Land Product Validation (LPV) Sub-group Meeting

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

Subgroup meeting
5 Dec 2023

NEXT LPV TELECON Feb 6, 2024

WORKING GROUP ON CALIBRATION & VALIDATION

Attendance

Participants

Michael Cosh
Fabrizio Niro
Jaime Nickeson
Lluis Perez-Planells
Joshua Gray
John Bolten
Tomoaki Miura
Angela Erb
Luke Brown
Victor Rodríguez-Galiano
Jorge Sanchez-Zapero
Carrie Vuyovich
Sylvain Leblanc
Sasha Tyukavina
Alex Gruber
Laura Duncanson
Juha Lemmetytinen
Glynn Hulley

Unavailable

Joshua Gray
Sophie Bontemps
Marie Weiss
Kim Calders
Neha Hunka
Louis Giglio
Bernardo Mota
Else Swinnen

2023 Focus Area Leads

	First Name	Last Name	Institution	Country	End of Term	Candidates
Admin	Michael	Cosh	USDA	USA	Apr 2025	
	Fabrizio	Niro	ESA	Italy	Apr 2025 (becomes 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)**	Nandika Tsendbazar
Biophysical	Marie	Weiss	INRA	France	**Sep 2023 (2nd term)**	Richard Fernandes
	Sylvain	Leblanc	Natural Resources Canada	Canada	**Sep 2023 (2nd term)**	Kai Yan
	Luke	Brown	University of Salford	UK	Jan 2026 (1st term)	
Fire/Burn Area	Louis	Giglio	University of Maryland	USA	Sep 2023 (1st term)	
	Bernardo	Mota	National Physical Lab	UK	Jan 2026 (1st term)	
Surface Rad	Zhuosen	Wang	GSFC	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 2023 (1st term)	
	Alexander	Gruber	TU Wien	Austria	**Oct 2023** (1nd 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	Finnish Meteorologial Inst.	Finland	Sep 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
						Carmelo Cammalleri
GPP/NPP						Maosheng Zhao

WCGV and LPV Plenary

Upcoming WGCV Plenaries

- *WGCV-53, March 5-8, 2024 CONAE, Cordoba, Argentina*
- *WGCV-54, Late 24 USGS, Sioux Falls, South Dakota*

American Geophysical Union Fall Meeting

LPV Town Hall, San Francisco, California

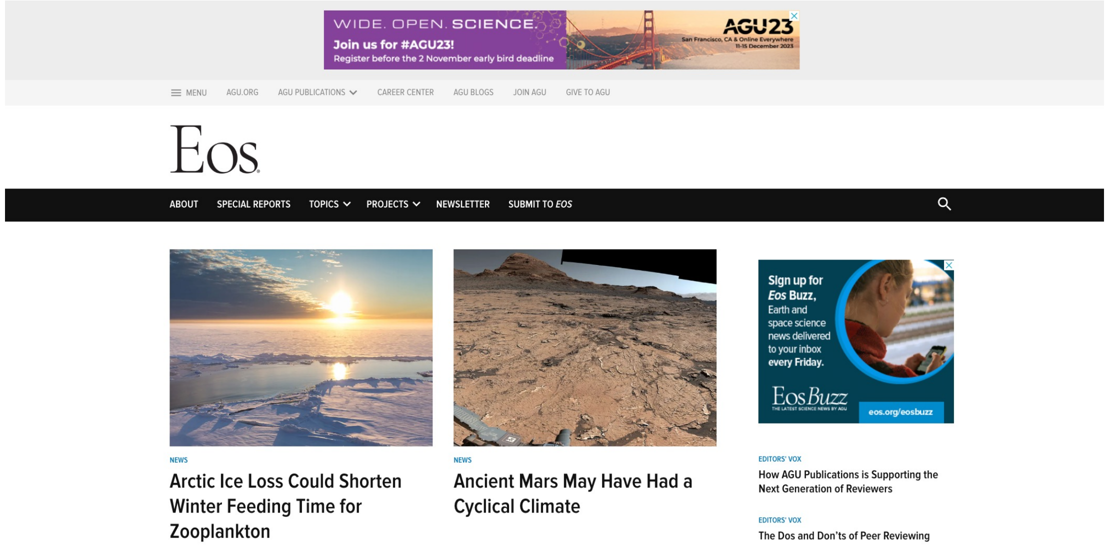
14 December 2023, Thursday 1pm PST

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

EOS paper: outcomes of LPVE23 WS

- A paper was prepared by F. Niro, M. Cosh and J. Nickeson to summarize the main takeaways from LPVE23 WS
- The paper was submitted to **EOS science magazine** published by AGU
- The paper was **accepted** for publication, the provisional title is (final editing on-going): ***Trustworthy Satellite Earth Observations for Science and Society***
- The aim of the paper is to raise **awareness** about the critical role of validation in both science and societal applications and to highlight remaining challenges and data gaps, as well as stressing the need for sustainability



Validation Stages

What needs to be moved to different validation stage?

Split snow into snow extent and SWE. Move to higher categories (TBD)

Biomass needs to be moved to stage 2 or possibly 3.

	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**

New Focus Areas

- Evapotranspiration (ET): Yun Yang, Carmelo Cammalleri
  - ECOSTRESS, GOES, LSTM, SBG, +
- Gross Primary Productivity/Net Primary Productivity (GPP/NPP):
  - FLEX, Landsat, NISAR, +

Protocols Status – Updates or Still on Track?

Focus Area	Protocol
Biophysical	LAI(2014)
Fire/Burn Area	Burned Area Targeting 2023 Active Fire next
Phenology	Targeting 2023
Vegetation Index	Targeting 2023 (60%)
Land Cover	Targeting 2023 (60%)
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

FA Web Status

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

Please update these by next call if you have not done so.

If anyone cannot access still, please reach out to me.

Focus Area	Home Page	Product table	Collaboration Page	References	Listserv	Letters to Community
Land Cover	May 2021	Sept 2022	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	Mar 2021	Jan 2023	Mar 2021	Oct 2022	Dec 2023	May 2020
LST/Emissivity	Mar 2021	Nov 2021	Mar 2021	Feb 2023	Dec 2023	
Fire/Burn Area	May 2021	Aug 2022	Mar 2020	Aug 2022	Dec 2023	
Soil Moisture	Mar 2021	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

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

Snow (1/3)

Recent Publications

Remote Sensing of Environment 300 (2024) 113843

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

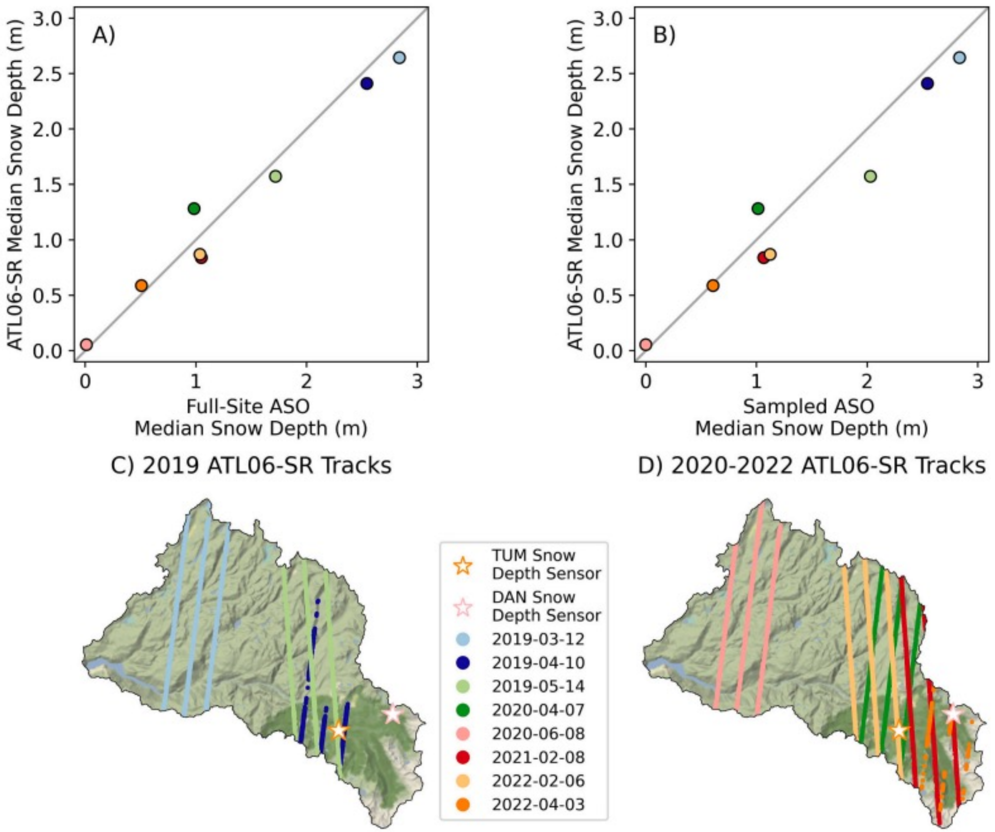
ELSEVIER

Mountain snow depth retrievals from customized processing of ICESat-2 satellite laser altimetry

Hannah Besso *, David Shean, Jessica D. Lundquist

University of Washington Department of Civil and Environmental Engineering, 1400 NE Campus Parkway, Seattle, WA 98195, United States of America

ICESat-2 data used to estimate basin-wide average snow depth in Tuolumne Basin, California



Snow (2/3)

SNOW – Field Measurement Schools

SNOW MEASUREMENT FIELD SCHOOL 2024

JANUARY 8 - 11, 2024

APPLICATION DEADLINE 10.18.2023

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

https://www.cuahsi.org/workshops/snow-measurement-field-school-2024

EGU SNOW SCIENCE WINTER SCHOOL 2024

FEBRUARY 25 – MARCH 2, 2024

APPLICATIONS OPEN OCTOBER 2023

Location: FMI Arctic Research Centre, Sodankylä, Finland

Both have selected participants
Lots of interest:

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

Snow (3/3)

Snow Campaign & Mission Activities

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)

Aboveground Biomass (1/3)

GEO-TREES update:

- BCI (Panama) completed in 2023. Led by Helene Muller-Landau.

  Census + ALS + TLS (3ha, instrument on loan from Ghent Uni)

- More sites (TBC) planned for 2024 by UCL and GFZ

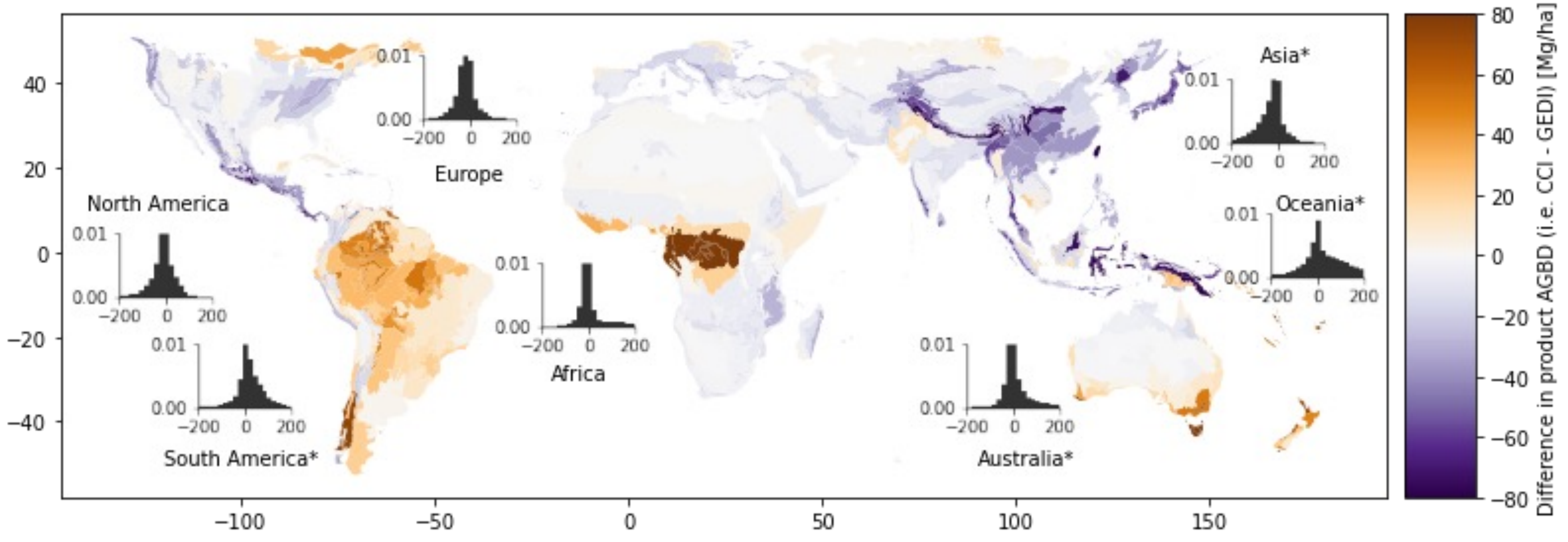
Photo credit: Luisa Fernanda Gómez Correa

Aboveground Biomass (2/3)

Biomass Harmonization: Product Intercomparison

Paper on NASA GEDI and ESA CCI global AGB map comparisons:

CCI 2020 v4 – GEDI AGBD v2



Paper presents an inter-comparison of the NASA GEDI v2 AGB estimates and ESA CCI v4 estimates, and the comparison of these estimates to NFI-based estimates in Mexico, Peru, Spain and Laos. It discusses how AGB map producers must align to inform policy and the UNFCCC GST.

https://iopscience.iop.org/article/10.1088/1748-9326/ad0b60

Aboveground Biomass (3/3)

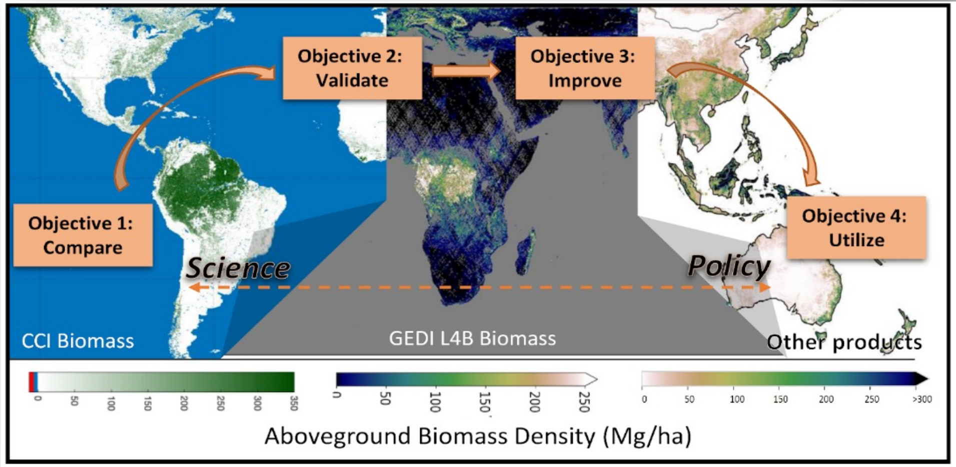
Upcoming Harmonization Work

- Biomass Expert's Workshop: March 20-22 2024

The University of Maryland and the USGS SilvaCarbon program are proposing a meeting with the AGB product developers, IPCC and a couple of stakeholder countries to find ways to integrate AGB maps in national reporting, ways to deal with the discrepancies in the products and in the uncertainty estimation underlying the methods in the products.

Expert Workshop: Basis and guidance for AGB map uptake
17 - 22 March 2024

Harmonizing Biomass Maps With Policy Needs:
Development of National Prototypes for Global Stocktake



- NASA CMS 2023 Grant:
  - Mexico, Ecuador, Ghana, Senegal

https://iopscience.iop.org/article/10.1088/1748-9326/ad0b60

Soil Moisture (1/4)

Cross-community workshop

International Space Science Institute (ISSI) workshop in Bern, Switzerland (13–17 November, 2023)

“Remote Sensing in Climatology – Essential Climate Variables (ECVs) and their uncertainties”

Bartsch	Annett	bgeos
Blazquez	Alejandro	LEGOS
Blessing	Simon	FastOpt GmbH
Bogusz	Janusz	Military University of Technology, Warsaw
Boergens	Eva	GFZ Potsdam
Bulgin	Claire	University of Reading
Camacho	Ferndando	University of Valencia
Cuynet	Amelie	LSCE/IPSL
Devastahale	Abhay	SMHI
Dobslaw	Henryk	GFZ Potsdam
Dorigo	Wouter	TU Wien
Gobron	Kevin	Université de Paris
Gou	Junyang	ETH Zurich
Gruber	Alexander	TU Wien
Güntner	Andreas	GFZ Potsdam
Hewitt	Helene	Metoffice
Hohensinn	Roland	ISSI Bern
Hollmann	Rainer	Deutscher Wetterdienst
Jäggi	Adrian	Universität Bern
Kern	Stefan	Universität Hamburg
Klos	Anna	Military University of Technology, Warsaw
Krinner	Gerhard	CNRS

Langsdale	Mary	Kings College London
Lavergne	Thomas	Meteorologisk institutt
MacIntosh	Claire	ESA-ECSAT
Mecklenburg	Susanne	ESA climate office
Merchant	Chris	University of Reading
Meyer	Ulrich	Universität Bern
Mikalsen	Anna-Christina	Deutscher Wetterdienst
Mittaz	Jonathan	University of Reading
Montillet	Jean-Phillipe	Universidade da Beira Interior / PMOD/WRC
Mortimer	Colleen	Environment and Climate Change Canada
Munoz-Sabater	Joaquin	ECMWF
Olivera	Louis	LSCE/IPSL
Povey	Adam	University of Leicester
Rast	Michael	ISSI Bern
Rayner	Nick	Metoffice
Salberg	Arnt-Børre	Norwegian Computing Center
Soja	Benedikt	ETH Zürich
Tetzlaff	Anke	meteoswiss
Velicogna	Isabella	UC Irvine
Verhoelst	Tijl	Belgian Institute for Space Aeronomy
Wooliams	Emma	National Physics Laboratory
Wunderle	Stefan	Universität Bern

Soil Moisture (2/4)

Cross-community workshop -

Several collaborative peer-reviewed articles planned; published as a volume of the ISSI Space Science Series in Springer's Surveys in Geophysics (aiming at end 2024)

- Status quo of uncertainty budgets for ECVs from gravity field recovery missions (Jäggi et al.)
- Observations fit for climate science: accounting for uncertainty and handling covariances (Wooliams et al.)
- Building uncertainty trees and informing uncertainty across data levels (Mittaz et al.)
- Uncertainty of uncertainty estimates (Gobron et al.)
- Uncertainties of ECVs from deep learning (Gou et al.)
- Technical approaches to uncertainty propagation and covariance computation (Blessing et al.)
- Best practices for estimating trends from (selected) ECV time series (Hohensin et al.)
- Uncertainty validation (Verhoelst et al.)
- Making sense of uncertainties – asking the right questions (Gruber et al.)
- How to use uncertainty information in the analysis of ECVs (Povey et al.)
- Uncertainty components at different spatial and temporal scales (Bulgin et al.)
- Assessing stability in ECVs (Dorigo et al.)
- Pitfalls of using independent observations for evaluation without thinking (Kern et al.)

Soil Moisture (3/4)

Validation of high-resolution soil moisture products

- The community is moving towards higher-resolution soil moisture products 25–40 km → 1–3 km → field scale (currently mostly experimental)

- **Currently, no agreed-upon approach to evaluate the added information content in downscaled / high-resolution products**

- Soil moisture products mostly evaluated in terms of their skill in capturing temporal dynamics rather than absolute values
  - Most high-resolution products outperformed by coarse-resolution products when compared to ground measurements
  - More relevant: **Spatial** information content

Candidate for an update to the soil moisture validation good practices protocol!

- A method has been proposed by Crow et al. (2022)
  - Evaluating temporal and spatial skill using sparse networks
    - Criterion 1 (temporal information): $\mathrm{Var}(\mathrm{SM_C} - \mathrm{SM_P}) - \mathrm{Var}(\mathrm{SM_F} - \mathrm{SM_P})$
    - Criterion 2 (spatial information): $R^2(\mathrm{SM_F}, \mathrm{SM_P}) / R^2(\mathrm{SM_C}, \mathrm{SM_P})$

Crow, W. T., Chen, F., & Colliander, A. (2022). Benchmarking downscaled satellite-based soil moisture products using sparse, point-scale ground observations. *Remote Sensing of Environment*, *283*, 113300. https://doi.org/10.1016/j.rse.2022.113300

Soil Moisture (4/4)

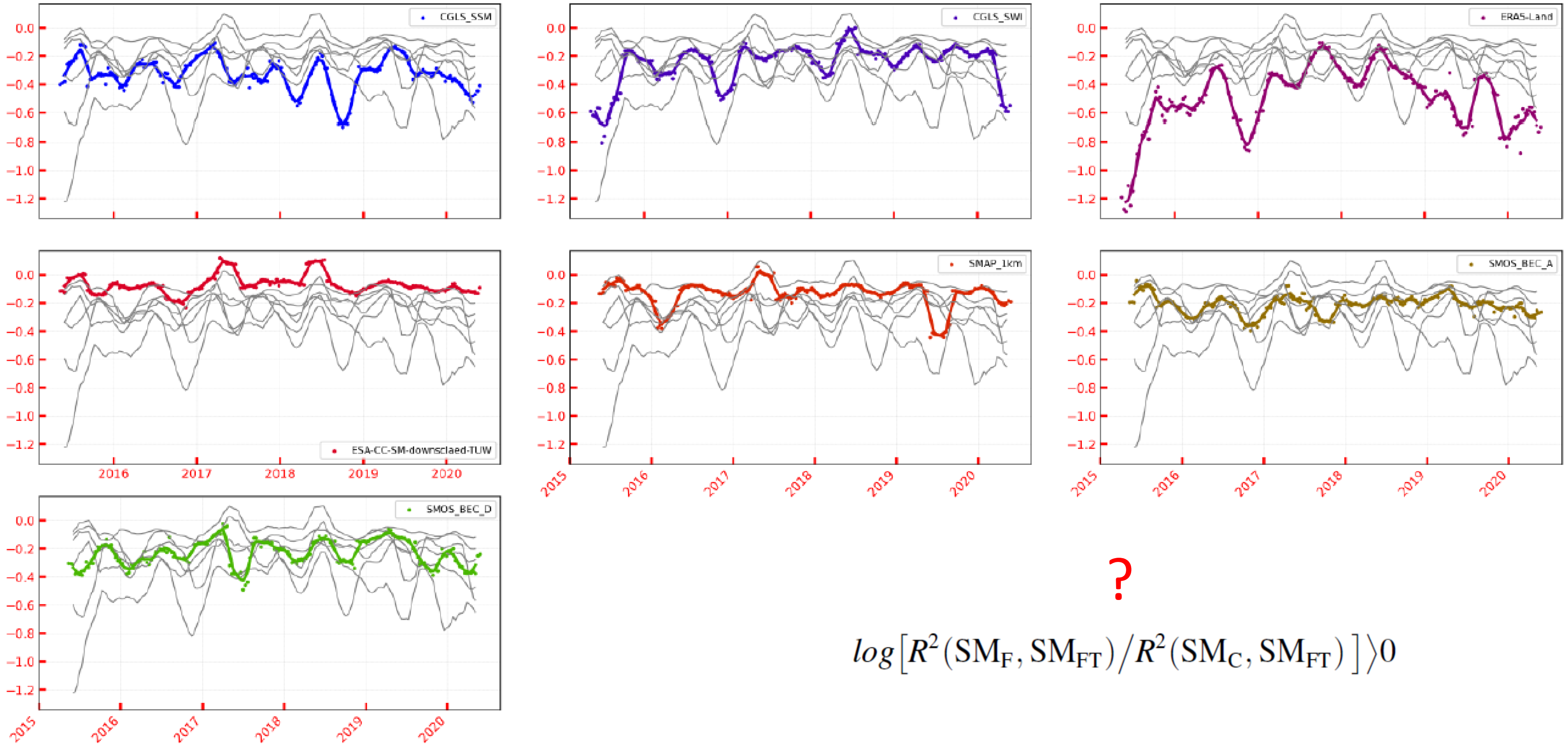
Validation of high-resolution soil moisture products

Example: Comparison of the spatial **skill of 1 km products relative to that of ESA CCI SM (25 km)**

Carried out as part of the 4D-Hydro project (ESA)

Products used:

- CGLS (Sentinel-1 retrieval)
- CGLS-SWI (ASCAT/S-1 fusion)
- ERA5-Land (modelled)
- ESA CCI (downscaled)
- SMAP BEC (downscaled)
- SMOS BEC (downscaled)



?

$$log\left[R^2(SM_F, SM_{FT})/R^2(SM_C, SM_{FT})\right]\rangle 0$$

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 (January 31, 2023)
- Revised the outline and shared the revised outline with them (March 15, 2023)
- Completed the first complete draft (December 3, 2023)
- Plan to have the group review one more time and send out for community-wide feedback (December 2023 or January 2024)

Co-lead Recruitment

- Included the recruitment information in the latest news letter
- Plan to ask several people for interest after the first protocol draft is ready for community-wide feedback

Vegetation Indices (2/2)

Contents

Land Cover (1/2)

Protocol update: first draft 90% ready

- First draft in progress (co-author review and edits)
- First draft finalized

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

Tentative outline:

✓ Compiled first draft will be sent to all co-authors for comments by the end of 2023

✓ Protocol version 0.0 to be sent out for broader community review early in 2024

Land Cover (2/2)

Product list update ongoing…

- ✓ Update data access/validation links;
- ✓ Update temporal coverage for the products that are being updated;
- ✓ Add missing recently published maps (e.g. global 10-m resolution land cover maps);
- ✓ Remove datasets with missing validation information, continental-scale datasets not updated, and prototype products that have been replaced with operational products.

	A	B	C	D	E	F	G	H	I	J
1	Topic	ProductCategory	ProductDescription	ProductID	Institution	WGCVgroup	SpatialCoverag	TemporalScale	SpatialScale	Source
5	LC	Land Cover Products - (	Global Land Cover	IGBP-DIScover	IGBP	Land Cover	global	annual	1 km	AVHRR
6	LC	Land Cover Products - (	Global Land Cover	UMD	University of Maryland	Land Cover	global	annual	1 km, 8 km, 1 de	AVHRR
7	LC	Land Cover Products - (	Global Land Cover	LC-CCI	ESA	Land Cover	global	annual	300 m	AVHRR, SPOT-V
8	LC	Land Cover Products - (	Global Land Cover	GLC2000	JRC	Land Cover	global	annual	1 km	SPOT-VGT
9	LC	Land Cover Products - !	Global mangrove distribution		USGS (distributed by I	Land Cover	global	annual	30 m	Landsat
10	LC	Land Cover Products - !	Global urban exten	MODIS Urban E	University of Wisconsi	Land Cover	global	annual	500m	MODIS
11	LC	Land Cover Products - (	Land Cover		Commission for Envirc	Land Cover	North America	annual	250 m	MODIS
12	LC	Land Cover Products - (	Global Land Cover	GlobeLand30	National Geomatics C	Land Cover	global	annual	30 m	Landsat and HJ-1
13	LC	Land Cover Products - (	Global Land Cover	FROM-GLC	Tsinghua University	Land Cover	global	annual	30 m	Landsat
14	LC	Land Cover Products - (	Global Land Cover	FROM-GLC	Tsinghua University	Land Cover	global	annual	10 m	Sentinel-2
15	LC	Land Cover Products - (	Global Land Cover	MCD12C1	NASA/Boston Universi	Land Cover	global	annual	0.05 deg	MODIS
16	LC	Land Cover Products - (	Global Land Cover	MCD12Q1	NASA/Boston Universi	Land Cover	global	annual	500 m	MODIS
17	LC	Land Cover Products - !	Global forest cover	Global forest cha	University of Maryland	Land Cover	global	annual	30 m	Landsat
18	LC	Land Cover Products - !	Global cropland ex	MODIS Croplanc	NASA and USDA (GL	Land Cover	global	8-year	250 m	MODIS
19	LC	Land Cover Products - (	Global Land Cover	GLCNMO	CEReS and Chiba Uni	Land Cover	global	annual	1 km	MODIS
20	LC	Land Cover Products - (	Global Land Cover	GlobCover	ESA	Land Cover	global	annual	300 m	MERIS
21	LC	Land Cover Change	Land Cover Chang		Commission for Envirc	Land Cover	North America	annual	250 m	MODIS
22	LC	Land Cover Products - (	Land Cover		Commission for Envirc	Land Cover	North America	annual	30 m	Landsat
23	LC	Land Cover Products - (	Land Cover		Commission for Envirc	Land Cover	North America	annual	250 m	MODIS
24	LC	Land Cover Products - !	Global water bodie	LC-CCI Water Bc	ESA	Land Cover	global	decadal	150 m	Envisat-ASAR
25	LC	Land Cover Change	Land Cover Chang		Commission for Envirc	Land Cover	North America	annual	30 m	Landsat
26	LC	Land Cover Products - !	Global urban exten	Global Urban Fo	DLR	Land Cover	global	annual	12 m, 84 m	TerraSAR-X, Tanl
27	LC	Land Cover Products - !	European urban ex	European Settler	JRC	Land Cover	pan-European	annual	2.5 m, 10 m, 100	SPOT5 and SPO
28	LC	Land Cover Products - (	Surface Type		NOAA	Land Cover	global	annual	1 km	VIIRS
29	LC	Land Cover Products - (	Land Cover		Commission for Envirc	Land Cover	North America	annual	30 m	Landsat/RapidEy
30	LC	Land Cover Products - !	Global cropland ex	GFSAD	USGS	Land Cover	global	annual	30 m	Landsat, MODIS,
31	LC	Land Cover Products - (	Global Land Cover	Copernicus Glob	EU Copernicus Land I	Land Cover	global	annual	100 m	PROBA-V
32	LC	Land Cover Products - (	Global Land Cover	C3S Land Cover	EU Copernicus Climat	Land Cover	global	annual	300 m	AVHRR, SPOT-V
33	LC	Land Cover Change	Long Term Global I	Long Term Globa	University of Maryland	Land Cover	global	annual	0.05 degree	AVHRR
34	LC	Land Cover Products - (	Global Land Cover	Global Land Cov	University of Maryland	Land Cover	global	annual	30m	Landsat
35	LC	Land Cover Products - !	Global Cropland ex	Global Cropland	University of Maryland	Land Cover	global	4-year epochs	30 m	Landsat
36	LC	Land Cover Products - !	Global Surface Wa	Global Surface V	University of Maryland	Land Cover	global	annual, monthl	30m	Landsat
37	LC	Land Cover Change	Global Land Cover	UMD Global LCL	University of Maryland	Land Cover	global	5 years	30m	Landsat
38	LC	Land Cover Products - (	Global Land Cover	WorldCover	ESA	Land Cover	global	annual	10m	Sentinel-1, Sentir
39	LC	Land Cover Products - (	Global Land Cover	GLC-FCS30	Chinese Academy of S	Land Cover	global	annual	30m	Landsat
40	LC	Land Cover Products - (	Global Land Cover	ESRI Land Cove	ESRI	Land Cover	global	annual	10m	Sentinel-2
41	LC	Land Cover Products - (	Global Land Cover	Dynamic World	Google	Land Cover	global	near real-time	10m	Sentinel-2
42										
43		current updates (Dec 1 2023, Sasha T) - agreed to add with Sophie								
44		consider removing - pending								
45		broken link, can't find working								
46		agreed to remove with Sophie								
47										

	K	L	M	N	O	P
1	DataLink	Contact	ContactEmail	ValidationLink	Publication	TemporalCoverage
5	https://daac.ornl.gov/cgi-bin/dsviewe	Userservices	uso@daac.ornl.gov		Husak et al., 1999; Sce	1992 - 1993
6	https://daac.ornl.gov/cgi-bin/dsviewe	Matt Hansen	mhansen@umd.edu		Hansen, et al., 2000	1992 - 1993
7	http://maps.elie.ucl.ac.be/CCI/viewe	ESA CCI LC projec	contact@esa-landcover-c	http://maps.elie.ucl.ac.be	Defourny et al 2011	1992 - 2020
8	http://forobs.jrc.ec.europa.eu/produc	Hans-Juergen Stib	hans-juergen.stibig@jrc.it	http://ieeexplore.ieee.org	Bartholome & Belward,	1999 - 2000
9	http://data.unep-wcmc.org/datasets/	Chandra Giri	cgiri@usgs.gov	http://onlinelibrary.wiley.c	Giri at al., 2010	1997 - 2000
10	https://sage.nelson.wisc.edu/data-a	Annemarie Schnei	aschneider4@wisc.edu	http://iopscience.iop.org/	Schneider et al. 2009	2001 - 2002
11	http://www.cec.org/north-american-e	CEC secretariat	info@cec.org			2005
12	http://www.globallandcover.com/defa	National Geomatic	chenjun@nsdi.gov.cn	https://www.mdpi.com/22	Chen et al. 2017	2000, 2010, 2020
13	https://data-starcloud.pcl.ac.cn/reso	Peng Gong	penggong@tsinghua.ed	https://doi.org/10.108	Gong, P. et al 2013	2010, 2015, 2017
14	https://data-starcloud.pcl.ac.cn/reso	Peng Gong	penggong@tsinghua.ed	https://doi.org/10.1016/j.	Gong, P. et al 2019	2017
15	https://lpdaac.usgs.gov/products/m	Mark Friedl	friedl@bu.edu	https://modis-land.gsfc.nasa.gov/ValStatus.php		2001- 2022
16	https://lpdaac.usgs.gov/products/m	Mark Friedl	friedl@bu.edu	https://modis-land.gsfc.nasa.gov/ValStatus.php		2001 - 2022
17	https://glad.earthengine.app/view/gl	Matt Hansen	mhansen@umd.edu	https://doi.org/10.1126/s	Hansen et al. 2013	2000 - 2022
18	http://glad.umd.edu/dataset/gce/glot	Matt Hansen; Pete	mhansen@umd.edu ; pota	http://www.mdpi.com/20	Pittman et al. 2010	2002 - 2008
19	https://globalmaps.github.io/glcnmo.	Ryutaro Tateishi	tateishi@faculty.chiba-u.jp	http://dx.doi.org/10.1080	Tateishi, et al., 2011	2003, 2008, 2013
20	http://due.esrin.esa.int/page_globco	Pierre Defourny	pierre.defourny@uclouvai	http://due.esrin.esa.int/fil	Bicheron et al., 2008; E	2005, 2006, 2009
21	http://www.cec.org/north-american-e	CEC secretariat	info@cec.org			2005 - 2010
22	http://www.cec.org/north-american-e	CEC secretariat	info@cec.org			2010
23	http://www.cec.org/north-american-e	CEC secretariat	info@cec.org			2010
24	http://maps.elie.ucl.ac.be/CCI/viewe	ESA CCI LC projec	contact@esa-landcover-c	http://www.mdpi.com/20	Lamarche et al. 2017	2005 - 2015
25	http://www.cec.org/north-american-e	CEC secretariat	info@cec.org			2010 - 2015
26	http://www.dlr.de/eoc/en/desktopdef	Thomas Esch; GUI	thomas.esch@dlr.de			2011 - 2013
27	https://land.copernicus.eu/pan-euro	Matina Halkja	Matina.Halkia@jrc.ec.euro			2012
28	https://www.star.nesdis.noaa.gov/jps	Xiwu Zhan	xiwu.zhan@noaa.gov			2012 - 2022
29	http://www.cec.org/north-american-e	CEC secretariat	info@cec.org			2015
30	https://www.usgs.gov/centers/wgsc/	GFSAD project	croplands.dev@gmail.com	https://pubs.usgs.gov/pp	Thenkabail et all. 2021	2015
31	https://land.copernicus.eu/global/prc	Copernicus Global	helpdeskticket@vgt.vito.be	https://land.copernicus.e	https://doi.org/10.1016/	2015 - 2019
32	https://cds.climate.copernicus.eu/cd	Copernicus C3S su	copernicus-support@ecm	https://cds.climate.copernicus.eu/cdsapp#!/data		2016 - 2020
33	https://glad.umd.edu/dataset/long-te	Xiao-Peng Song	xpsongrs@gmail.com	https://doi.org/10.1038/	Song et al. 2018	1982 - 2016
34	https://glad.umd.edu/dataset/global-	Matt Hansen	mhansen@umd.edu	https://doi.org/10.1088/	Hansen et al. 2022	2019
35	https://glad.umd.edu/dataset/croplar	Peter Potapov	potapov@umd.edu	https://doi.org/10.1038/	Potapov et al. 2022	2003 - 2019
36	https://glad.umd.edu/dataset/globa	Amy Pickens	ahudson2@terpmail.umd.	https://glad.umd.edu/dat	Pickens et al. 2020	1999 - 2021
37	https://glad.earthengine.app/view/gl	Peter Potapov	potapov@umd.edu	https://doi.org/10.3389/	Potapov et al. 2022	2000 - 2020
38	https://esa-worldcover.org/en/data-a	WorldCover projec	remotesensing@vito.be	https://esa-worldcover.s3	Tsendbazar et al. 2021	2020, 2021
39	https://zenodo.org/records/428092	Liangyun Liu	liuly@radi.ac.cn	https://essd.copernicus.	Zhang et al., 2021	2015
40	https://livingatlas.arcgis.com/landcover/			https://doi.org/10.1109/IC	Karra et al., 2021	2017-2022
41	https://dynamicworld.app/			https://doi.org/10.1038	Brown et al., 2022	2017-present

Biophysical (1/5)

Two potential new co-leads nominated & to be written to

New Users for Better ICOS (NUBICOS) project starting in 2024

- WP to look at how ICOS can support satellite data calibration and validation (including FAPAR)

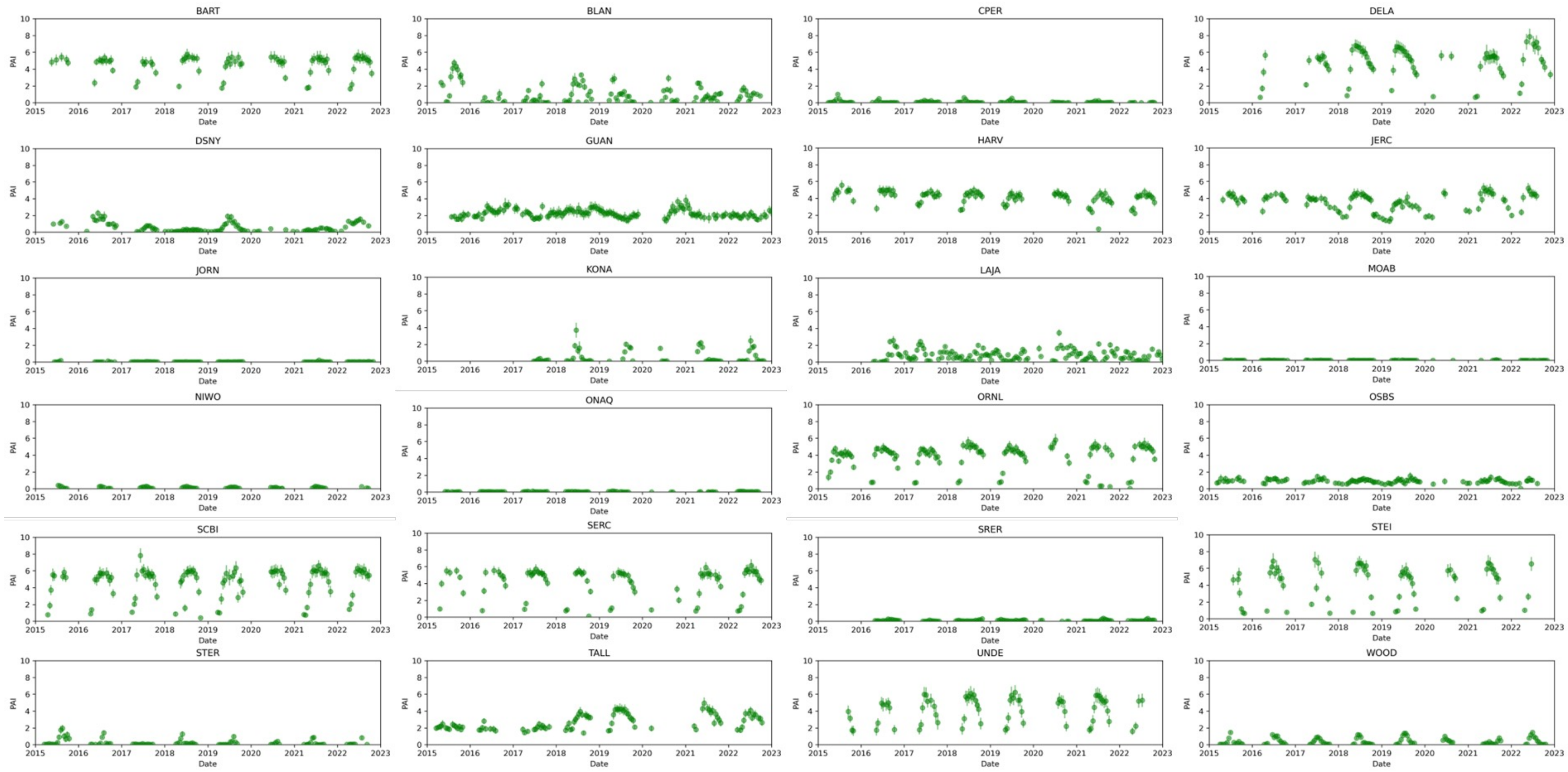
Luke & Sylvain working to verify 'CoverPy' with simulated images

- Like HemiPy, but for digital cover photography (DCP) - **main method being used by TERN for LAI**
- Provision of uncertainties following FRM4VEG procedures
- Available on GitHub: https://github.com/luke-a-brown/coverpy

Biophysical (2/5)

GROUNDED EO progress presented at Joint EC-ESA Earth System Science Workshop

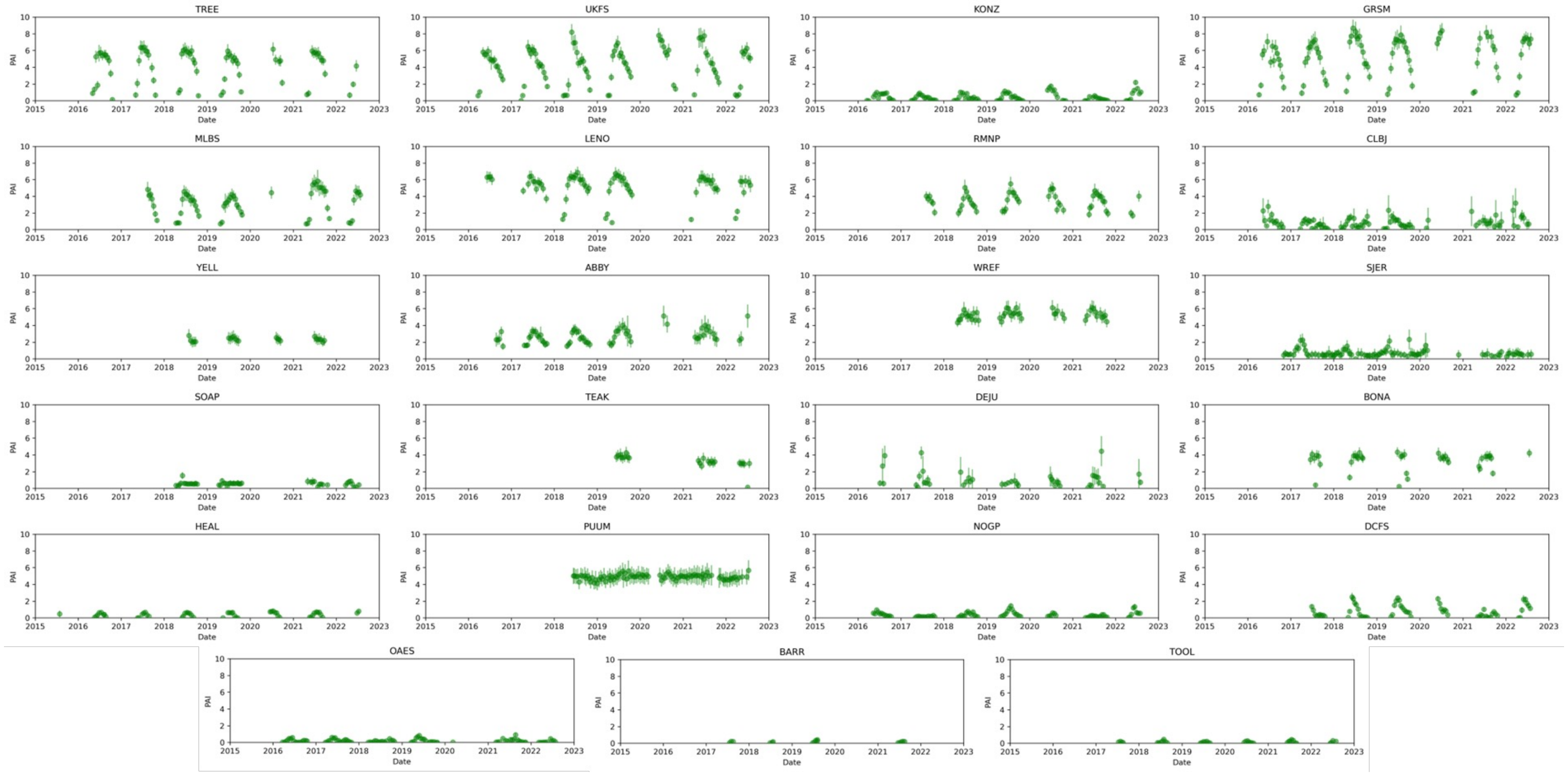
- NEON – US (1/2)



Biophysical (3/5)

GROUNDED EO progress presented at Joint EC-ESA Earth System Science Workshop

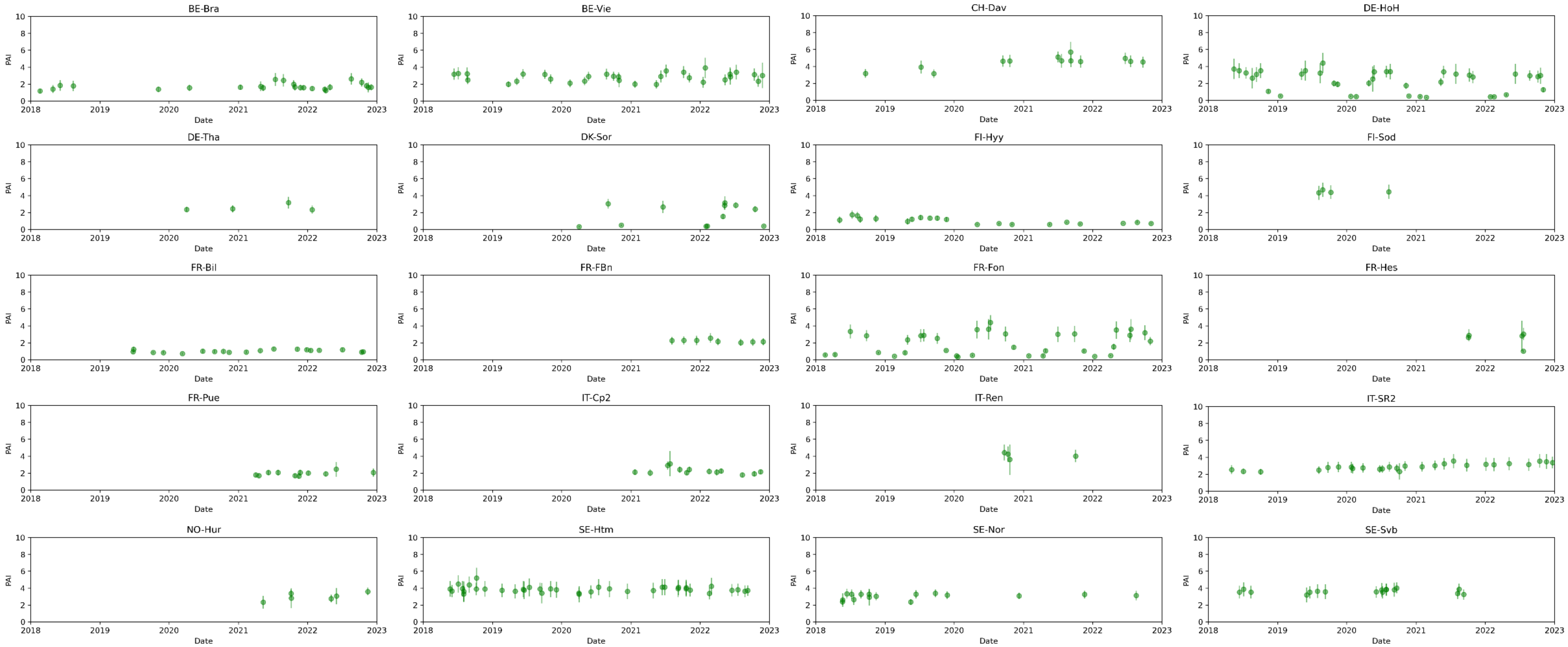
- NEON – US (2/2)



Biophysical (4/5)

GROUNDED EO progress presented at Joint EC-ESA Earth System Science Workshop

- ICOS - Europe

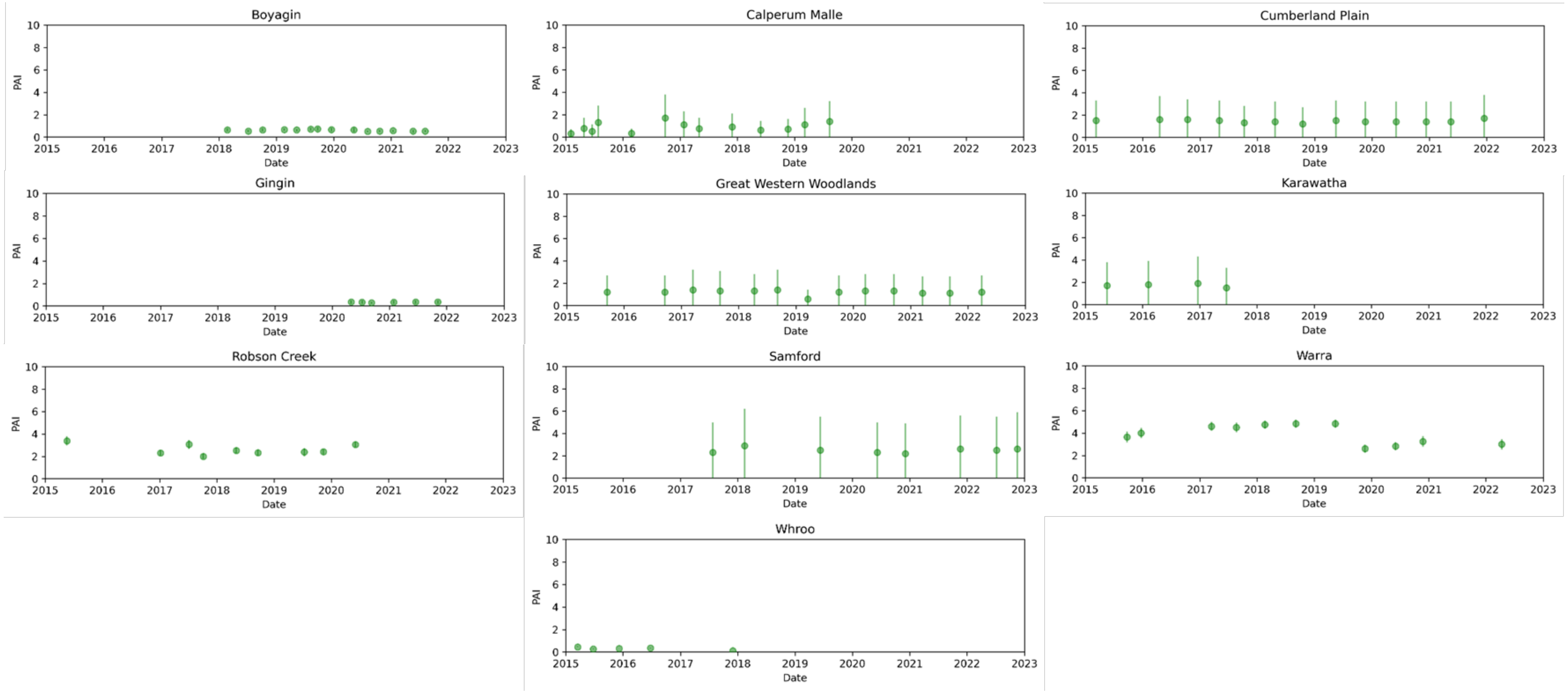


WORKING GROUP ON CALIBRATION & VALIDATION

Biophysical (5/5)

GROUNDED EO progress presented at Joint EC-ESA Earth System Science Workshop

- TERN – Australia



Fire

- No updates

LST & E (1/6)

Conferences

- ECOSTRESS Science Team Meeting, Ventura, CA, 13-17 Oct, 2023
- TIR Product Harmonization Meeting, ESTEC, Noordwijk, 14-16 Nov, 2023
- Sentinel-3 Val. Team (S3VT) meeting, Darmstadt, Germany, 5-7 Dec 2023

Project News

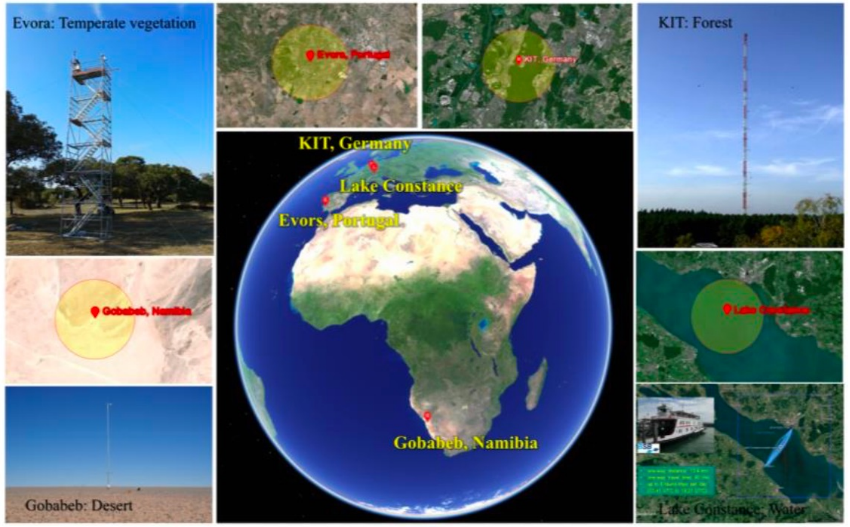
- Kick Off meeting of TIRCALNet preparation study in November 2023
- Extension of Copernicus LAW stations is ongoing
- ECOSTRESS resumed 5-band acquisitions in March 2023
- ECOSTRESS Collection 2 LST&E products released in Nov 2022
- – – –
- New L2 data in UTM projection, cloud optimized geotiffs (COG) Improved cloud and water masks
- Improved geolocation matching accuracy
- • Surface Biology and Geology (SBG) TIR component in Phase-A and approaching System Requirements Review (SRR) in early November

LST & E (2/6)

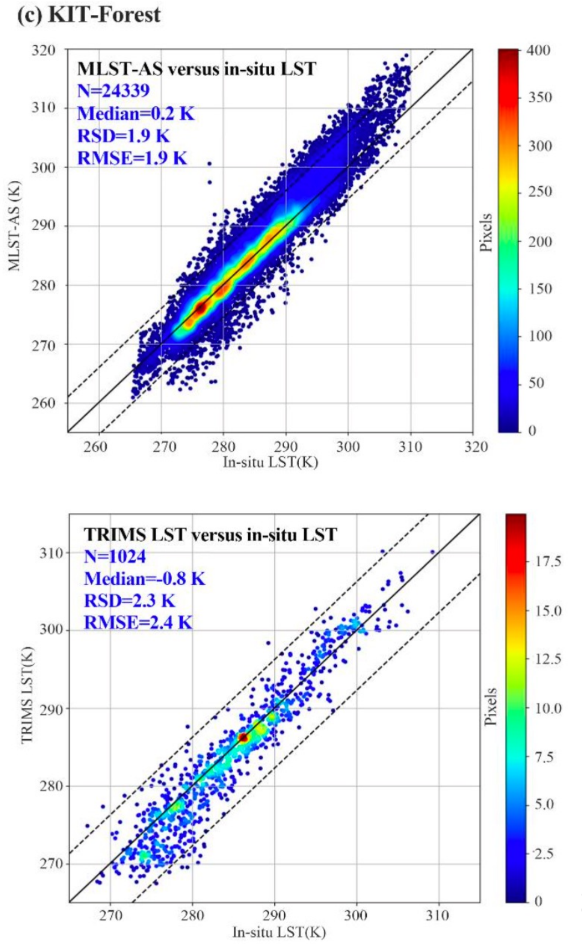
Investigation and validation of two all-weather land surface temperature products with in-situ measurements (Meng et al., 2023)

- Meteosat Second Generation (MSG) Land Surface Temperature - All Sky (MLST-AS) (Martins et al., 2019)
- Thermal and Reanalysis Integrating Moderate-resolution Spatial-seamless Land Surface Temperature (TRIMS LST) (Zhang et al., 2021)

- Validation sites:



- Results:



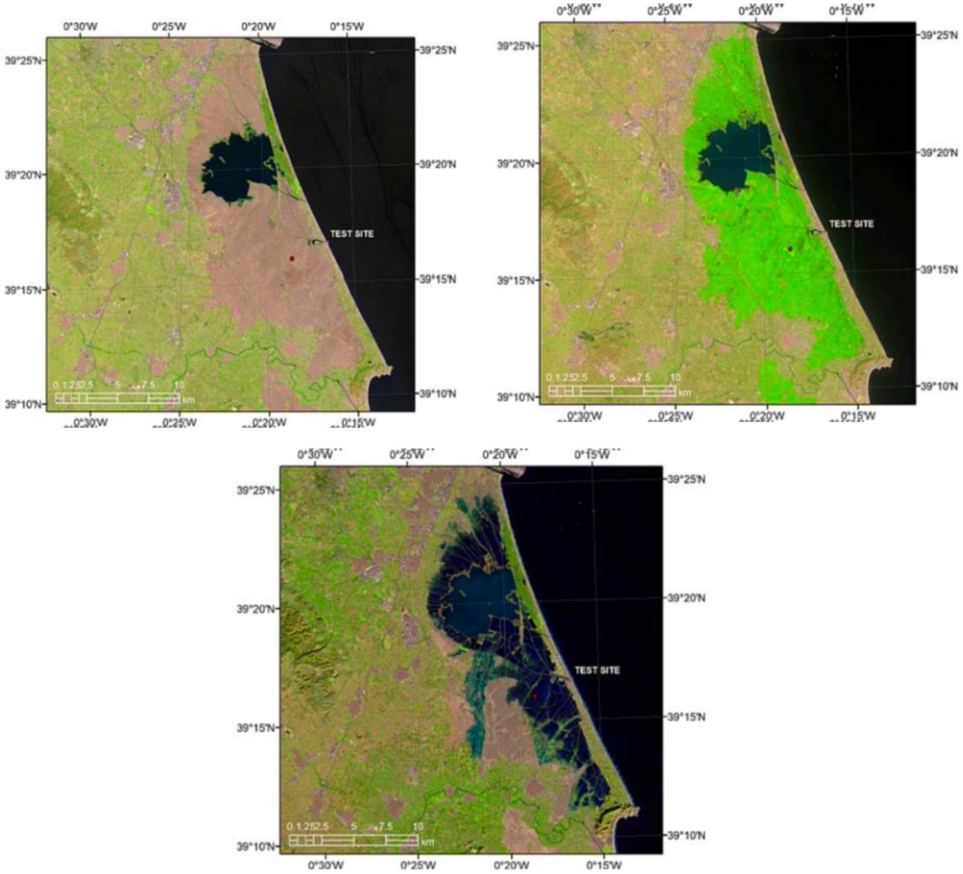
DOI: 10.1080/10095020.2023.2255037

LST & E (3/6)

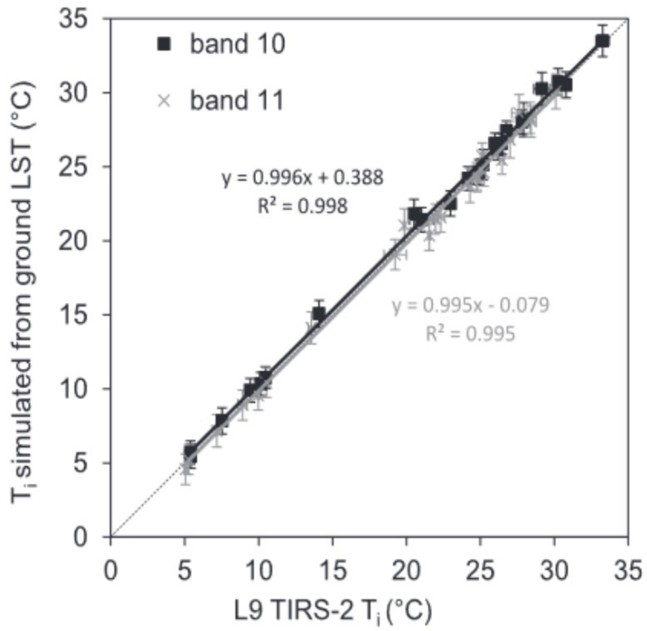
Evaluation of Landsat-9 TIRS-2 calibrations and LST retrievals : (Niclòs et al. 2023)

- Evaluation of TIRS-2 channels calibration, before and after the reprocessing in March 2023
- Validation of operational Landsat-9 LST product and alternative algorithms.

Validation Site



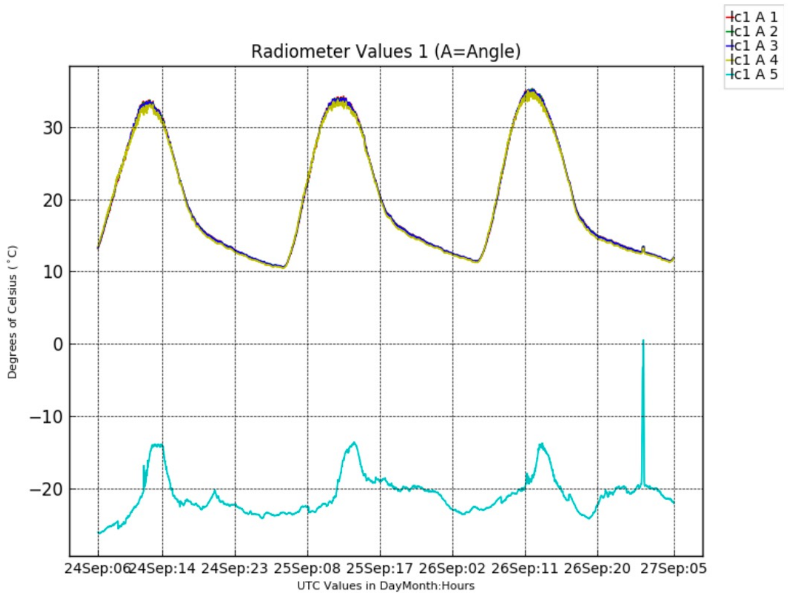
Results:



DOI: 10.1016/j.jag.2023.103576

LST & E (4/6)

New LST Validation Site - La Crau, France



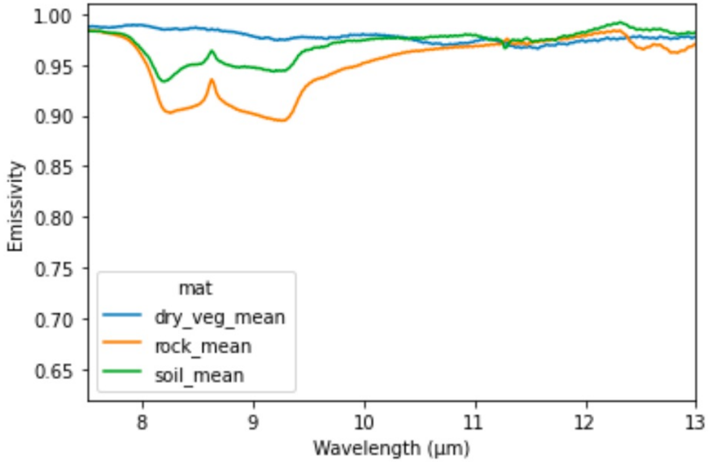
LST & E (5/6)

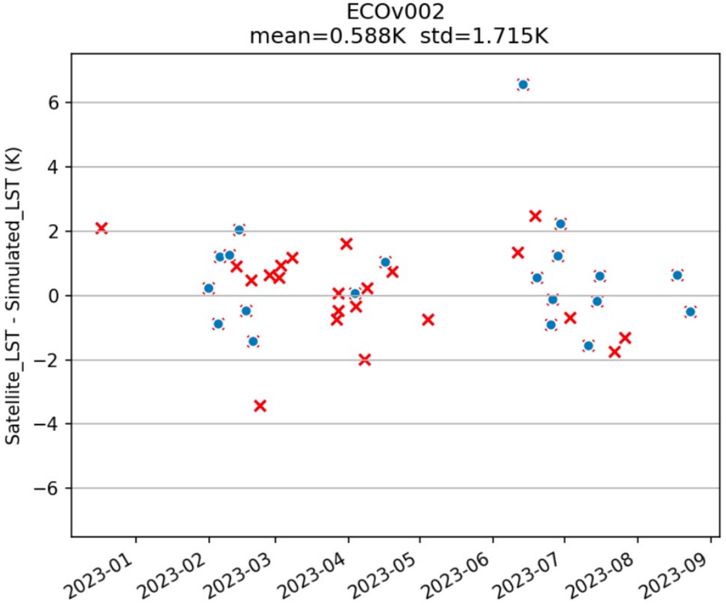
La Crau first validation results

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)

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





→ <u>Future processing:</u> Emissivity estimation is the main area for improvement

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

Slight positive bias + significant dispersion

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

LST & E (6/6)

Recent Publications

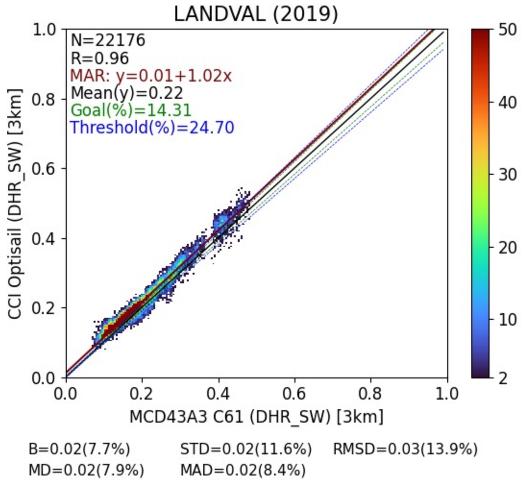
- Meng et al. (2023), Investigation and validation of two all-weather land surface temperature products with in-situ measurements, Geo-spatial Information Science, DOI: 10.1080/10095020.2023.2255037

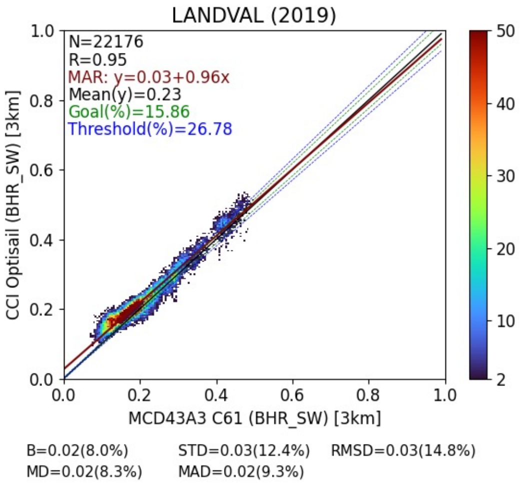
- Niclòs et al. (2023), Evaluating Landsat-9 TIRS-2 calibrations and land surface temperature retrievals against ground measurements using multi-instrument spatial and temporal sampling along transects, Int. J. Appl. Earth Obs. Geoinf., 125, 103576

Surface Radiation

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

- **Copernicus C3S**
  - Sentinel-3 OLCI+SLSTR will be based in a new input data (CGLS Sentinel-3 TOC-r v2.3), which improves the geolocation mismatch between OLCI and SLSTR acquisitions.
  - Validation expected by 1st quarter 2024.
- **ESA CCI LAI/fAPAR vegetation parameters**
  - Project is able to provide surface albedo products based on OPTISAIL instead the classical approach based on *BRDF retrieval+angular&spectral integration*.
  - Currently based on SPOT/VGT & PROBA-V but it is expected a multi-sensor approach (including Sentinel-3, MODIS & VIIRS).
  - Preliminary validation is ongoing.





Land Surface Phenology (1/6)

Special issue in **Remote Sensing:**

"Cropland Phenology Monitoring Based on Cloud-Computing Platforms“

Special Issue Editors:

a) **Dr. Jochem Verrelst**

Guest Editor (Laboratory for Earth Observation, Image Processing Laboratory - Scientific Park, University of Valencia, Catedrático José Beltrán, 2, 46980 Paterna, Valencia, Spain)

b) **Dr. Katja Berger**

Guest Editor (Laboratory for Earth Observation, Image Processing Laboratory - Scientific Park, University of Valencia, Catedrático José Beltrán, 2, 46980 Paterna, Valencia, Spain)

c) **Dr. Egor Prikaziuk**

Guest Editor (Faculty Geo-Information Science and Earth Observation, ITC, University of Twente, Enschede, The Netherlands)

d) **Prof. Dr. Clement Atzberger**

Guest Editor (Institute of Geomatics, University of Natural Resources and Life Sciences, 1090 Vienna, Austria)

Deadline for manuscript submissions: **29 February 2024**

Land Surface Phenology (2/6)

WORKING GROUP ON CALIBRATION & VALIDATION

CEOS

scientific **data**

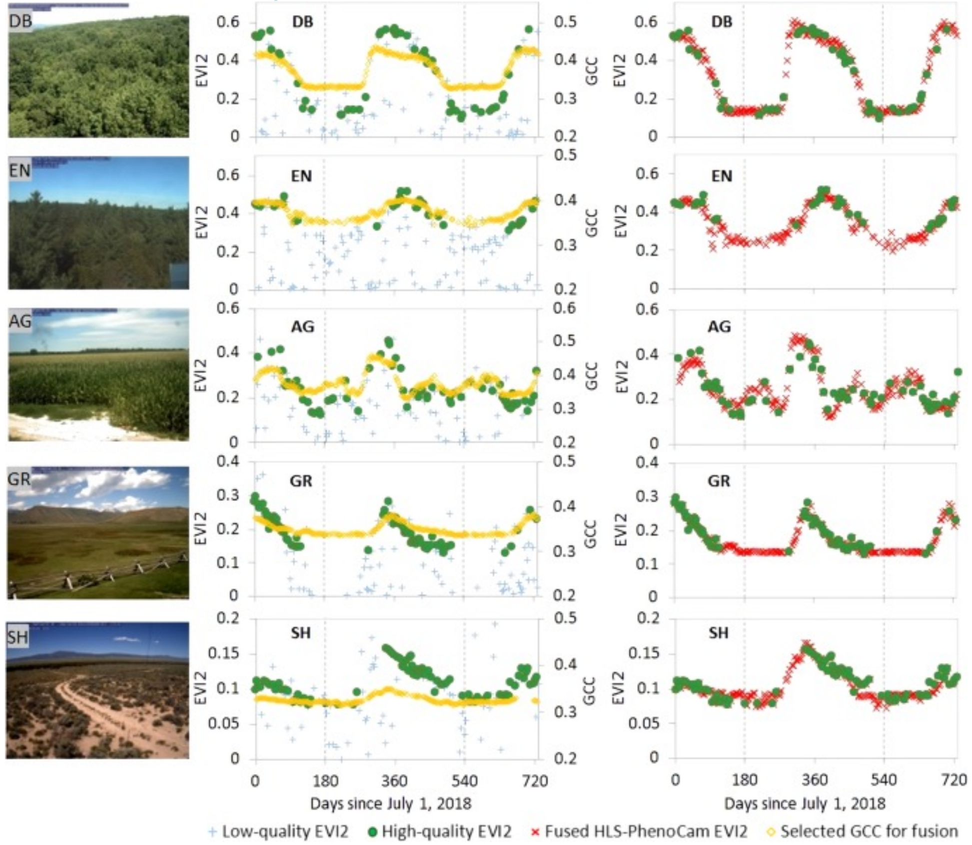
Check for updates

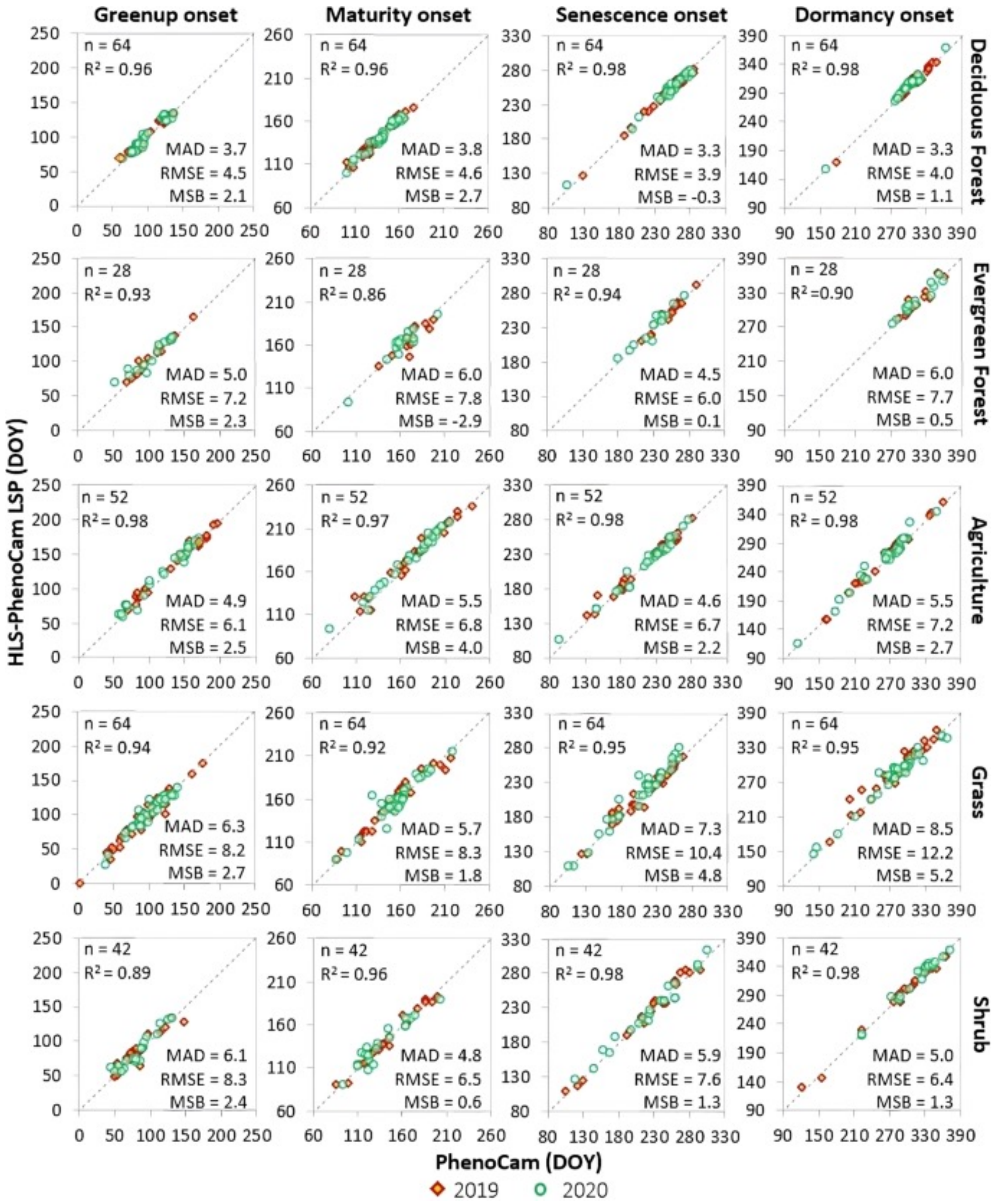
OPEN

DATA DESCRIPTOR

HP-LSP: A reference of land surface phenology from fused Harmonized Landsat and Sentinel-2 with PhenoCam data

Khuong H. Tran[1], Xiaoyang Zhang[1]✉, Yongchang Ye[1], Yu Shen[1], Shuai Gao[1], Yuxia Liu[1] & Andrew Richardson[2,3]





Land Surface Phenology (3/6)

Contents lists available at ScienceDirect

ISPRS Journal of Photogrammetry and Remote Sensing

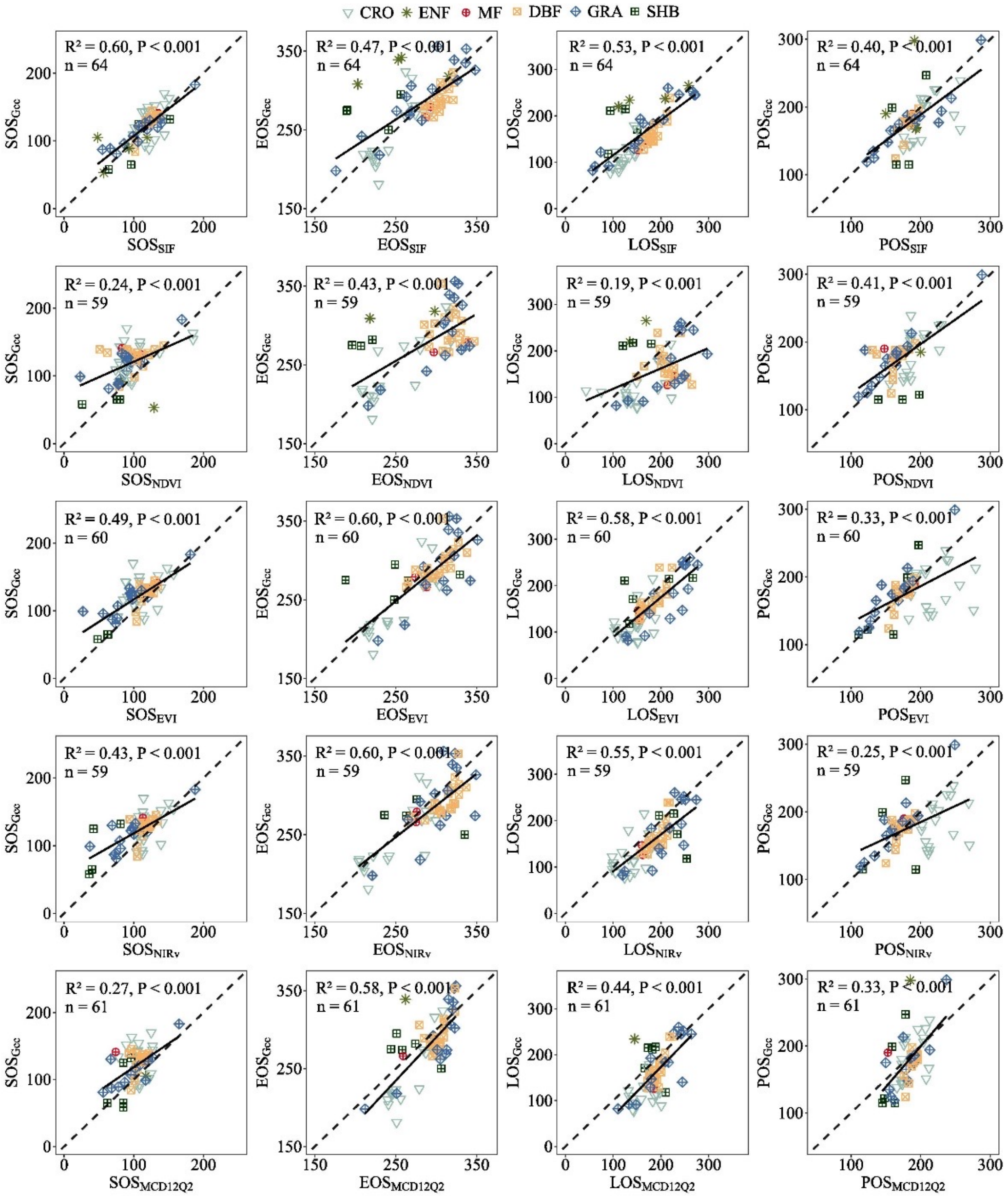
journal homepage: www.elsevier.com/locate/isprsjprs

Solar-induced chlorophyll fluorescence captures photosynthetic phenology better than traditional vegetation indices

Jingru Zhang[a,b,*], Alemu Gonsamo[a], Xiaojuan Tong[b], Jingfeng Xiao[c], Cheryl A. Rogers[a], Shuhong Qin[a,d], Peirong Liu[b], Peiyang Yu[b], Pu Ma[e]

LSP (TROPOMI SIF, MODIS NDVI, EVI, NIRv, and MCD12Q2)- compared with phenocams (Gcc)

broadleaf forest (DBF), evergreen needleleaf forest (ENF), mixed forest (MF), shrubland (SHB), grassland (GRA), and cropland (CRO).



Land Surface Phenology (4/6)

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ELSEVIER

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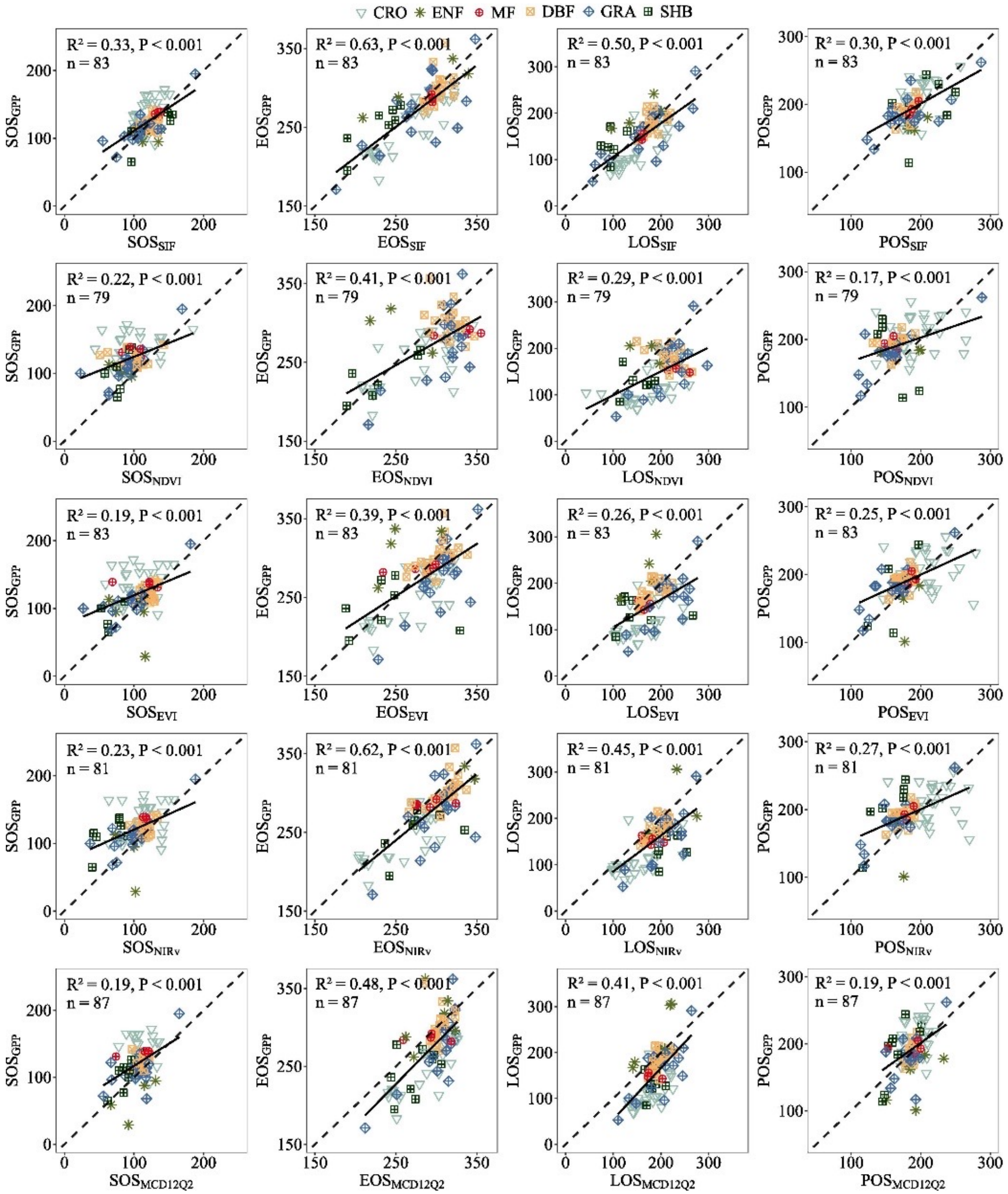

Land Surface Phenology (5/6)

Contents lists available at ScienceDirect

ISPRS Journal of Photogrammetry and Remote Sensing

journal homepage: www.elsevier.com/locate/isprsjprs

ELSEVIER

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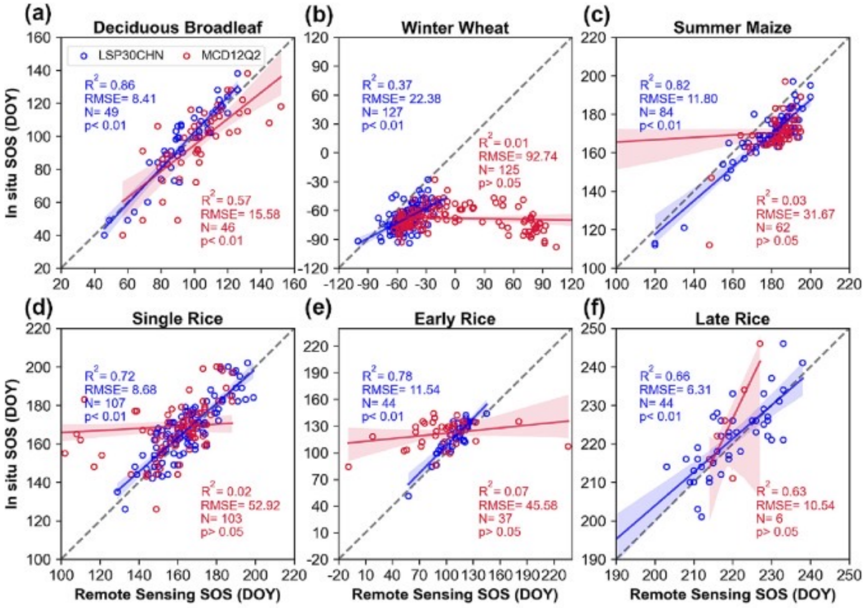
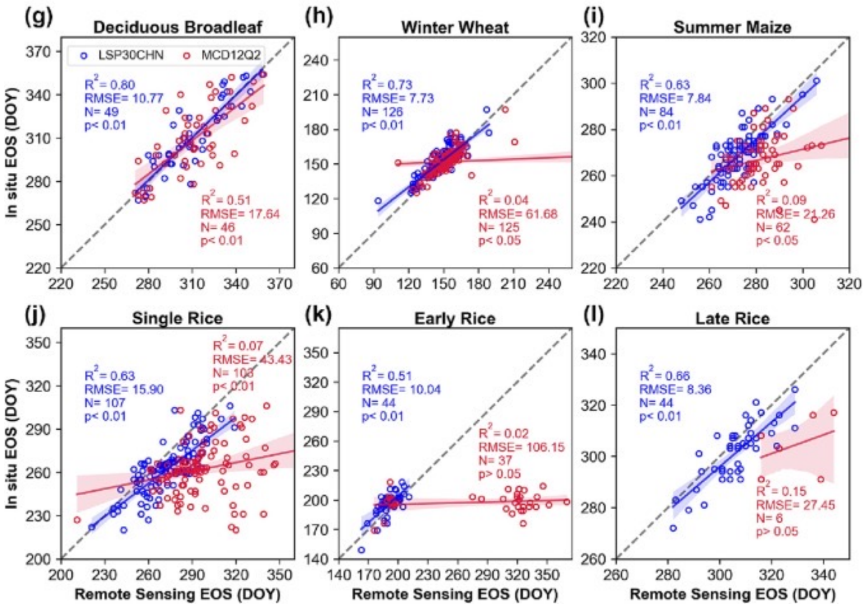
A robust and unified land surface phenology algorithm for diverse biomes and growth cycles in China by using harmonized Landsat and Sentinel-2 imagery

Jilin Yang [a,b], Jinwei Dong [b,*], Luo Liu [c], Miaomiao Zhao [d], Xiaoyang Zhang [e], Xuecao Li [f], Junhu Dai [b], Huanjiong Wang [b], Chaoyang Wu [b], Nanshan You [b], Shibo Fang [g], Yong Pang [h], Yingli He [b], Guosong Zhao [i], Xiangming Xiao [j], Quansheng Ge [b,*]

LSP (LSP30CHN) compared with in-situ observations for SOS (a-f) and EOS (g-l) dates across six vegetation types.





Land Surface Phenology (6/6)

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LSP30CHN and other two phenology compared with PhenoCam across five vegetation types in North America.