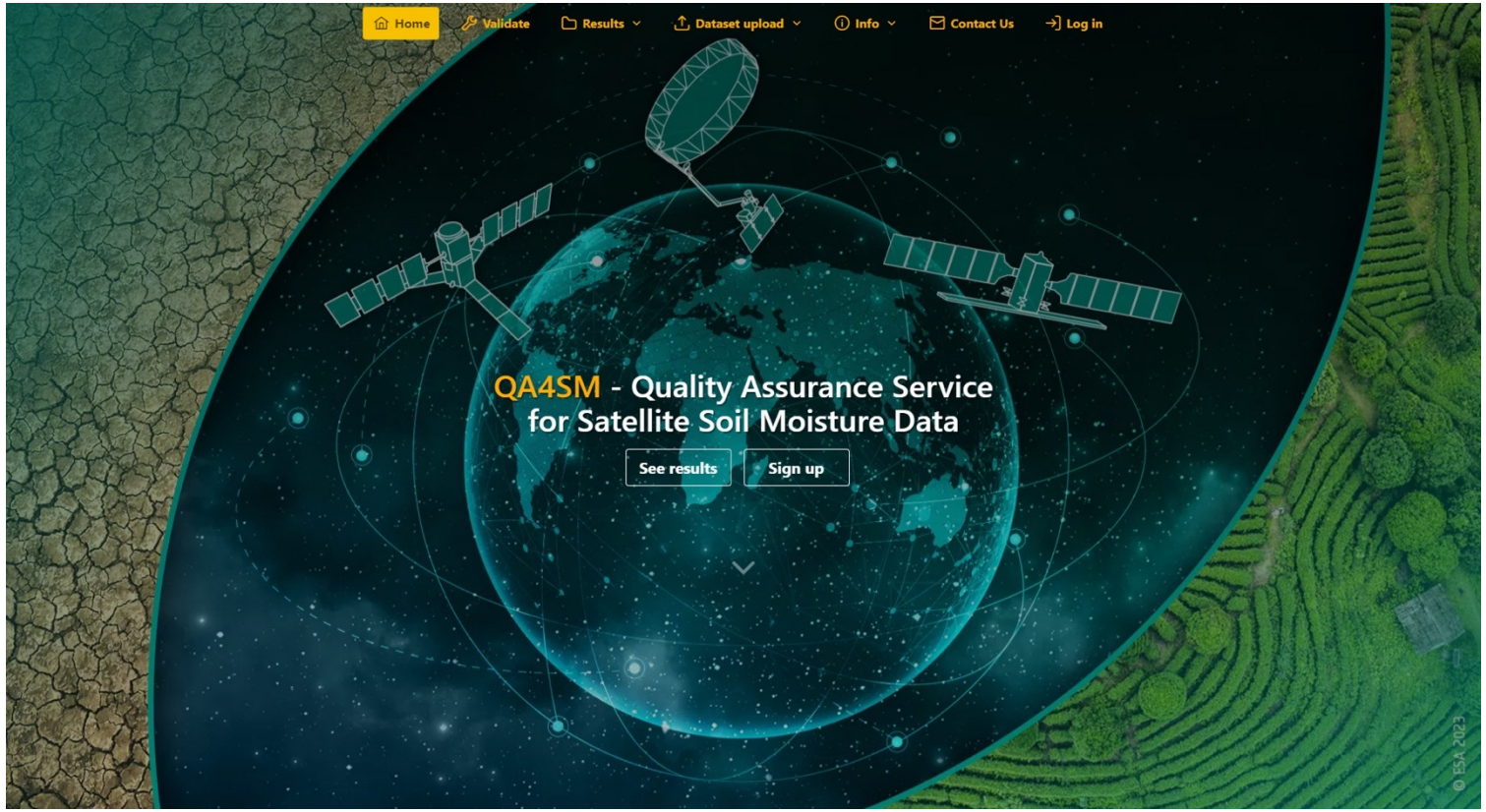


The governance structure for GEO-TREES is currently under review. Our mission is for the governance to represent all key stakeholders in the global GEO-TREES initiative. We expect to implement an updated governance model by the end of January 2024.

Soil Moisture (1/2)

Quality Assurance for Soil Moisture (QA4SM; https://qa4sm.eu/)

- New release (facelift, new features...)
- Soon: functionality for fully automated regular dataset validation using FRMs and good practice protocols
- QA4SM workshop planned during the 7th Soil Moisture Validation and Application Workshop (East Lansing, 4 – 7 June 2024)



Soil Moisture (2/2)

Upcoming workshops:

- BIPM-WMO Metrology for Climate Action Workshop 2024
  - 16-18 September @ BIPM headquarters, Sevres, France (hybrid)
  - Call for papers expected in February
  - 2022 workshop report: https://www.bipm.org/en/doi/10.59161/Rapport202303

Relevant projects:

- 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.

Vegetation Indices

- Focus Area lead recruitment status
- Protocol Development

Land Cover

- Protocol development update (Stehman and Foody to review entire document. LPV leads to also have a look.) Looking to have a version for the LC community in the next month or two.

- Reviewing product list. Need to confer on final edits. The LC leads are considering limiting their Product page to only those with validation information, due to the heritage of these products and their value and usage. The subgroup decided that this can be done by focus area. Many older products that may not be validated are sometimes the only LC source for that time frame and are thus still used in LC change studies.

- New co-lead recruitment, ready to formally invite identified candidate.

Biophysical

Richard Fernandes

- Will be joining as a new co-lead and will lead the update of LAI validation good practices

Renewal of co-lead: proposed names

- Kai Yan (MODIS team) , Hao Tang (GEDI product), Bert Gielen (ICOS for satellite validation)

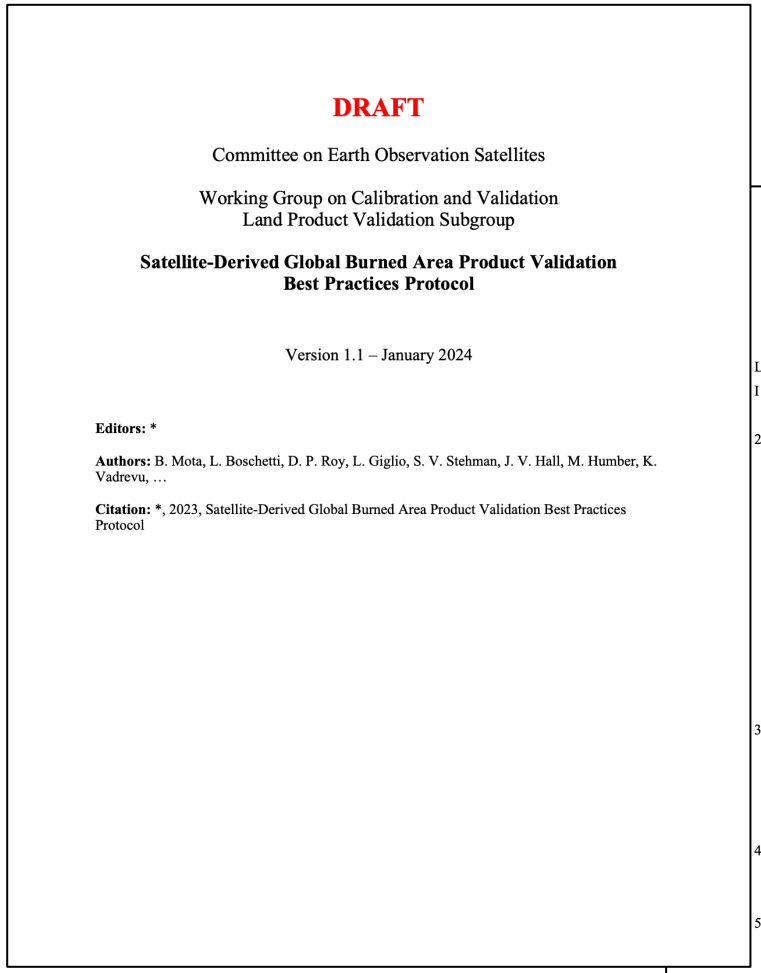
New product to be added to the LPV page

- Dataset Record: ESA Vegetation Parameters Climate Change Initiative (Vegetation_Parameters_cci): LAI and fAPAR, Version 1.0 (ceda.ac.uk)
- Numerical inversion of a radiative transfer model for each pixel (OptiSAIL). The data have a 5-day temporal resolution, but data from moving 10-day window intervals have been used as input for the retrieval

Fire Disturbance (1/3)

Validation Protocol Status

- Update of 11-page 2010 draft burned area validation protocol ongoing
- Currently 22 pages
- Engaged additional section authors
- Active Fire protocol to follow



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Committee on Earth Observation Satellites

Working Group on Calibration and Validation
Land Product Validation Subgroup

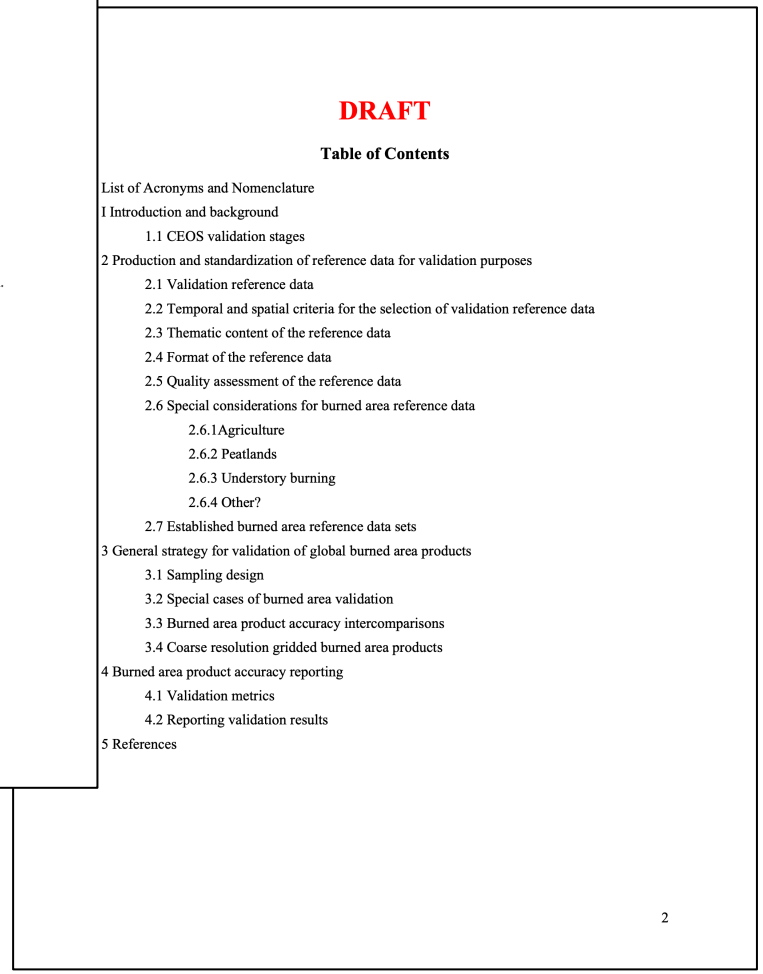
Satellite-Derived Global Burned Area Product Validation Best Practices Protocol

Version 1.1 – January 2024

Editors: *

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

Citation: *, 2023, Satellite-Derived Global Burned Area Product Validation Best Practices Protocol



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Fire Disturbance (2/3)

Recent Publications – Active Fire

- Schiks, T. J., Wotton, B. M., & Martell, D. L. (2024). Remote Sensing Active Fire Detection Tools Support Growth Reconstruction for Large Boreal Wildfires. *Fire*, 7, 26.
  - *"Our study findings highlight the need for future validations to account for the presence of spatial autocorrelation, a pervasive issue in ecology that is often neglected in day-of-burn analyses."*

Fire Disturbance (3/3)

Recent Publications – Burned Area

- Walker, K. (2024). Overcoming Common Pitfalls to Improve the Accuracy of Crop Residue Burning Measurement Based on Remote Sensing Data. *Remote Sensing*, 16, 342.
- Guo, R., Yan, J., Zheng, H., & Wu, B. (2024). Assessment of the Analytic Burned Area Index for Forest Fire Severity Detection Using Sentinel and Landsat Data. *Fire*, 7, 19.
- Liu, P., Liu, Y., Guo, X., Zhao, W., Wu, H., & Xu, W. (2023). Burned area detection and mapping using time series Sentinel-2 multispectral images. *Remote Sensing of Environment*, 296, 113753.

LST & E (1/3)

Upcoming Conferences

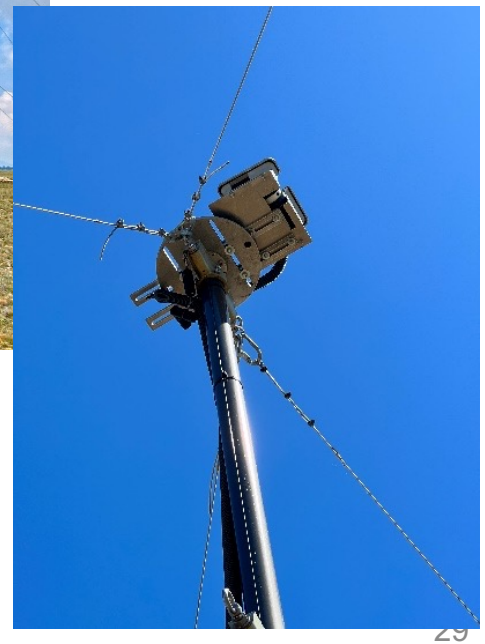
- Surface Biology and Geology (SBG) annual workshop, June 4-6, 2024
- EARSeL Symposium, Manchester, June 17-20
- IGARSS, Athens, 7-12 July 2024 special session on TIR:
  - Innovative EO applications based on high spatial and temporal resolution thermal data
- 7th International Symposium on Recent Advances in Quantitative Remote Sensing (RAQRS'VII), Valencia, Sep 23-27

- TIRCALNet preparation study, coordination meeting in January 2024
- Extension of Copernicus LAW stations is ongoing
- ECOSTRESS forward processing and reprocessing for Collection 2 higher level products (ET, ESI, WUE) has begun
- SBG-TIR Key Decision Point (KDP)-B expected in March 2024
- International science workshop on High resolution Thermal remote sensing expected in India during November 2024

LST & E (2/3)

TIRCalNet Preparation Study

- Goal: Prepare the roadmap for the TIRCalNet operations.
- Cooperation between TIRCalNet Preparation Study team (Uni. Leicester, KIT, RAL Space) and CNES and JPL.
- Study at La Crau site:
  - Characterization of site uncertainties.
  - Characterization of instruments uncertainties.
  - Characterization of atmospheric propagation approach.



LST & E (3/3)

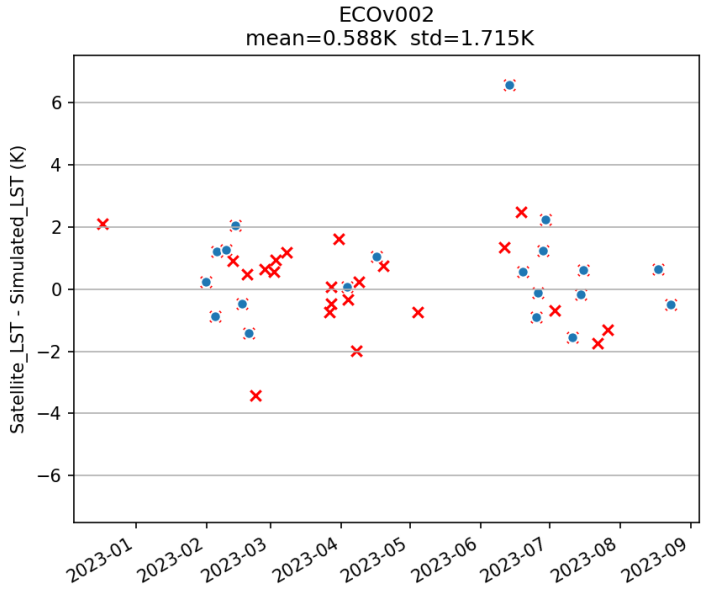
First LST validation results at La Crau, France

CNES decision to develop an instrumented site for thermal infrared sensors for future TIR missions, including CNES/ISRO mission TRISHNA, at La Crau, France in addition to the current RadCalNet site

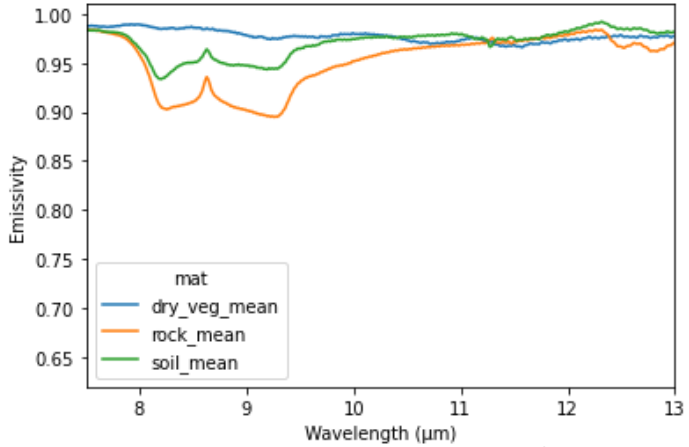
- Dec 2022: Installation of a JPL radiometer (NASA/JPL)
- June 2023: Installation of a CIMEL CE312 radiometer (LOA)

Slight positive bias + significant dispersion

Blue dots → visual check of the image (cloud mask / radiometric artefacts)



Current processing: Emissivity derived from the fraction of vegetation and sample measurements (NASA JPL)



→ Future processing: Emissivity estimation is the main area for improvement

→Temperature/Emissivity separation using the CIMEL CE312 multi-spectral data

Surface Radiation (1/3)

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

- FA Web Status Updates

Focus Area	Home Page	Product table	Collaboration Page	References	Listserv	Letters to Community
Surface Rad/Albedo	Jan 2024	In progress	In progress	In progress	Dec 2024	draft

Surface Radiation (2/3)

- **New publications**

Upgrade and extension of LSA-SAF land surface albedo archive from EPS Metop/AVHRR: description and quality assessment

Anthéa Delmotte, Daniel Juncu, Xavier Ceamanos, Isabel F. Trigo & Sandra Gomes

Article: 2300043 | Received 03 Dec 2022, Accepted 22 Dec 2023, Published online: 21 Jan 2024

- Surface Albedo CDR based on EPS Metop/AVHRR.

Data generation	Satellite	Sensor	Metop-A	Metop-B	Spatial Coverage
Reprocessing (ETAL-R)	Metop-A and B	AVHRR	2007/01/25–2014/12/31	2015/01/01–2021/06/30	Global

- Validation based on CEOS LPV protocol, but spatially limited:
  - Evaluation completeness and stability.
  - Direct validation is very limited: only data from 6 stations are used.
  - Local product intercomparison with MODIS as reference (6 stations + 4 additional areas).

Surface Radiation (3/3)

Upcoming Meetings

- **International Radiation Symposium 2024,** Hangzhou, China -- 17-21 June 2024
  http://www.irs2024.org/

- **18th BSRN Scientific Review and Workshop,** Japan Meteorological Agency Headquarters, Tokyo, Japan-- 1-5 July 2024.
  https://bsrn.awi.de/meetings/2024/

- **7th International Symposium on Recent Advances in Quantitative Remote Sensing,** Torrent (Valencia)-Spain-- 23-27th September 2024.
  https://ipl.uv.es/raqrs

- **Special Issue – "Remote Sensing of Solar Radiation Absorbed by Land Surfaces“**
  https://www.mdpi.com/journal/remotesensing/special_issues/V7S2F2XJ36

Land Surface Phenology

- No input

Snow (1/3)

Recent Publications

Article

Evidence of human influence on Northern Hemisphere snow loss

https://doi.org/10.1038/s41586-023-06794-y
Received: 2 March 2023
Accepted: 24 October 2023
Published online: 10 January 2024
Open access
Check for updates

Alexander R. Gottlieb[1,2] & Justin S. Mankin[2,3,4]

Documenting the rate, magnitude and causes of snow loss is essential to benchmark the pace of climate change and to manage the differential water security risks of snowpack declines[1–4]. So far, however, observational uncertainties in snow mass[5,6] have made the detection and attribution of human-forced snow losses elusive, undermining societal preparedness. Here we show that human-caused warming has caused declines in Northern Hemisphere-scale March snowpack over the 1981–2020 period. Using an ensemble of snowpack reconstructions, we identify robust snow trends in 82 out of 169 major Northern Hemisphere river basins, 31 of which we can confidently attribute to human influence. Most crucially, we show a generalizable an highly nonlinear temperature sensitivity of snowpack, in which snow becomes marginally more sensitive to one degree Celsius of warming as climatological winter temperatures exceed minus eight degrees Celsius. Such nonlinearity explains the lac of widespread snow loss so far and augurs much sharper declines and water security risks in the most populous basins. Together, our results emphasize that human-forc snow losses and their water consequences are attributable—even absent their clear detection in individual snow products—and will accelerate and homogenize with near-term warming, posing risks to water resources in the absence of substantial climate mitigation.

News & views

Climate science

Snow loss pinned to human-induced emissions

Jouni Pulliainen

Analysis of a large, varied data set reveals that snow cover in the Northern Hemisphere has undergone marked changes in the past four decades. Evidence that humans caused the shift suggests that snow loss will accelerate in the future. See p.293

climate-model predictions of these variables. The authors modelled the historical change in snow water equivalent on the basis of observations, and estimated the impact of humans on snow loss by combining the data-based model with climate-model predictions. In general, climate-model simulations do not capture the spatio-temporal behaviour of snow water equivalent accurately enough to register changes at the scale of river basins. Gottlieb and Mankin overcame this problem by assessing the relationship between snow mass and the two driving variables — precipitation and temperature — through analysis of an extensive data set of observations in the Northern Hemisphere. The analysis revealed that anthropo-

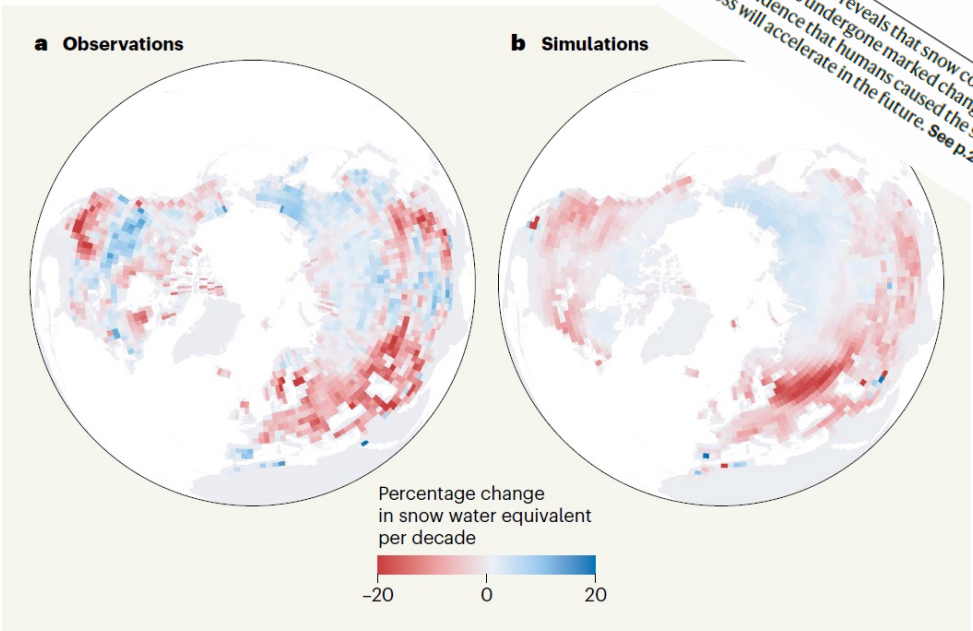


Figure 1 | Mapping human-induced snow loss. Gottlieb and Mankin[1] assembled data from various sources to reveal the temperature dependence of a measure of snow mass known as snow water equivalent. **a**, They showed that March snow mass generally decreased between 1981 and 2020 at low latitudes in the Northern Hemisphere. Shown here is an ensemble of 'gridded' snow data, which are interpolated over a spatially uniform grid. **b**, Climate-model simulations that include both natural and anthropogenic drivers correlate with the observations shown in **a** more closely than do simulations that include only natural drivers (not shown). However, simulations alone are not sufficient to reproduce river-basin-scale trends. This disagreement highlights the need for Gottlieb and Mankin's innovative fusion of data and modelling to predict the impact of humans on the future availability of fresh water. (Adapted from Fig. 2 in ref. 1.)

Snow (2/3)

SNOW – Field Measurement Schools

SNOW MEASUREMENT FIELD SCHOOL 2024

JANUARY 8 - 11, 2024

Location: AMC Highland Center at Crawford Notch in Bretton Woods, New Hampshire

Photo credit: CUAHSI

EGU SNOW SCIENCE WINTER SCHOOL 2024

FEBRUARY 25 – MARCH 2, 2024

Location: FMI Arctic Research Centre, Sodankylä, Finland

Lots of interest:

- Over 80 applications for CUAHSI school (30 slots)
- Over 60 applications for EGU school (26 slots)

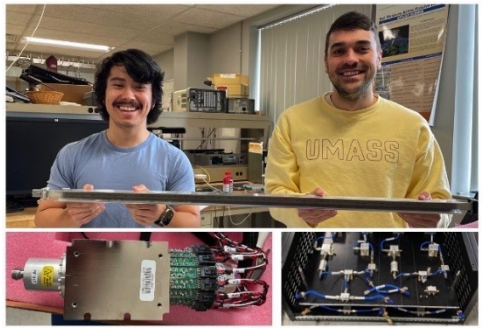
Snow (3/3)

Campaigns:

- University of Waterloo is conducting ongoing flights with their L-band and Ku-band (low) radar, CryoSAR, with coordinated ground measurements
  - Regular flights over Powassan, Ontario
  - Campaign planned for April in Cambridge Bay
- Finnish Meteorological Institute (FMI) has been conducting tower-based radar experiment at Sodankylä site
  - Focus on microwave signatures over northern wetlands, as proxy for methane emissions (2023-24)
  - SAR interferometry (L-band) for SWE over boreal forest
- **NASA IIP instrument, SNOWWI - C, Ku-band (low and high) - will be flown over Grand Mesa, CO in Feb** and April, 2023

Missions:

- Preparations for CIMR – passive microwave mission, will include retrieval algorithm for snow
- NASA Earth System Explorer – 2 snow mission concepts in review
- TSMM – Canadian snow mission concept (pre-Phase A)



Snow Water-equivalent Wide Swath Interferometer and Scatterometer (SNOWWI)

	Band	Freq (GHz)	Pol
Active	C	5.35	VV,VH
Active	Ku-Lo	13.60	VV,VH
Active	Ku-Hi	17.25	VV,VH

	Band	Freq (GHz)	Pol
Active	C	5-6	VV, HH, HV, VH
Active	Ku	14-15	VV, HH, HV, VH