Land Product Validation (LPV) Sub-group Meeting

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

Subgroup meeting
06 Dec 2022

NEXT LPV TELECON Feb 7, 2023

Attendance

Participants

Michael Cosh
Fabrizio Niro
Jaime Nickeson
Zhuosen Wang
Sasha Tyukavina
Frank Göttsche
Sophie Bontemps
Laura Duncanson
Gareth Roberts
Joshua Gray
John Bolten
Chris Crawford
Dominique Carrer
Marie Weiss
Tomoaki Miura
Else Swinnen
Hongliang Fang
Sylvain Leblanc
Joshua Gray
Louis Giglio

Unavailable

Victor Rodríguez-Galiano
John Armston
Mat Disney
Carsten Montzka
Glynn Hulley

Meetings

Past

- WGCV. October 3-5, 2022, Tokyo Japan

Future and Proposed

- Two meetings at ESA/ESRIN in Frascati next summer
  - Working Group on Cal/Val: June 5-9, 2023
  - Land Product Validation and Evolution (LPVE): June 12-14, 2023
- We propose holding a 1 to 1.5-day plenary following LPVE, at ESRIN
- Land Product Validation Plenary: June 15, 2023, Frascati

Protocol Schedules (LPV work plan)

Focus Area	Protocol	
Biophysical	LAI (2014)	
Fire/Burn Area	Targeting summer 2023	
Phenology	Targeting summer 2023	
Vegetation Index	Targeting summer 2023	
Land Cover	Targeting spring 2023	
Snow Cover		
Surface Radiation	Albedo (2019)	
Soil Moisture	SM (2020)	
LST and Emissivity	LST (2019)	
Aboveground Biomass	AGWB (2021)	

Focus Area Lead Turnover

	First Name	Last Name	Institution	Location	End of Term
Main	Michael	Cosh	USDA	USA	Apr 2025 (final)
Main	Fabrizio	Niro	ESA	Italy	Apr 2025(promotion to Chair)
Main	Jaime	Nickeson	GSFC	USA	never
Land Cover	Alexandra	Tyukavina	University of Maryland	USA	March 2024 (1st term)
Land Cover	Sophie	Bontemps	Université Catholique de Louvain	Belgium	Oct 2023 (2nd term)
Biophysical	Marie	Weiss	INRA	France	Sep 2023 (2nd term)
Biophysical	Sylvain	Leblanc	Natural Resources Canada	Canada	Sept 2023 (2nd term)
** Biophysical	Hongliang	Fang	CAS	China	Dec 2022 (2nd term)
Fire/Burn Area	Louis	Giglio	University of Maryland	USA	Sep 2023 (1st term)
* Fire/Burn Are	Gareth	Roberts	University of Southampton	UK	Dec 2022 (2nd term)
** Surface Rad	Zhuosen	Wang	UMD/GSFC	USA	Dec 2022 (2nd term)
Surface Rad	Dominique	Carrer	Météo-France	France	June 2024 (2nd term)
Soil Moisture	John	Bolten	NASA GSFC	USA	Apr 2023 (1st term)
Soil Moisture	Carsten	Montzka	Jülich Research Centre	Germany	Sept 2023 (2nd term)
LST	Glynn	Hulley	NASA/JPL	USA	July 2024 (2nd term)
LST	Frank	Goettsche	Karlsruhe Institute of Technology	Germany	Dec 2022 (2nd term)
Phenology	Joshua	Gray	North Carolina State University	USA	Jan 2025 (2nd term)
Phenology	Victor	Rodríguez-Galiano	University of Seville	Spain	Aug 2025 (2nd term)
~~Snow Cover~~	~~Simon~~	~~Gascon~~	~~cesbio~~	~~France~~	~~May 2023 (1st term)~~
Snow Cover	Chris	Crawford	USGS	USA	May 2023 (1st term)
Veg Index	Tomoaki	Miura	University of Hawai'i	USA	Dec 2022 (2nd term)
Veg Index	Else	Swinnen	VITO	Belgium	Apr 2023 (2nd term)
Biomass	Laura	Duncanson	UMD/GSFC	USA	Dec 2022 (2nd term)
Biomass	John	Armston	UMD/GSFC	USA	Dec 2022 (2nd term)
Biomass	Mat	Disney	UCL	UK	Dec 2022 (2nd term)

FA Web Status

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

Focus Area Reports

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

Surface Radiation (1/3)

New co-leads candidates

- Jorge Sánchez-Zapero from EOLAB
- Angela Erb from UMB

ECV Inventory v4.1 by CEOS-CGMS Working Group on Climate (WGClimate)

- Several NASA MODIS/VIIRS operational products (e.g. albedo) are not listed.

2022 GCOS Implementation Plan (GCOS-244)

- **Action C5: ECV-specific satellite data processing method improvements**
- Ensure that the Bidirectional Reflectance Distribution Function (BRDF) parameters are provided together with surface albedo.

Surface Radiation (2/3)

2022 GCOS ECVs Requirements (GCOS-245)

Spectral and Broadband albedo with Associated Spectral Bidirectional Reflectance Distribution Function (BRDF) Parameters

GCOS-200

ECV Products and Requirements for Albedo

*These products and requirements reflect the Implementation Plan 2016 (**GCOS-200**). GCOS is reviewing and will update the requirements until 2022. More information on: **gcos.wmo.int**.*

PRODUCT	DEFINITION	FREQUENCY	RESOLUTION	REQUIRED MEASUREMENT UNCERTAINTY	STABILITY	STANDARDS/ REFERENCES
Maps of directional hemispherical reflectance (DHR) albedo for adaptation	Albedo without diffuse irradiance component.	Daily	50m	max(5%; 0.0025)	max(1%; 0.001)	
Maps of bi-hemispherical reflectance (BHR) albedo for adaptation	Albedo with isotropic illumination only (white-sky)		50m	max(5%; 0.0025)	max(1%; 0.001)	
Maps of DHR albedo for modelling	Albedo without diffuse irradiance component.	Daily	200/500m	max(5%; 0.0025)	max(1%; 0.001)	
Maps of BHR albedo for modelling	Albedo with isotropic illumination only (white-sky)		200/500m	max(5%; 0.0025)	max(1%; 0.001)	

Surface Radiation (3/3)

2022 GCOS ECVs Requirements (GCOS-245)

Spectral and Broadband albedo with Associated Spectral Bidirectional Reflectance Distribution Function (BRDF) Parameters

Item needed	Unit	Metric	[1]	Value	Notes
Horizontal Resolution	m		G	10	Due to the heterogeneous nature of terrestrial surfaces, having surface albedo at such scale will increase accuracy for further assimilation of local/regional climate model.
			B		
			T	250	Enable assimilation in earth/climate model.
Vertical Resolution			G	-	N/A
			B	-	
			T	-	
Temporal Resolution	day		G	1	For climate change services. Multi-angular instruments (including geostationary) and/or accumulation of daily data for BRDF parameters retrieval.
			B		
			T	10	For assimilation in earth/climate model. Same as above as mono-angular
Timeliness	day		G	1	For climate change services.
			B		
			T	5	For NRT reanalysis.
Required Measurement Uncertainty	%	1 standard deviation or error covariance matrix, with associated PDF shape (functional form of estimated error distribution for the term)	G	3% for values ≥0.05; 0.0015 (absolute value) for smaller values	"A change of 1% to the Earth's albedo has a radiative effect of 3.4 W/m^2" Over snow-free and snow-covered land, climate, biogeochemical, hydrological, and weather forecast models require this uncertainty.
			B		
			T	5% for values ≥0.05; 0.0025 for smaller values	See Ohring, et al. 2005

Goal (G)

Breakthrough (B)

Threshold (T)

Phenology

- No updates at this time.

Soil Moisture

News:

- International Soil Moisture Network (ISMN) completed the transfer of the Network from TU Vienna to German Federal Institute of Hydrology.
- They are asking for data providers to provide additional variables, such as soil temperature or precipitation to help improve the interpretation of soil moisture time series. Moreover, they are thinking of developing an API to easily access the ISMN data.

Workshops:

- 7th Satellite Soil Moisture Validation and Application Workshop, Fall 2024?, New Orleans, USA?

Vegetation Indices

Protocol Development

- Completed a protocol outline by co-leads (October 2022)
- 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)
- Planning to have a kick-off meeting with the expert group to review the procedure, expectation, and timeline

Vegetation Indices

Began drafting an outline of the VI validation good practices document, referring to:

- The good practices documents of LAI and albedo
- The outcomes from the last VI focus area workshop (December 2018)

New publication on product inter-comparison:

- Tran, N. N., Huete, A., Nguyen, H., Grant, I., Miura, T., Ma, X., . . . Ebert, E. (2020). Seasonal comparisons of Himawari-8 AHI and MODIS vegetation indices over latitudinal Australian grassland sites. Remote Sensing, 12(15), 2494. doi:10.3390/rs12152494

Biomass (1/5)

Latest Updates

- ICESat-2 and GEDI have now been on orbit for four years
  - GEDI requesting extension on ISS; review by NASA next week.
  - Support letters from CEOS members ESA, DLR, and others
- GEDI biomass products continue to mature, validation focused primarily at the aggregate level as field campaigns have been limited.
- ICESat-2 boreal biomass product finalized
- There is a desire to have single joint GEDI + ICESat-2 biomass product – likely in 2023
- NISAR and ESA BIOMASS launches in early 2024
  - BIOMASS mission plans to calibrate their biomass product using GEDI's footprint-level biomass product
- GEO-TREES still gaining momentum

  Third-party biomass maps are starting to emerge – validation is ever more important!

Biomass (2/5)

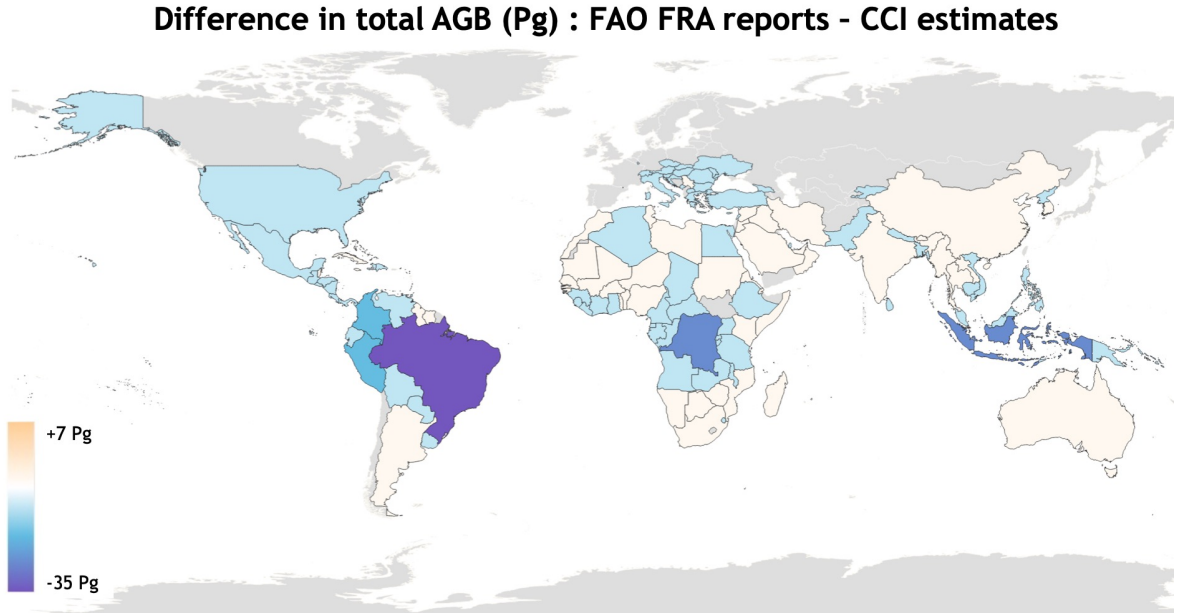
Biomass harmonization activities continue:

- Broad goal remains the same – facilitate uptake of biomass products for policy
  - Validation with country NFI data
  - Intercomparison globally by biome and ecoregion to understand discrepancies
  - Working with partner countries to validate and foster data uptake (Mexico, Ecuador, Peru, Solomon Islands, Paraguay, Ghana, others...)
  - Linked to CEOS AFOLU

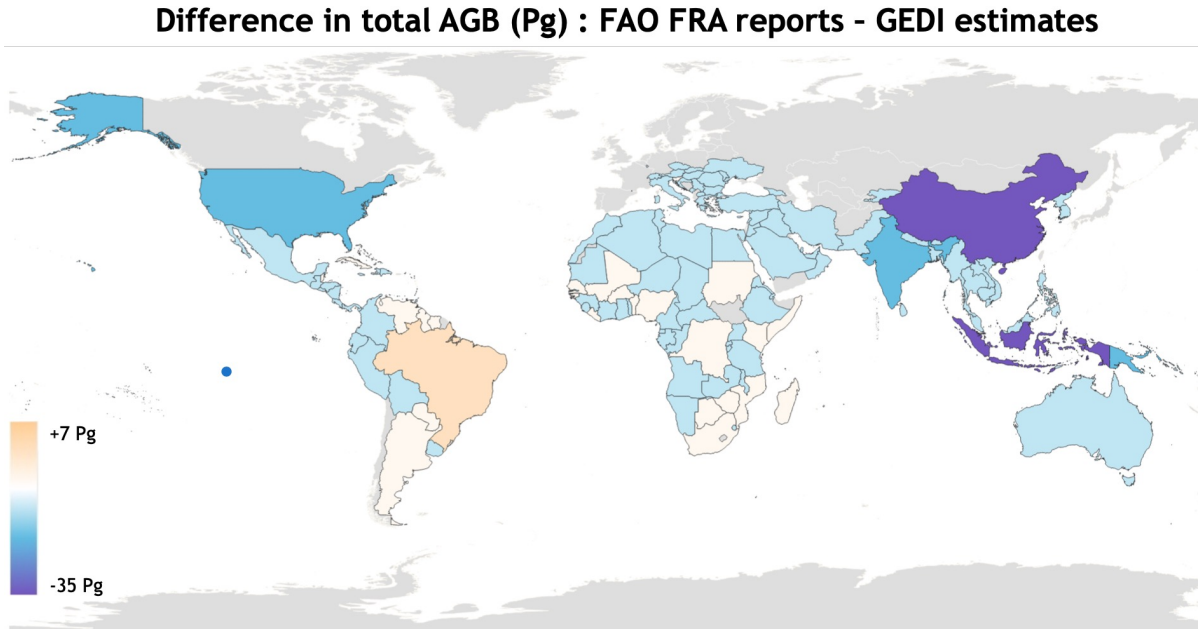
- Validation of Change – the future of LPV Biomass
  - For policy and science applications, biomass change products desires and forthcoming
  - Validation of change chapter still not developed
  - Planned for next update of the protocol

Biomass (3/5)

Comparing National Total AGB to FAO's FRA: CCI



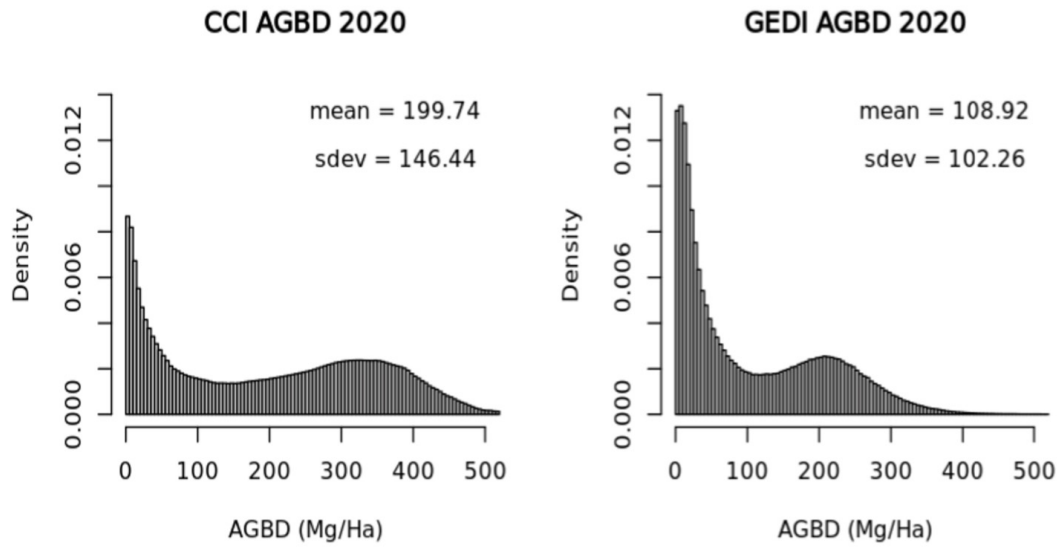
Comparing National Total AGB to FAO's FRA: GEDI



Neha Joshi Hunka et al., in prep

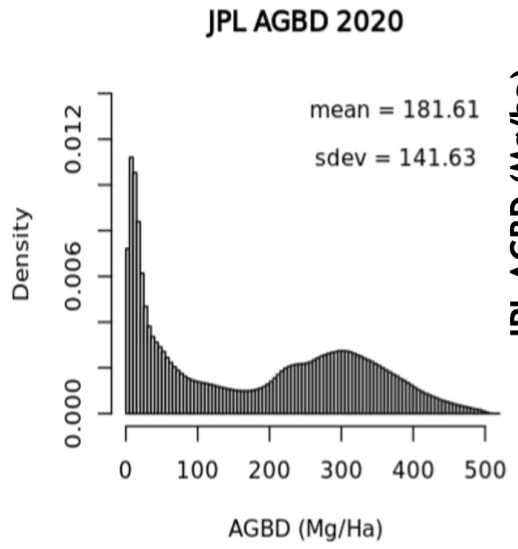
CEOS WORKING GROUP ON CALIBRATION & VALIDATION

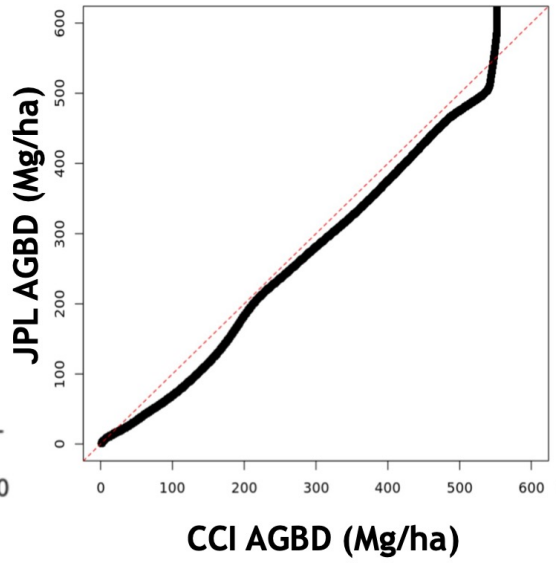
Biomass (4/5)

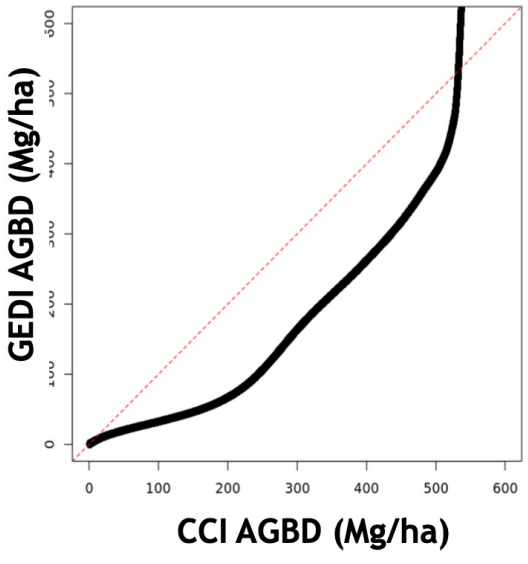


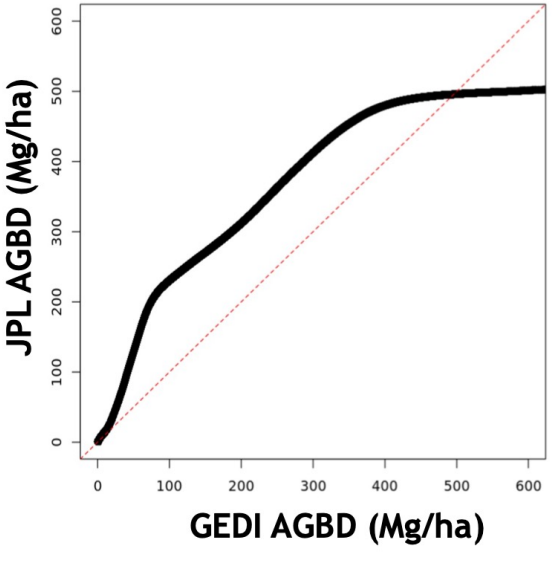
Tropical Subtropical Moist Broadleaf Forests Africa

JPL and CCI match closely, GEDI lower in low biomass, higher in highest biomass





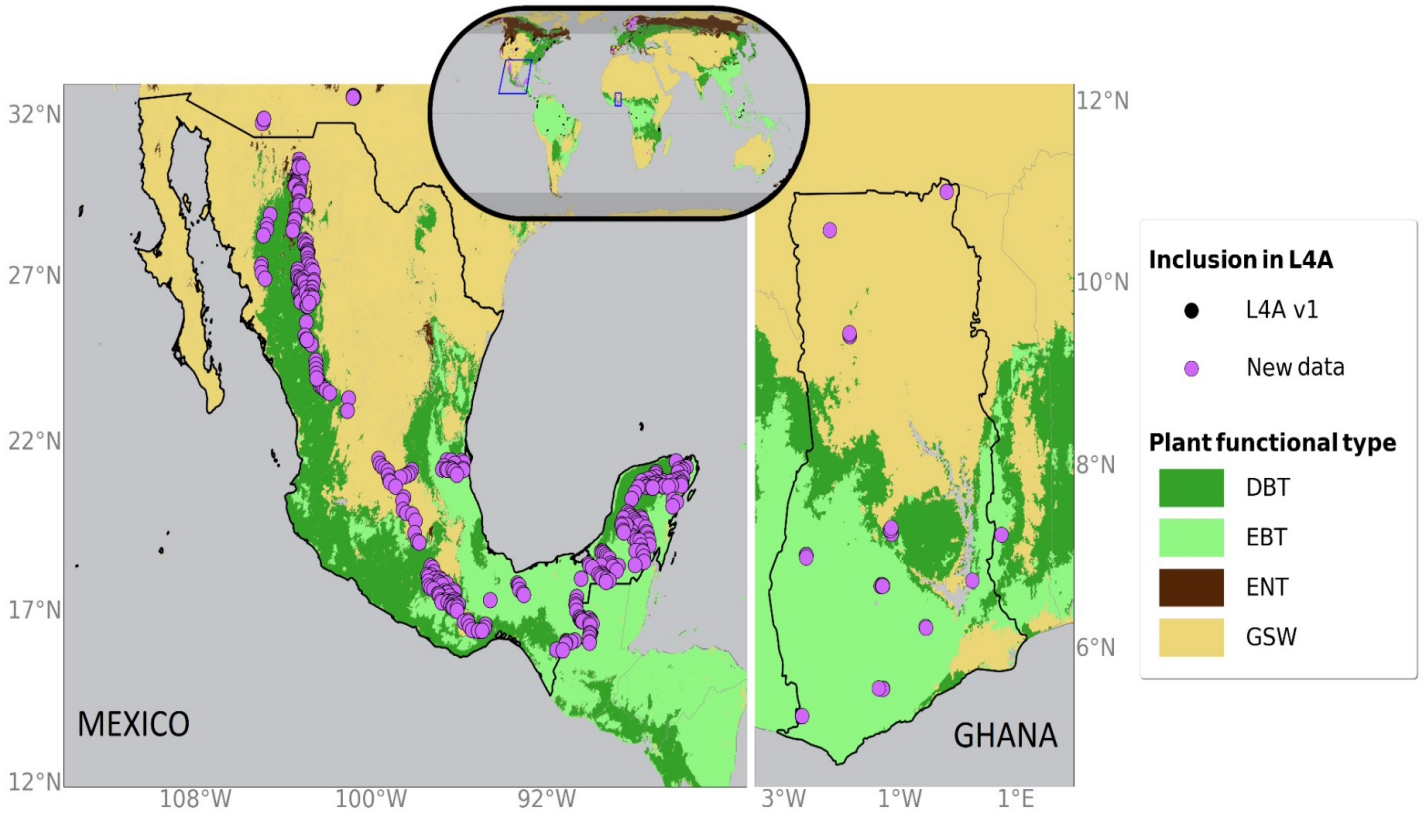




Biomass (5/5)

Working with Countries on National Product Validation

- Paraguay, Peru, Ecuador, Mexico, Ghana, many others…
- Where field + lidar are available, L4A can be updated / customized nationally
- Where NFI data are available products can be nationally validated & bias-corrected



Snow

- The IACS-MRI-WMO Joint Body Status on Mountain Snow Cover has started a project to improve the information on mountain snow at global scale, Kickoff Meeting was Oct. 11th (**contact: Wolfgang Schöner, University of Graz**).
- The Global Cryosphere Watch of WMO is planning a workshop, hosted at EUMETSAT, to prepare a concept paper on the status and needs for an intercomparison of satellite snow products over mountains (**contact : Rodica Nitu, WMO**)
- INARCH will carry out a Common Observing Period Experiment (COPE) across the network of research basins, focusing on obtaining high-quality measurements to the extent possible, starting in 2022 to coincide with the start of the snow season in the southern hemisphere, and carrying on until 2024. During this COPE we will ensure all sensors are working, enhance observations at our mountain research basins, fly supplementary UAV acquisitions, run high resolution models and work together for comparison of processes, data sharing, and model testing in challenging environments. **https://inarch.usask.ca/science-basins/cope.php**

Land Cover (1/3)

Protocol update:

- Call for contributions sent out on October 13;
- Great community feedback/interest!
- Several new sub-sections proposed by the community members (e.g. validation of near-real-time maps, local and site specific accuracy assessment);
- By now we have semi-finalized leads and contributors for all chapters;
- First draft deadline December 24;
- First contributions are coming in!!!

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:

Executive summary **(Sophie Bontemps, Sasha Tyukavina)**

1. Introduction **(co-leads/contributors: Sophie Bontemps, Sasha Tyukavina)**
   - 1.1. Scope of the guidelines
   - 1.2. CEOS Validation stages **(contributor: Nandika Tsendbazar (stage 4 specifics))**
   - 1.3. Current state of global and continental-scale land cover and change mapping and validation **(contributor: Sasha Tyukavina, Amy Pickens, Peter Potapov)**
   - 1.4. Diversity of quality assessment purposes (benchmarking, uncertainty flag, product assessment=validation) **(contributor: Pierre Defourny)**
   - 1.5. …
2. Definitions and general principles **(co-leads: Sophie Bontemps, + TBD)**
   - 2.1. Land cover, land cover change, land use **(contributors: IIASA, Pierre Defourny, Bryant Serre, Gerbrand Koren)**
   - 2.2. Categorical maps vs. continuous fields (e.g. % tree cover) **(contributor: Pierre Defourny, Bryant Serre, Gerbrand Koren)**
   - 2.3. Land cover change maps **(contributors: IIASA, Nandika Tsendbazar, Bryant Serre, Gerbrand Koren)**
   - 2.4. Confidence-building, accuracy assessment and inter-comparison with existing products **(contributor: Sophie Bontemps)**
   - 2.5. Map accuracy assessment vs. classification uncertainty **(contributors: Gerardo Lopez Saldana, Sophie Bontemps)**
   - 2.6. • Accuracy metrics and area estimates **(contributors: Giles Foody)**
   - 2.7. …
3. Sampling design **(co-leads/contributors: Pontus Olofsson, Sasha Tyukavina)**
   - 3.1. Sampling unit (point vs. pixel vs. polygon)
   - 3.2. Common probability sampling designs
   - 3.3. Cluster sampling: one- and two-stage
   - 3.4. Stratification (in space and in time)
   - 3.5. Sample size planning and allocation to strata
4. Response design **(co-leads: Julien Radoux, Giles Foody?)**

Land Cover (2/3)

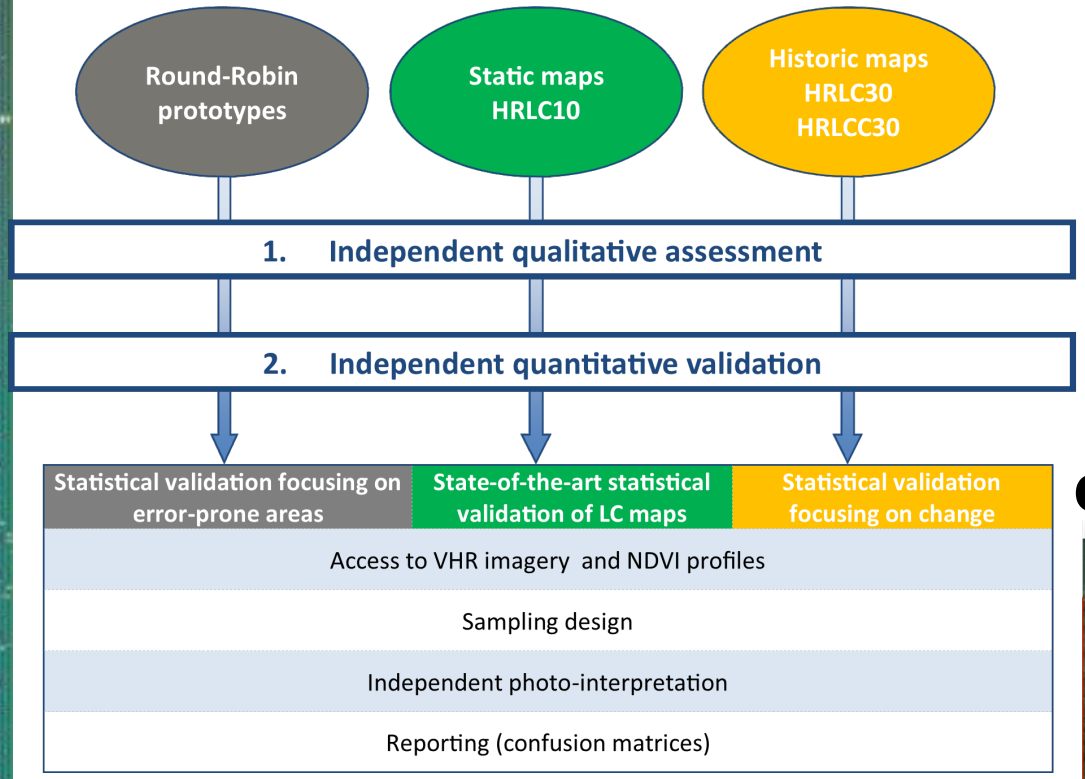
4.1. Sample labeling protocol **(contributors: IIASA, Julien Radoux, Peter Potapov)**
4.2. ● Quality of reference data **(contributors: IIASA, Giles Foody, Pierre Defourny)**
4.3. Accounting for reference data uncertainty **(contributors: Nandika Tsendbazar, Sasha Tyukavina, Julien Radoux)**

5. Analysis **(co-leads/contributors: Pontus Olofsson, Sasha Tyukavina)**
   5.1. When sampling strata match map classes: confusion matrix
      5.1.1. Estimating accuracy
      5.1.2. Estimating area
   5.2. When sampling strata a different from map classes: direct estimator from reference data
      5.2.1. Estimating accuracy
      5.2.2. Estimating area
   5.3. Model-assisted estimators of area: post-stratification, difference, regression and ratio estimators
6. Sources of reference data **(co-leads: Linda See, + TBD)**
   6.1. Time-series of medium resolution optical data **(contributor: Gerardo Lopez Saldana)**
   6.2. High resolution optical data **(contributors: IIASA, Nandika Tsendbazar, Flavie Pelletier)**
   6.3. Spaceborn and airborne lidar data **(contributor: Flavie Pelletier)**
   6.4. Data from UAV **(contributor: Gerbrand Koren)**
   6.5. Ground surveys **(contributor: Xiangming Xiao, Raphaël d'Andrimont)**
   6.6. Existing land cover maps **(contributor: Bryant Serre, Flavie Pelletier)**
   6.7. ● Expert-based methods vs. crowdsourcing **(contributors: IIASA, Sasha Tyukavina)**
7. Examples of global and continental-scale validation efforts **(co-lead: Sophie Bontemps)**
   7.1. Copernicus 100m land cover map validation **(contributors: IIASA, Nandika Tsendbazar)**
   7.2. ESA Climate Change Initiative global land cover time series **(contributor: Céline Lamarche)**
   7.3. ESA Climate Change Initiative High Resolution Land Cover product **(contributor: Céline Lamarche)**
   7.4. UMD GLAD single-class land cover and change map validation (forest, water, cropland, bare ground) **(contributor: Sasha Tyukavina)**
   7.5. ESA Climate Change Initiative Water Bodies product **(contributor: Céline Lamarche)**
   7.6. EU Copernicus HRL, EU crop map **(contributor: Raphaël d'Andrimont)**
   7.7. OSFAC **(contributor: Landing Mane - to be confirmed)**
   7.8. Validation strategy for land cover and land cover change in support of GLanCE **(contributor: BU)**
   7.9. Validation strategy for landscape metrics **(contributor: Bryant Serre)**
8. Challenges and future directions **(co-lead: Pierre Defourny)**
   8.1. Operational validation updates **(contributor: Nandika Tsendbazar)**
   8.2. Assessing accuracy of near real-time maps **(contributor: Johannes Reiche, Amy Pickens, Eric Bullock)**
   8.3. Towards more standardized validation datasets and collections of reference data (*examples of standardized reference datasets: EU reference datasets: LUCAS, harmonised in-situ data, Copernicus4GEOGLAM*, **contributor: Raphaël d'Andrimont**)
   8.4. Local and site specific accuracy assessment **(contributor: Sytze de Bruin)**
   8.5. Towards land use validation
   8.6. …

Protocol update (continued)…

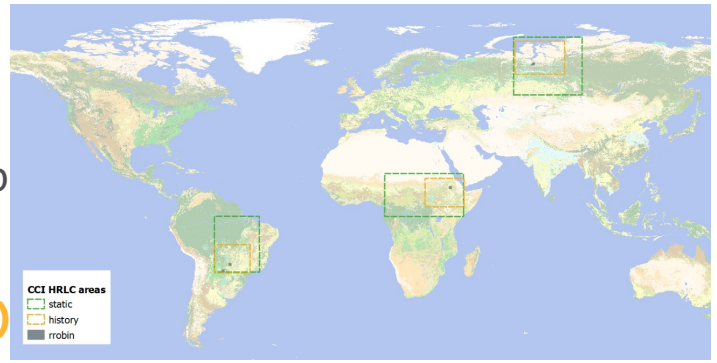
Land Cover (3/3)

CCI HRLC: Specific per-product validation



- 1 stratified random sampling design and validation database per type of product (LC and LCC) and per region covered
- Following guidelines of Olofsson et al., 2013

UCLouvain



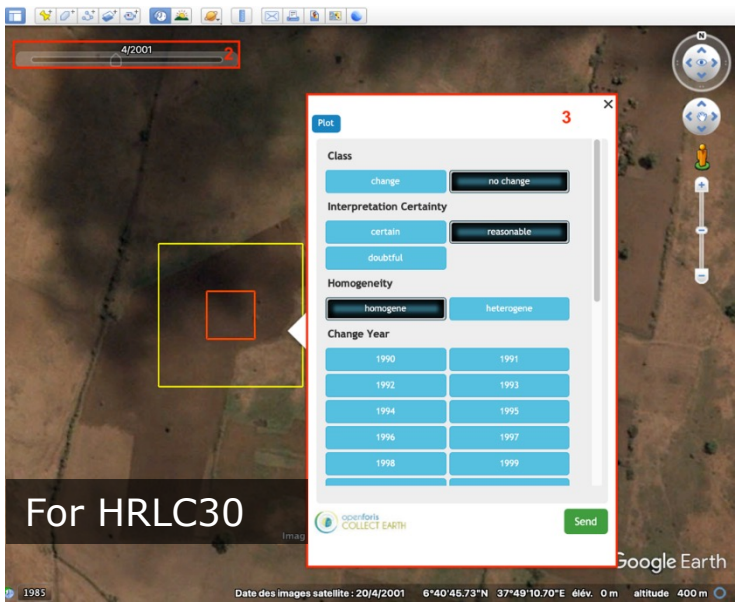
HRLC10 (2019)

- 10m LC classification map
- 16 LC classes

HRLC30 (1990 – 2019)

- 30 m LC classification maps
- 16 LC classes
- Annual LC in 5-y periods

Collect Earth for LC and LCC interpretation



CEOS WORKING GROUP ON CALIBRATION & VALIDATION

Biophysical (1/2)

- First Forum on Remote Sensing Field Experiments and Validation, Nov 4-6, Beijing, China.
- Special session in IGARSS (Pasadena, Jul 16-21, 2023) , conveners: R. Fernandes & M. Weiss
  - CCS.54: From Need to Product: Recent Advances in Mapping and Validation of Vegetation Biophysical Parameters at Regional to Global Extents
    (Abstract submission due on Jan 13, 2013)
- Proposed field work in Northern Canada with indigenous community engagement (S. Leblanc).
- Co-leads change
  - Hongliang Fang (CAS) ends 2nd term.
  - Luke Brown (U. Salford) starts as new co-lead

Biophysical (2/2)

New products

- Xiao, Z., Song, J., Yang, H., Sun, R., & Li, J. (2022). A 250 m resolution global leaf area index product derived from MODIS surface reflectance data. International Journal of Remote Sensing, 43, 1409-1429, 10.1080/01431161.2022.2039415

- Xu, M., Liu, R., Chen, J.M., Liu, Y., Wolanin, A., Croft, H., He, L., Shang, R., Ju, W., Zhang, Y., He, Y., & Wang, R. (2022). A 21-Year Time Series of Global Leaf Chlorophyll Content Maps From MODIS Imagery. IEEE Tansactions on Geoscience and Remote Sensing, 6010.1109/TGRS.2022.3204185

Uncertainty/validation (HR)

- Martínez-Ferrer, L., Moreno-Martínez, Á., Campos-Taberner, M., García-Haro, F.J., Muñoz-Marí, J., Running, S.W., Kimball, J., Clinton, N., & Camps-Valls, G. (2022). Quantifying uncertainty in high resolution biophysical variable retrieval with machine learning. Remote Sensing of Environment, 28010.1016/j.rse.2022.113199

Ground measurement device

- Wang, H., Wu, Y., Ni, Q., & Liu, W. (2022). A Novel Wireless Leaf Area Index Sensor Based on a Combined U-Net Deep Learning Model. IEEE Sensors Journal, 22, 16573-16585, 10.1109/JSEN.2022.3188697

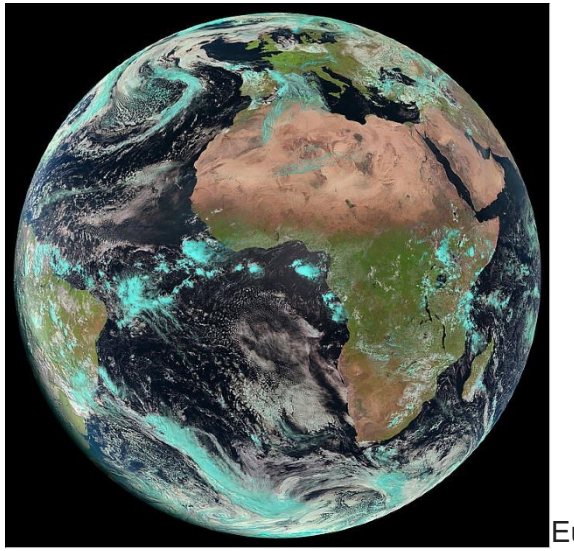
Fire Disturbance (1/2)

Recent News

Meteosat Third Generation (MTG)

Due for launch 13th December 2022

- Continuation of the SEVIRI active fire products
- Fire detections at 2km at the SSP and every 10 minutes over the full disk

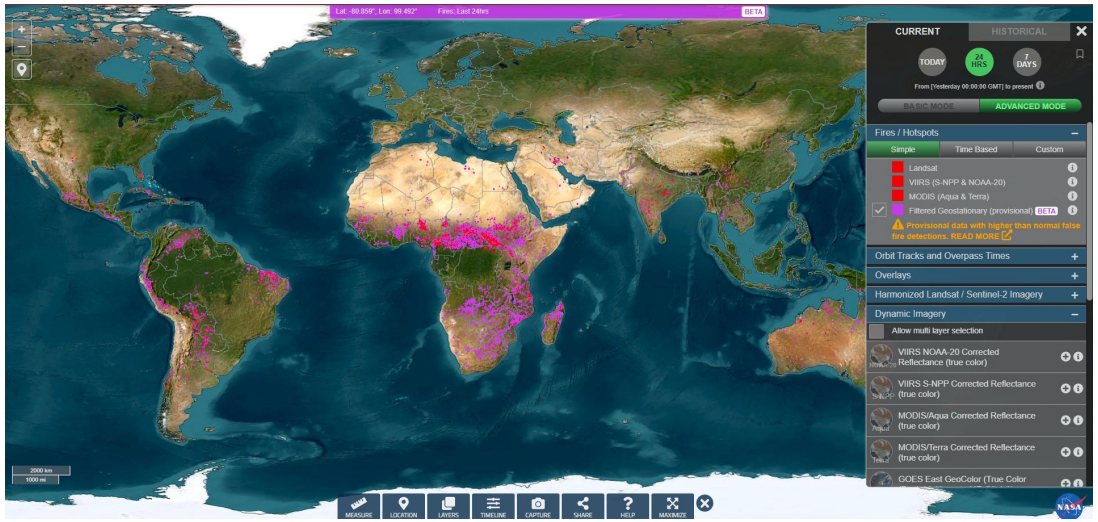


Eumetsat

NASA FIRMS

New data available

- Geostationary GOES, SEVIRI and Himawari active fire product data
- Landsat Fire and Thermal Anomaly (LFTA) product data



Fire Disturbance (2/2)

Recent Publications

Active fire

Chen, J., Li, R., Tao, M., Wang, L., Lin, C., Wang, J., Wang, L., Wang, Y. and Chen, L., 2022. Overview of the performance of satellite fire products in China: Uncertainties and challenges. *Atmospheric Environment*, *268*, p.118838.

Chen, J., Yao, Q., Chen, Z., Li, M., Hao, Z., Liu, C., Zheng, W., Xu, M., Chen, X., Yang, J. and Lv, Q., 2022. The Fengyun-3D (FY-3D) global active fire product: principle, methodology and validation. *Earth System Science Data*, *14*(8), pp.3489-3508.

Burned Area

Zhang, S., Zhao, H., Wu, Z. and Tan, L., 2022. Comparing the Ability of Burned Area Products to Detect Crop Residue Burning in China. *Remote Sensing*, *14*(3), p.693.

LST & Emissivity (1/5)

Conferences

- American Geophysical Union (AGU), Chicago, IL, 12-16 Dec 2022
  - GC33C - Advancing Global Imaging Spectroscopy and Thermal Infrared Measurements
- International High Resolution Thermal Workshop, ESRIN, Italy, 10-12 May
  - Preparatory activities for the upcoming High-resolution thermal missions such as TRISHNA, SBG and LSTM

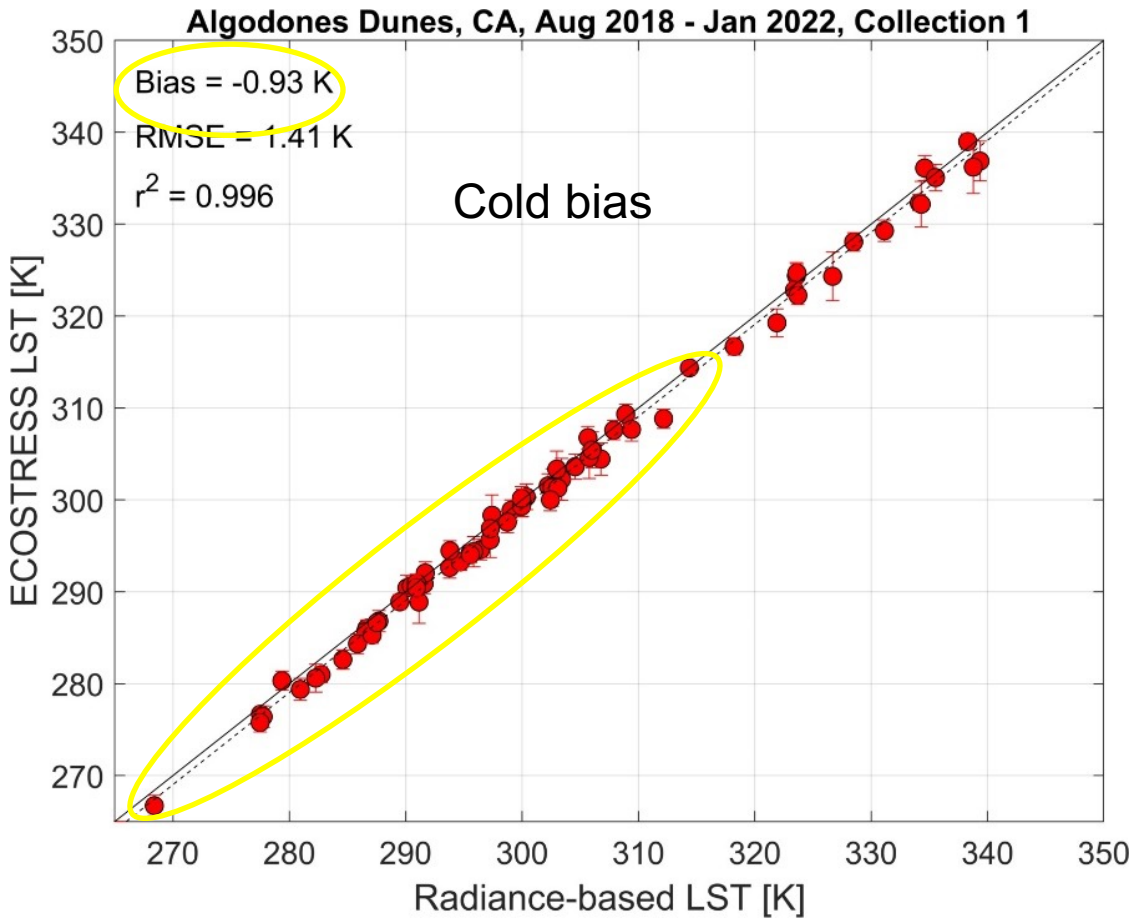
Project news

- ECOSTRESS collection 2 LST&E and cloud products available in forward processing
  - reprocessing of archive to begin in early 2022
- New VIIRS 375-m near real time LST product currently in testing and will be available in Spring 2022
- Release of VIIRS collection 2 LST&E expected soon at LPAAC
- LSA SAF processing chain for MTG-I1 (launch 13 Dec) day-1 products ready

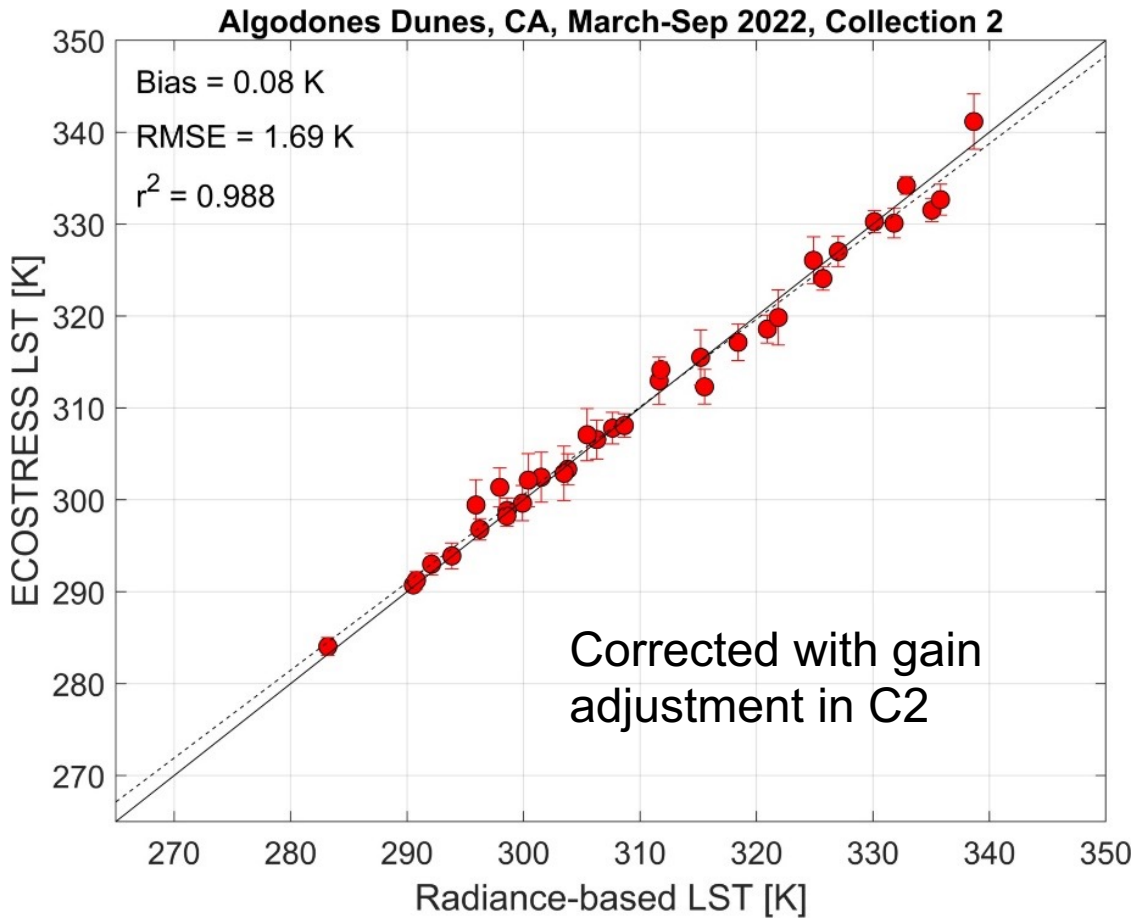
LST & Emissivity (2/5)

ECOSTRESS calibration fix in collection 2

Collection 1



Collection 2

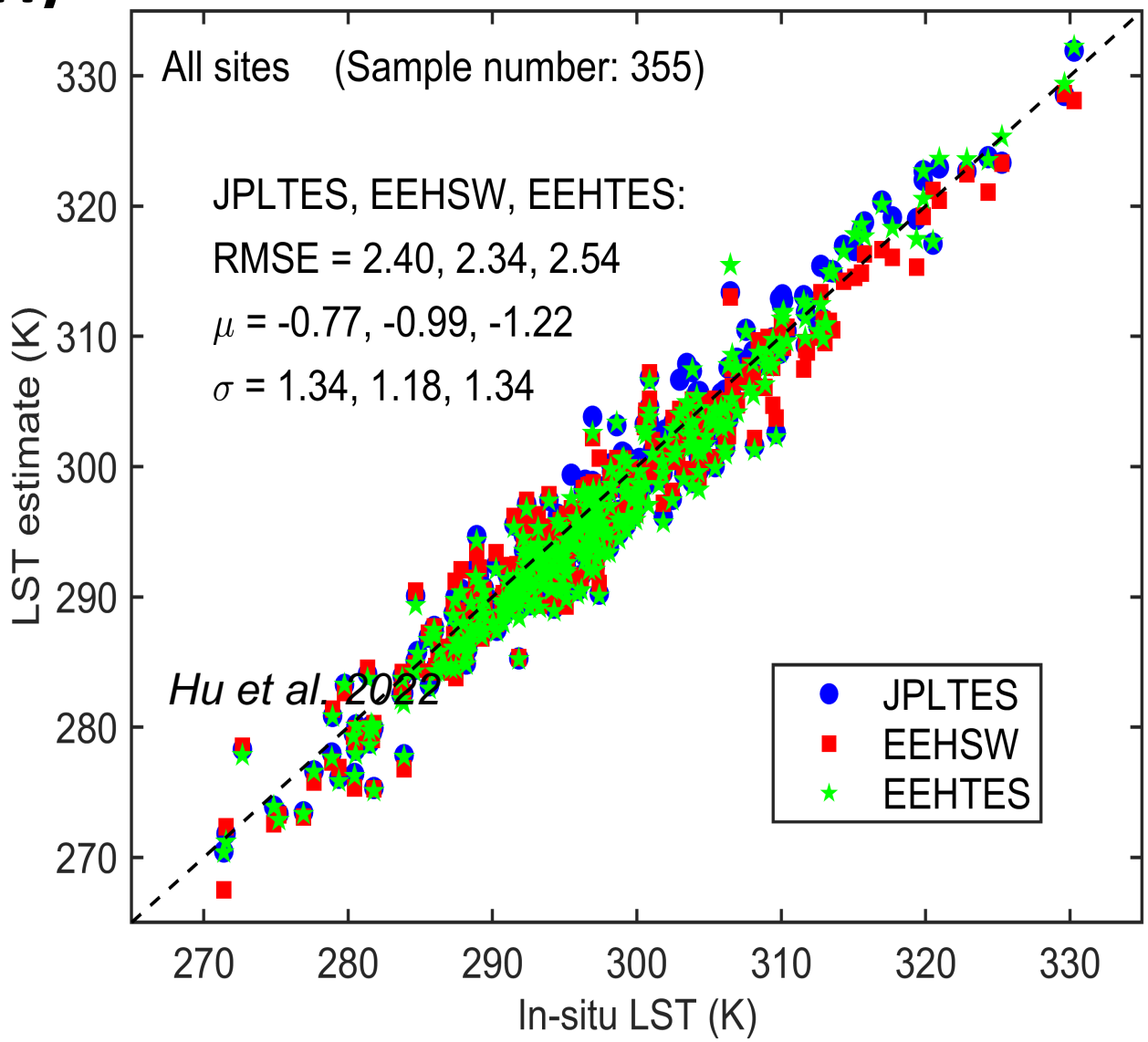


LST & Emissivity (3/5)

European ECOSTRESS Hub (EEH)

ESA funded EEH LST products compare well with standard NASA (JPLTES) LST product

EEH is developing LST and ET products for Europe and African in preparation for LSTM



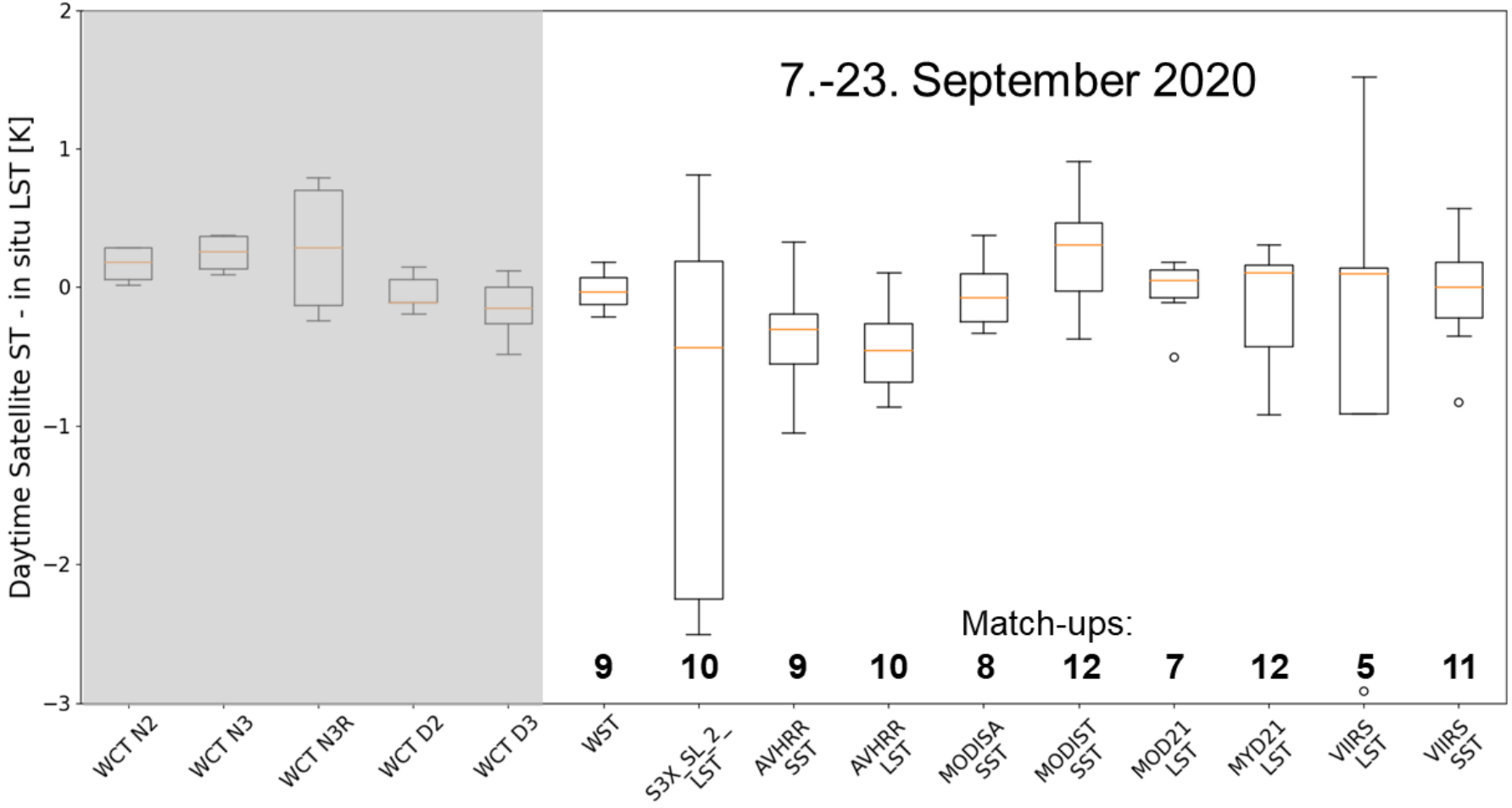
Hu et al. 2022

LST & Emissivity (4/5)

Thermal Infra-red Product Inter-comparison and Validation with FRM Radiometers

F. Göttsche[1], W. Wimmer[2], M. Martin[1] and L. Perez-Planells[1] ([1]KIT & [2]UoS)

EUMETSAT Lake Constance project



LST & Emissivity (5/5)

Recent LST&E publications

- Yamamoto et al. (2022), Uncertainty quantification in land surface temperature retrieved from Himawari-8/AHI data by operational algorithms, ISPRS Journal of Photogrammetry and Remote Sensing, doi: 10.1016/j.isprsjprs.2022.07.008.
- Rains et al. (2022), High-resolution all-sky land surface temperature and net radiation over Europe, Earth System Science Data, doi: 10.5194/essd-2022-302 (preprint).
- Pérez-Planells et al. (2022), Retrieval of land surface emissivities over partially vegetated surfaces from satellite data using radiative transfer models, IEEE Transactions on Geoscience and Remote Sensing, doi: 10.1109/TGRS.2022.3224639.
- Hu et al. (2022), Continental-scale evaluation of three ECOSTRESS land surface temperature products over Europe and Africa: Temperature-based validation and cross-satellite comparison, Remote Sensing of Environment, doi: 10.1016/j.rse.2022.113296.
- Liu et al. (2022), Ten Years of VIIRS Land Surface Temperature Product Validation, Remote Sensing, doi: 10.3390/rs14122863.
- Hong et al. (2022), A global dataset of spatiotemporally seamless daily mean land surface temperatures: generation, validation, and analysis, Earth System Science Data, doi: 10.5194/essd-14-3091-2022.