Land Cover Focus Area

Alexandra (Sasha) Tyukavina (U. Maryland, USA)
Nandika Tsendbazar (Wageningen University, Netherlands)

LPV plenary – June 26, 2025

Outline

- LC validation guidelines update
- LC validation methods
- New LC products
- Updates on LC validation datasets

Land Cover validation guidelines update

Main result of 2024:

Version 0.1 released for review on August 30!

Review: Comments from 12 reviewers received by the end of October, 2024. Reviewers from: Europe (6), USA (4), China (1), Brazil (1)

Overall feedback: overwhelmingly positive, valuable suggestions on improving text readability (e.g., pointing to parts of the text that need more clarity)

Main suggestion by multiple reviewers:

adding a “Definitions” section or a Glossary of terms, one reviewer provided a suggested list of terms to be included in this section.

Committee on Earth Observation Satellites
Working Group on Calibration and Validation
Land Product Validation Subgroup
Land Cover Focus Area

Land Cover and Change Map Accuracy Assessment and Area Estimation Good Practices Protocol

Version 0.1 - 2024

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

Chapter leads: Alexandra Tyukavina (Chapters 1 - 5), Sophie Bontemps (Chapters 1, 2, Appendix), Pontus Olofsson (Chapters 3, 5), Giles Foody and Julien Radoux (Chapter 4), Linda See and Bryant Serre (Chapter 6), Xiao-Peng Song (Chapter 7)

Land Cover validation guidelines update

Revision progress update:

Editors working on revisions in response to reviewers' comments.

Main changes so far:

- New 'Definitions' section;
- New section on GCOS requirements for Land Cover ECV products and Table 1.5 —>
- Added overview of aerial photography from traditional manned aircraft and a new Table 6.1 listing repositories of aerial photography;
- New subsection on Fiducial Reference Measurements (FRM) to the section about standardized reference datasets.

Goal:

Finalize version 1.0 by the end of Summer 2025

(3 out of 12 reviewers' comments left to address)

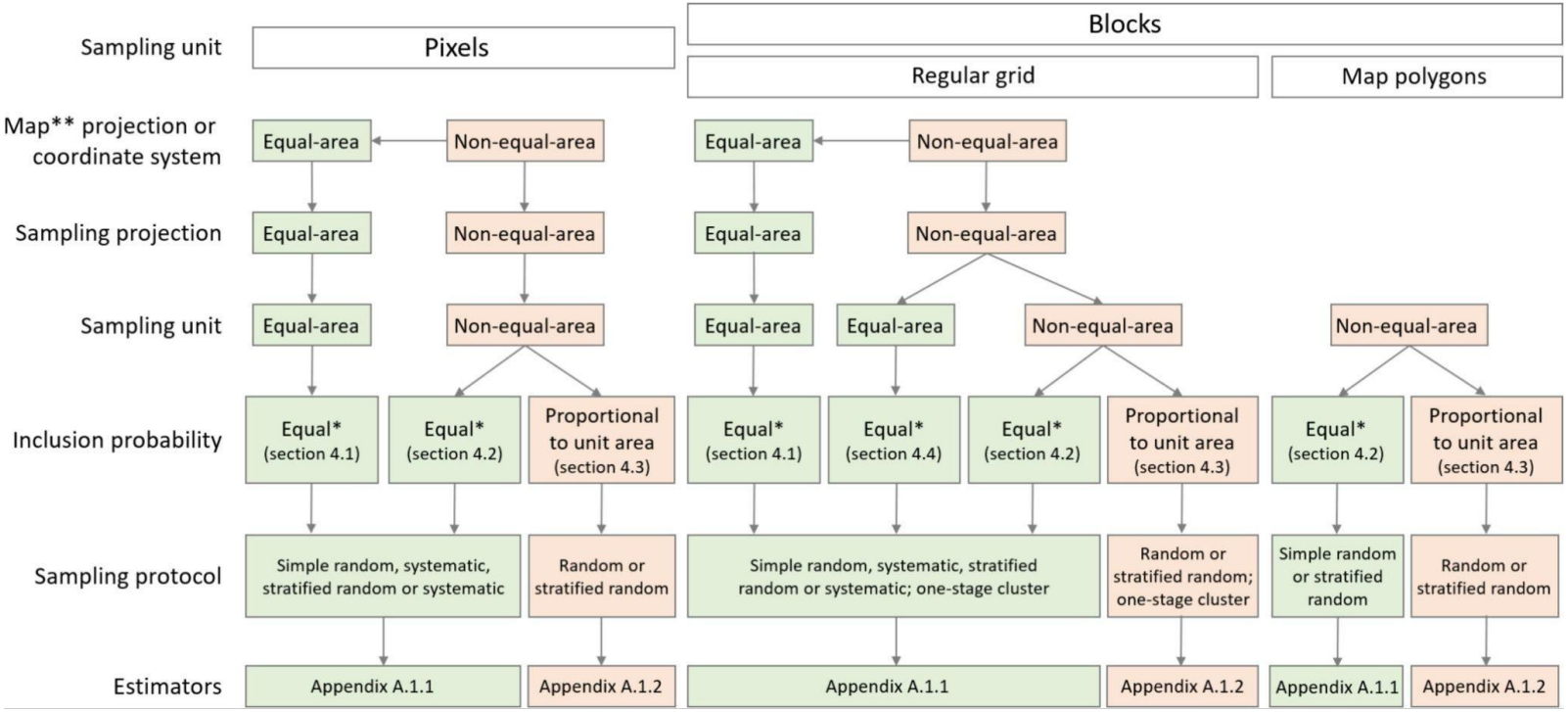
Table 1.5 Requirements for the Land Cover Essential Climate Variable (ECV) data products from the Global Climate Observing System (GCOS) 2022 Implementation plan (WMO, 2022)*

		ECV Product		
Requirements	**Requirement levels**	***Land Cover***	***Maps of High-Resolution Land Cover***	***Maps of Key IPCC Land Classes, Related Changes and Land Management Types***
Horizontal (spatial) resolution	Goal	100 - 300 m	< 10 m	10 - 300 m
	Breakthrough	300 m - 1 km	10 - 30 m	300 m - 1 km
	Threshold	> 1 km	300 - 100 m	1 km - 1 degree
Temporal resolution	Goal	1 month		
	Breakthrough	1 year		
	Threshold	5 years		
Timeliness (reporting/processing delay)	Goal	3 months		1 month
	Breakthrough	1 year		
	Threshold	5 years		
Temporal extent (time span)	Goal	> 50 years	30 - 50 years	> 100 years
	Breakthrough	10 - 50 years	10 - 30 years	50 years
	Threshold	One time		30 years
Required measurement uncertainty (95% confidence interval of overall map accuracy, omission and commission errors of individual land cover and change classes, and of area estimates)	Goal	5%		5%
	Breakthrough	20%		15%
	Threshold	35%		25%
Stability (change per decade in 95% confidence interval of omission and commission errors of individual land cover and change classes)	Goal	5%		
	Breakthrough	15%		
	Threshold	25%		

* **Vertical resolution** requirement is omitted from the table, because it does not apply to the Land Cover ECV products.
Goal is an ideal requirement above which further improvements are not necessary;
Breakthrough is an intermediate level between threshold and goal;
Threshold is the minimum requirement to be met to ensure that data are useful.

Validation methods

New paper: overview of global sampling methods + unified set of equations + code



ELSEVIER

Remote Sensing of Environment

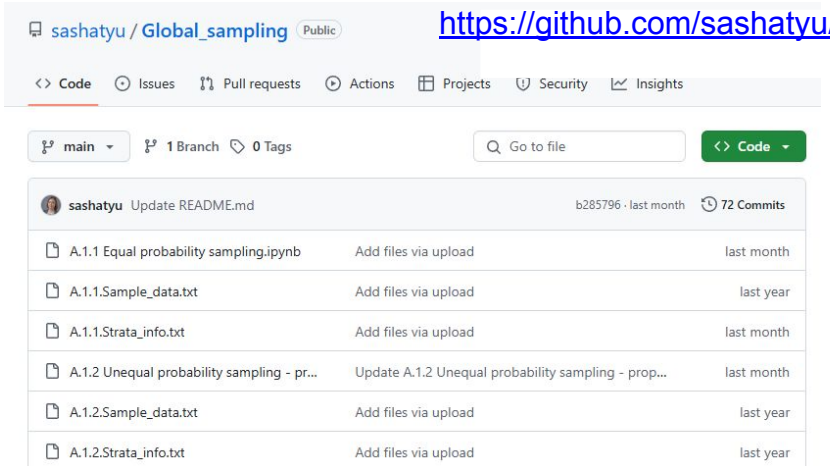
Volume 324, 1 July 2025, 114714

Practical global sampling methods for estimating area and map accuracy of land cover and change

Alexandra Tyukavina [a], Stephen V. Stehman [b], Amy H. Pickens [a], Peter Potapov [a], Matthew C. Hansen [a]

https://doi.org/10.1016/j.rse.2025.114714

https://github.com/sashatyu/Global_sampling



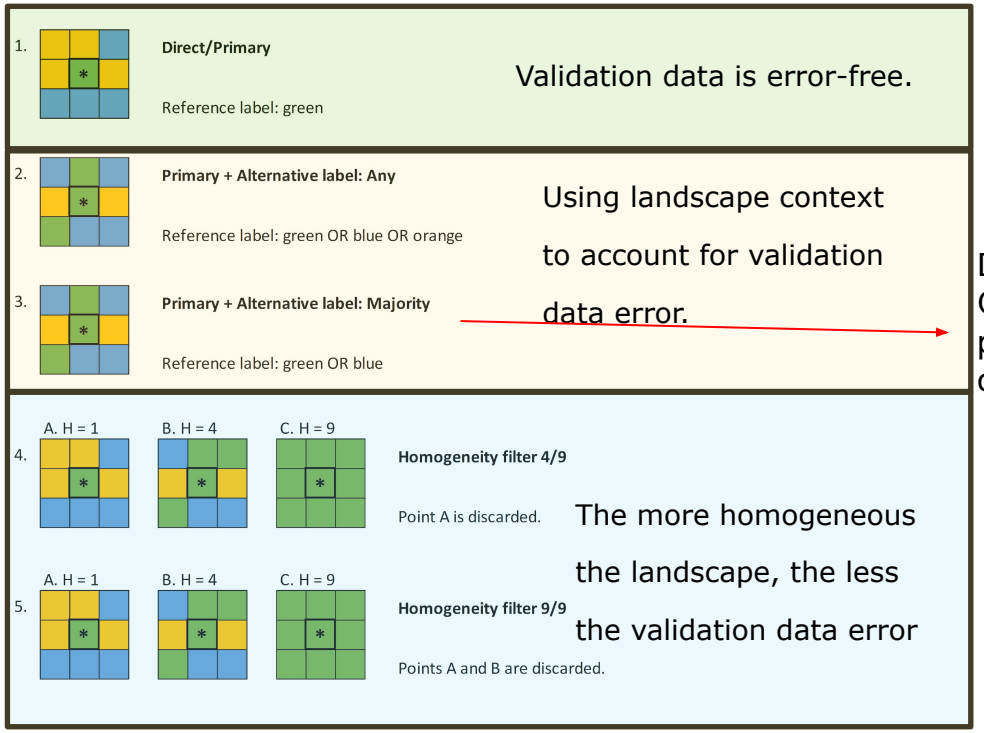
Validation methods

- Approaches to account validation data uncertainty for HR map validation

Remote Sensing of Environment
Volume 311, 1 September 2024, 114316

Comparative validation of recent 10m-resolution global land cover maps

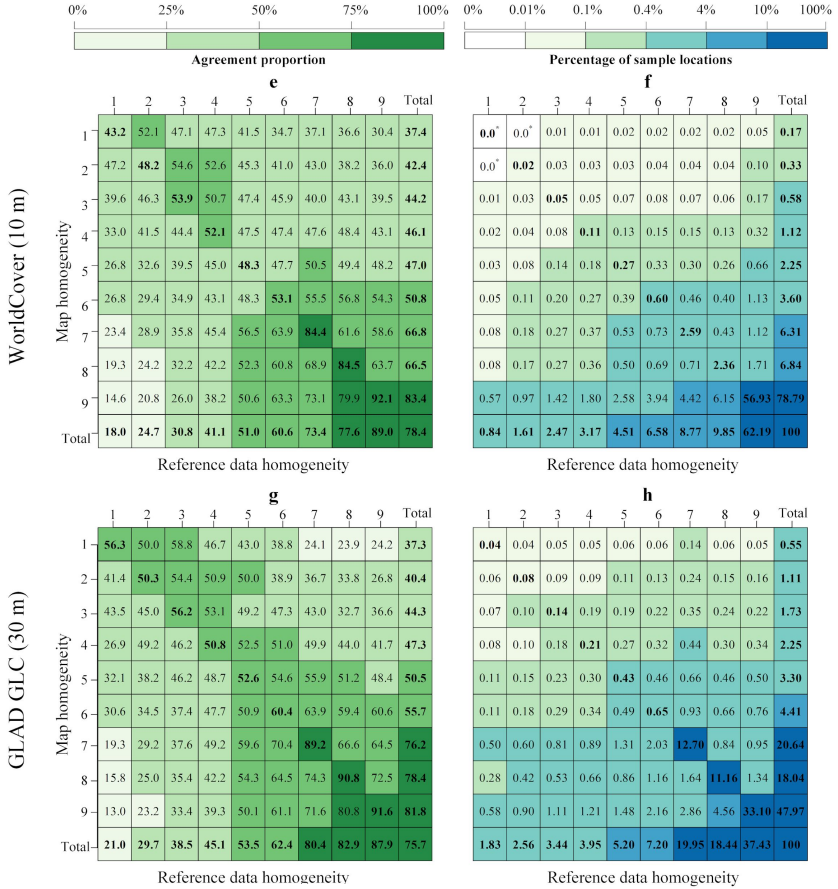
Panpan Xu [a], Nandin-Erdene Tsendbazar [a], Martin Herold [a b], Sytze de Bruin [a], Myke Koopmans [a], Tanya Birch [c], Sarah Carter [d], Steffen Fritz [e], Myroslava Lesiv [e], Elise Mazur [d], Amy Pickens [f], Peter Potapov [f], Fred Stolle [d], Alexandra Tyukavina [f], Ruben Van De Kerchove [g],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



Deemed most suitable. Others are either too pessimistic or optimistic

Considering the spatial context of the sample unit.

Map assessment at different homogeneity levels



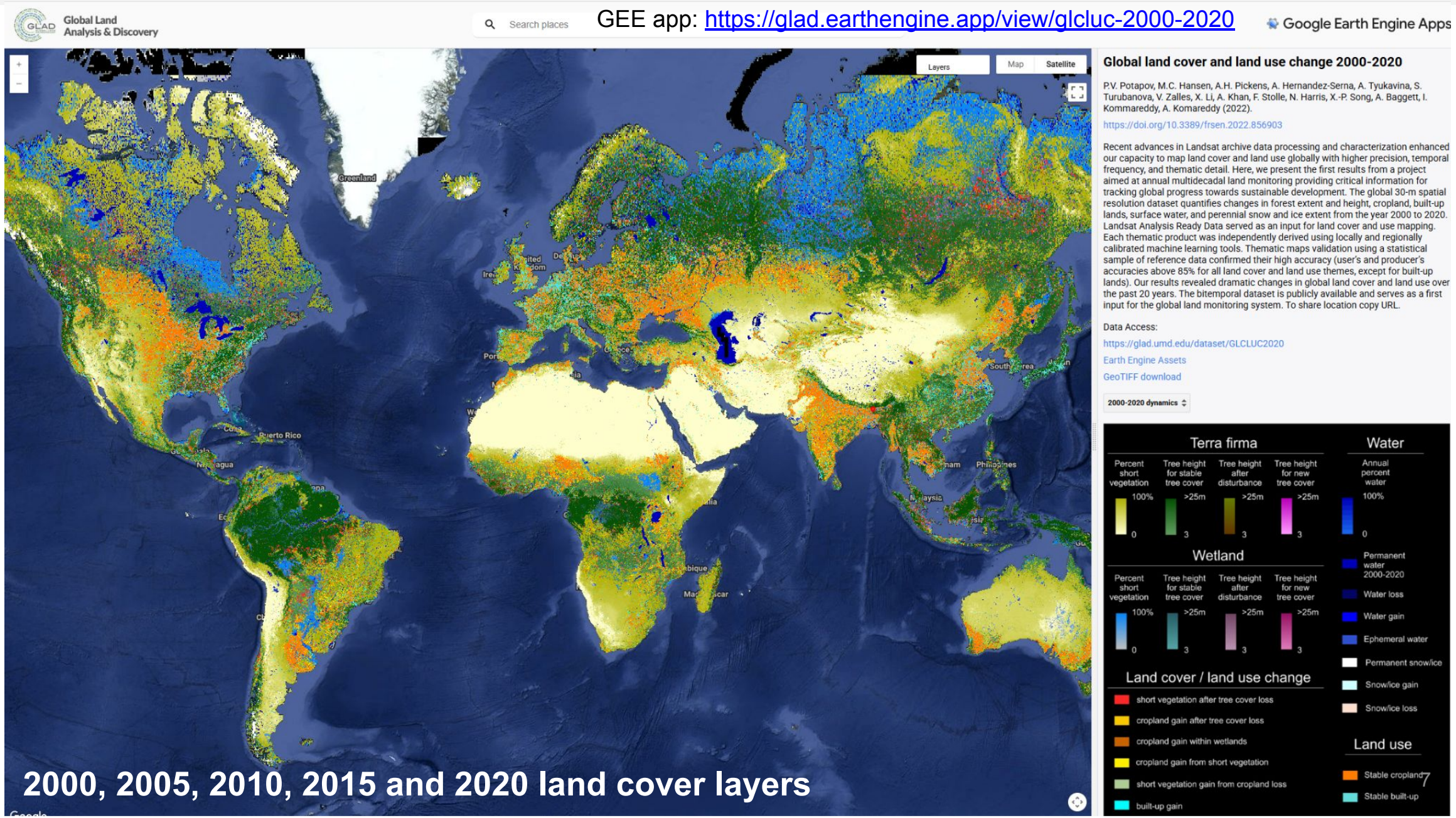
Map agreement

% sample units

Large difference in spatial detail.

New LC products - GLAD GLC: 5-year global land cover (2000-2020)

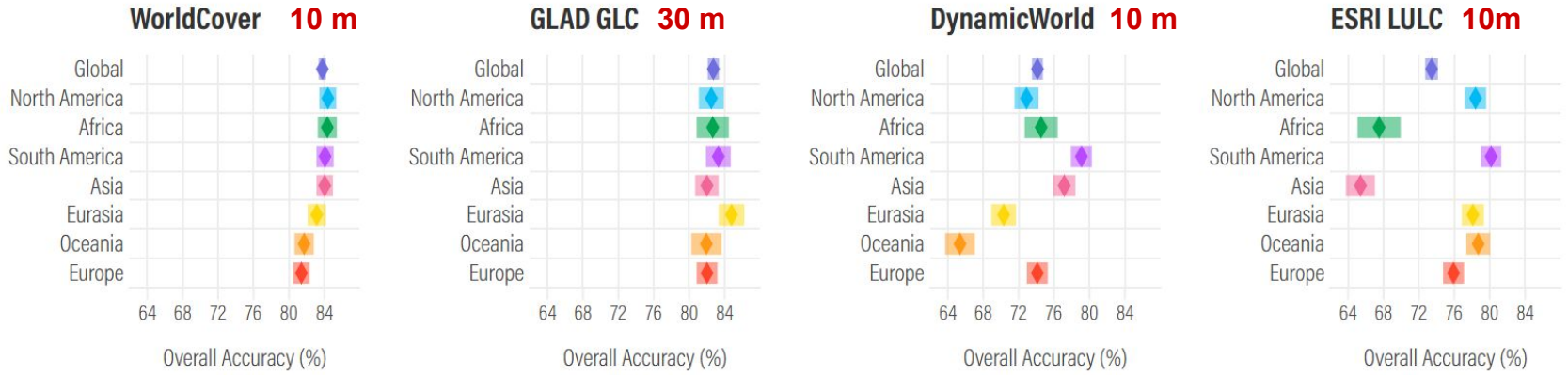
GEE app: https://glad.earthengine.app/view/glcluc-2000-2020



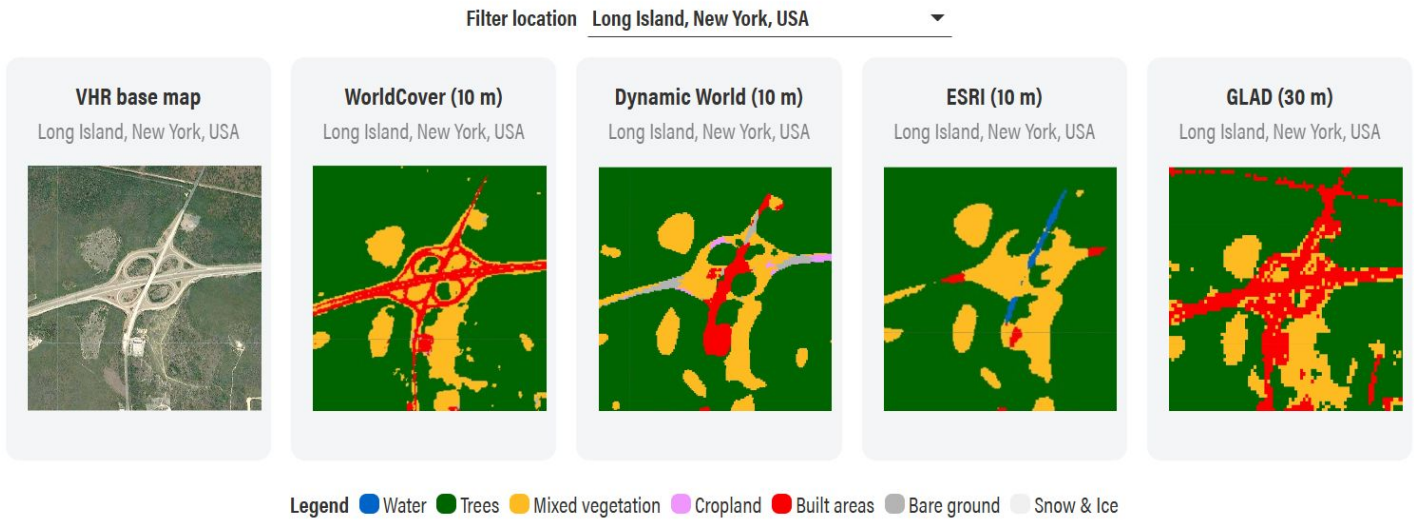
2000, 2005, 2010, 2015 and 2020 land cover layers

Accuracy of 10 m and 30m GLC maps

Overall accuracy of the global land cover maps by continent



Examples of global land cover maps in different landscapes



"WorldCover has the highest global accuracies followed by GLAD GLC, which outperforms WorldCover in Europe, Eurasia and Oceania.

High accuracies (above 80%) are seen across all continents for those two maps, where they consistently outperform Dynamic World and ESRI LULC."

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Comparative validation of recent 10m-resolution global land cover maps

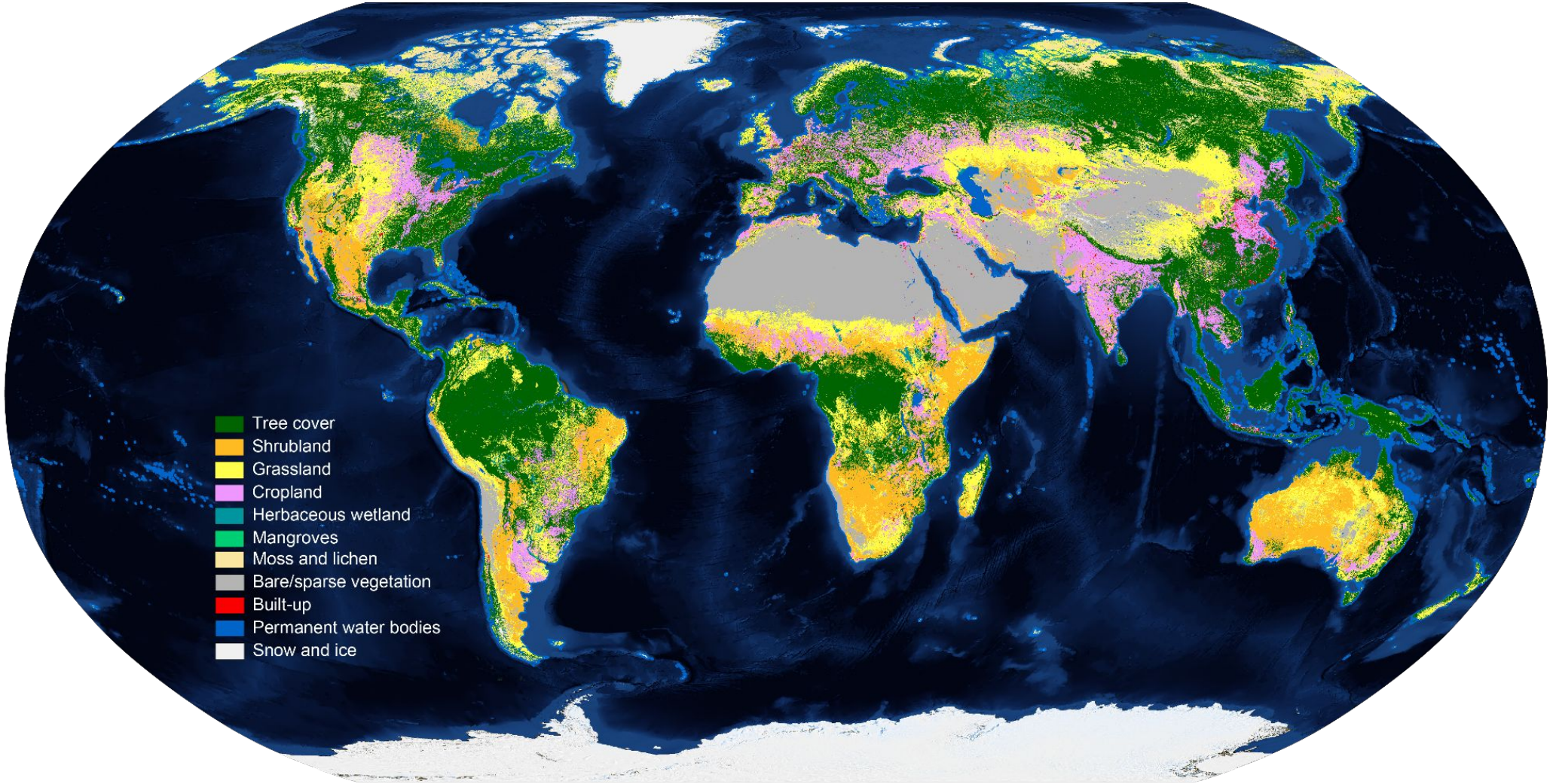
Panpan Xu [a], Nandin-Erdene Tsendbazar [a], Martin Herold [a b], Sytze de Bruin [a], Myke Koopmans [a], Tanya Birch [c], Sarah Carter [d], Steffen Fritz [e], Myroslava Lesiv [e], Elise Mazur [d], Amy Pickens [f], Peter Potapov [f], Fred Stolle [d], Alexandra Tyukavina [f], Ruben Van De Kerchove [g],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

https://doi.org/10.1016/j.rse.2024.114316

Blog post that has 30m GLAD GLD map in addition to 10m maps presented in the paper
https://landcarbonlab.org/insights/global-land-cover-maps-accuracy-applications/

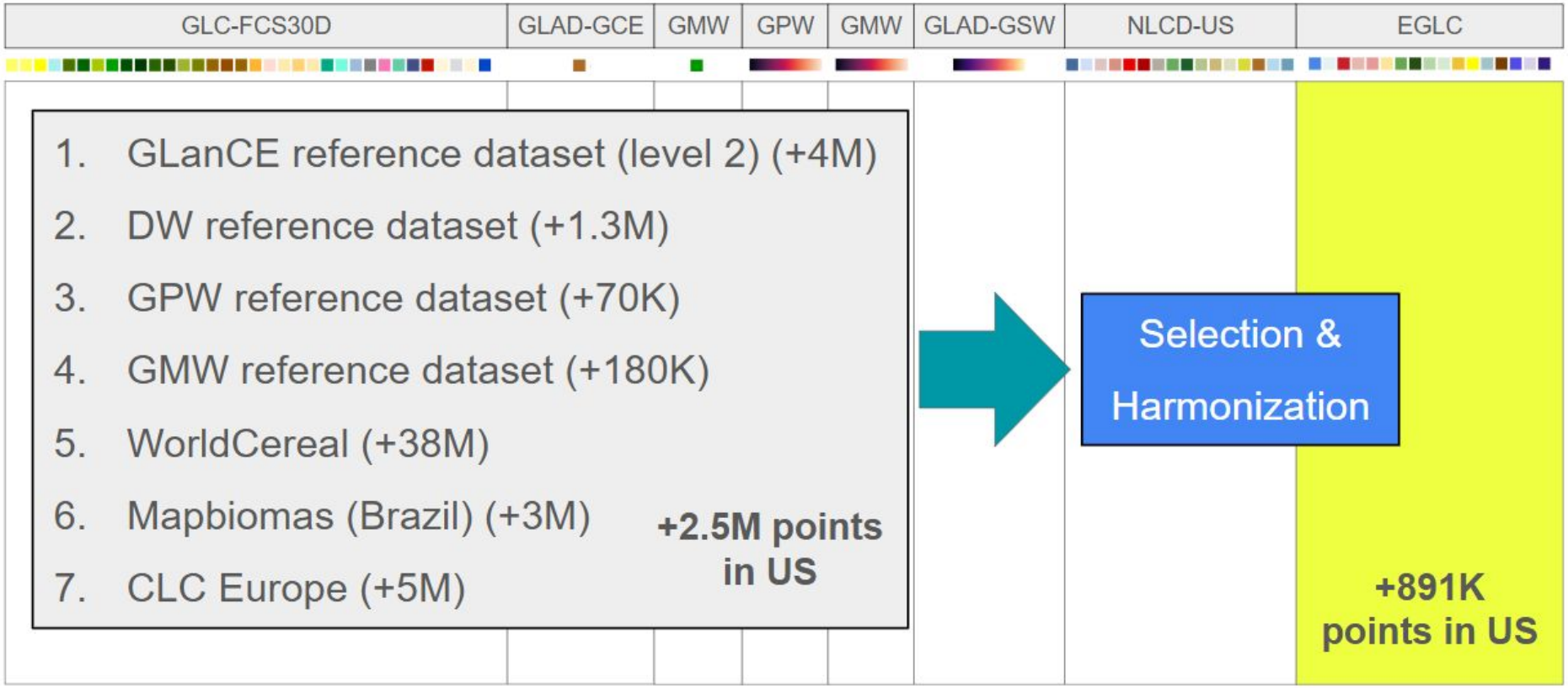
the LCFM Global Land Cover 2020, 10 m resolution (LCM-10m)

Copernicus Global Land Cover & Tropical Forest Mapping & Monitoring Service.



Release Today

OpenEarthMonitor - Ensemble Land Cover 30m 2000-2024+

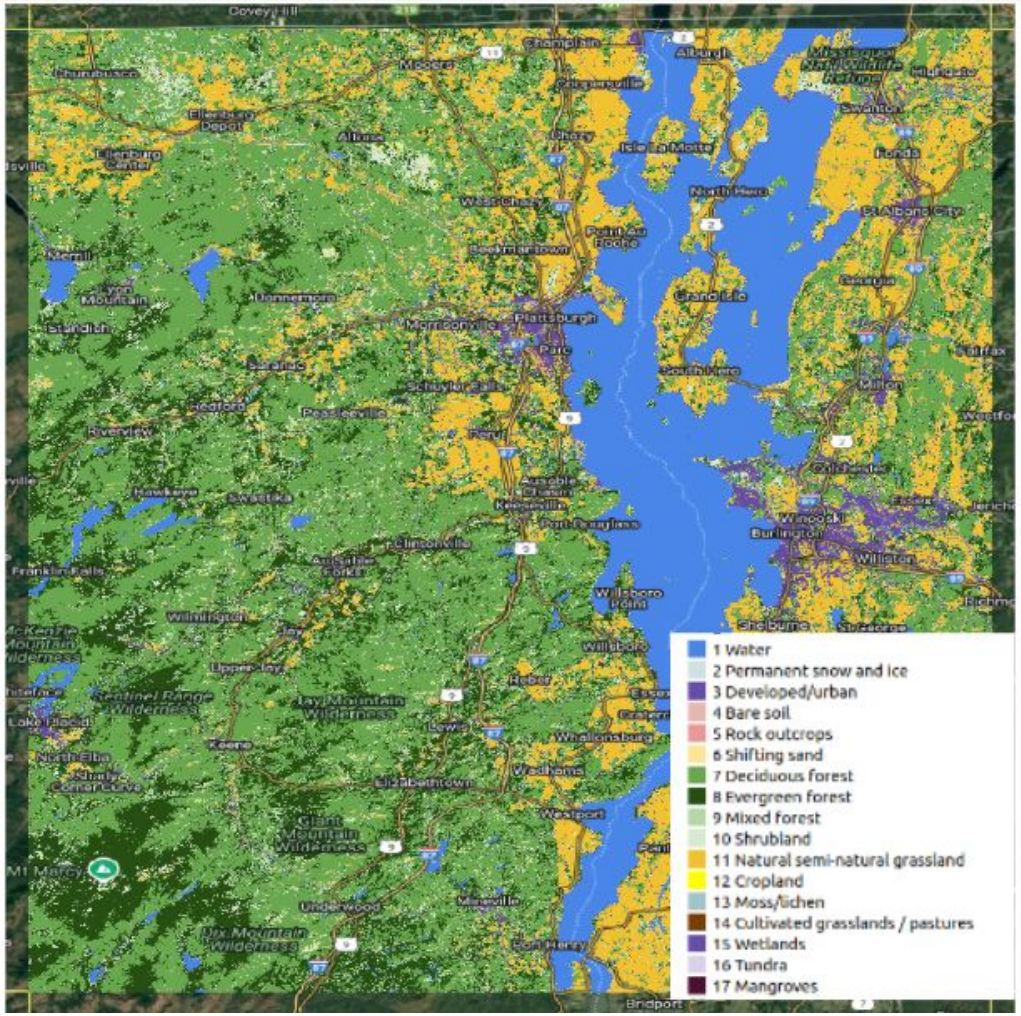


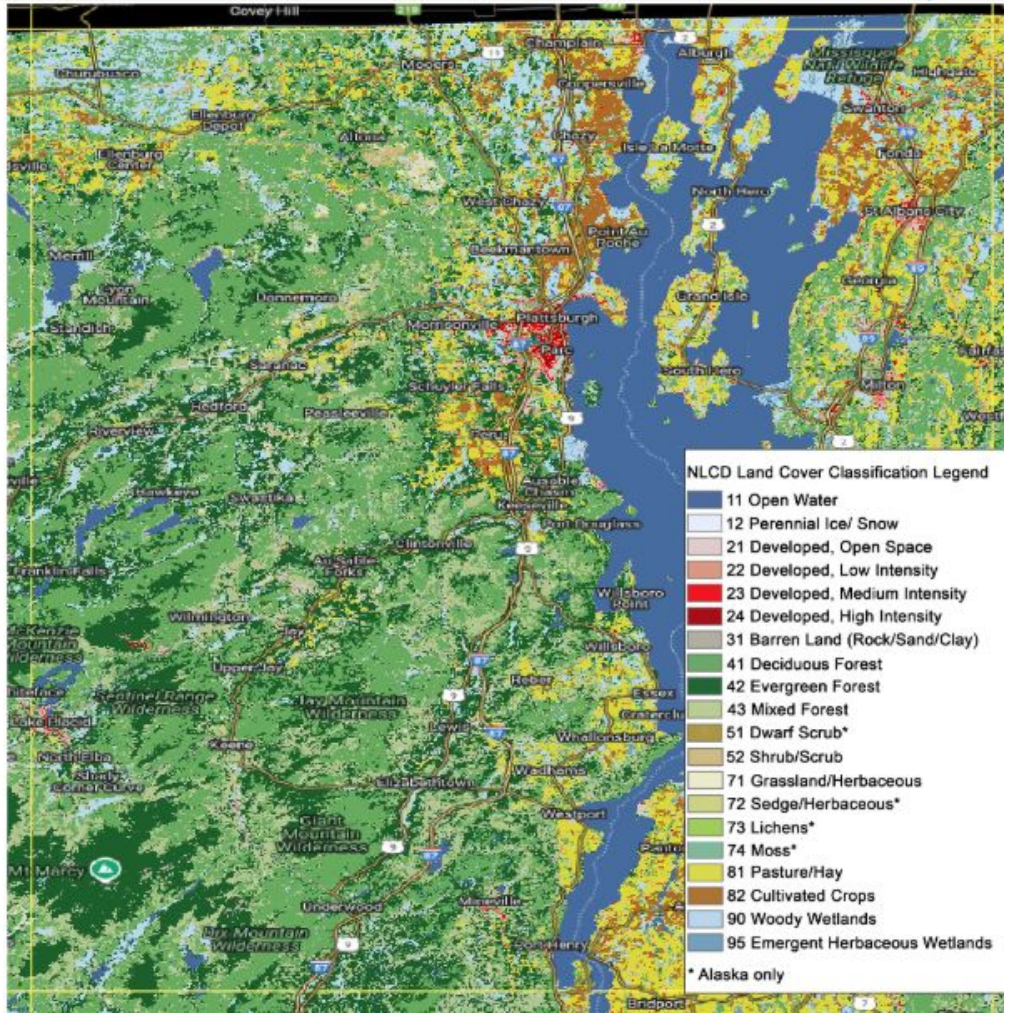
Global and regional map time series

Calibration using reference datasets

OpenEarthMonitor - Ensemble Land Cover 30m 2000-2024+

EGLC x NCLD classifications

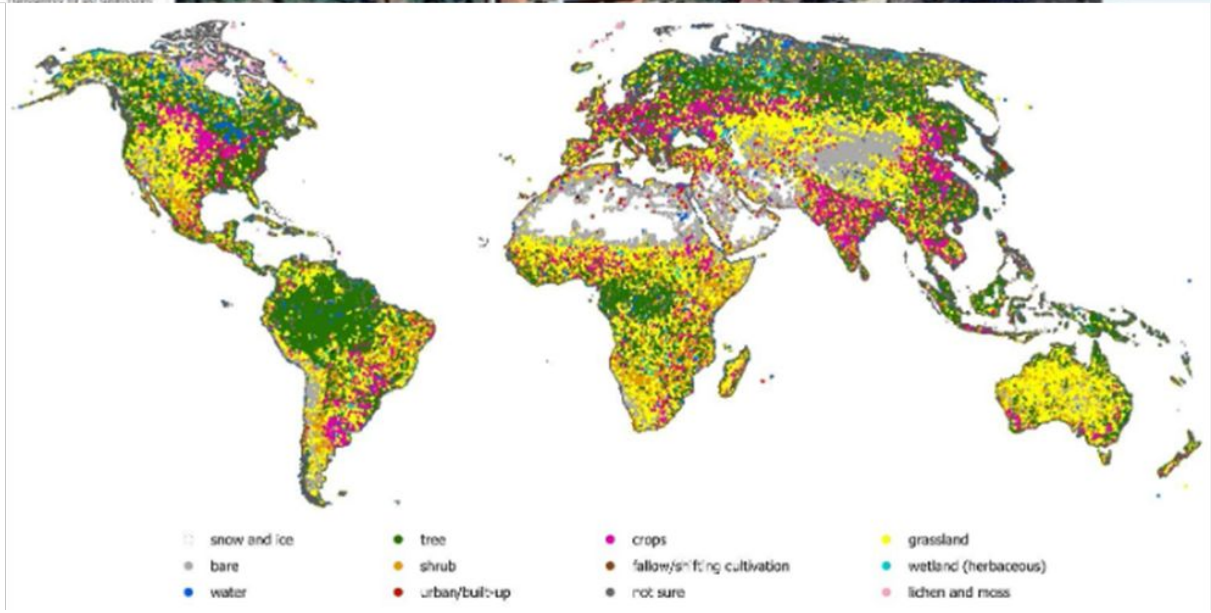




US as a pilot

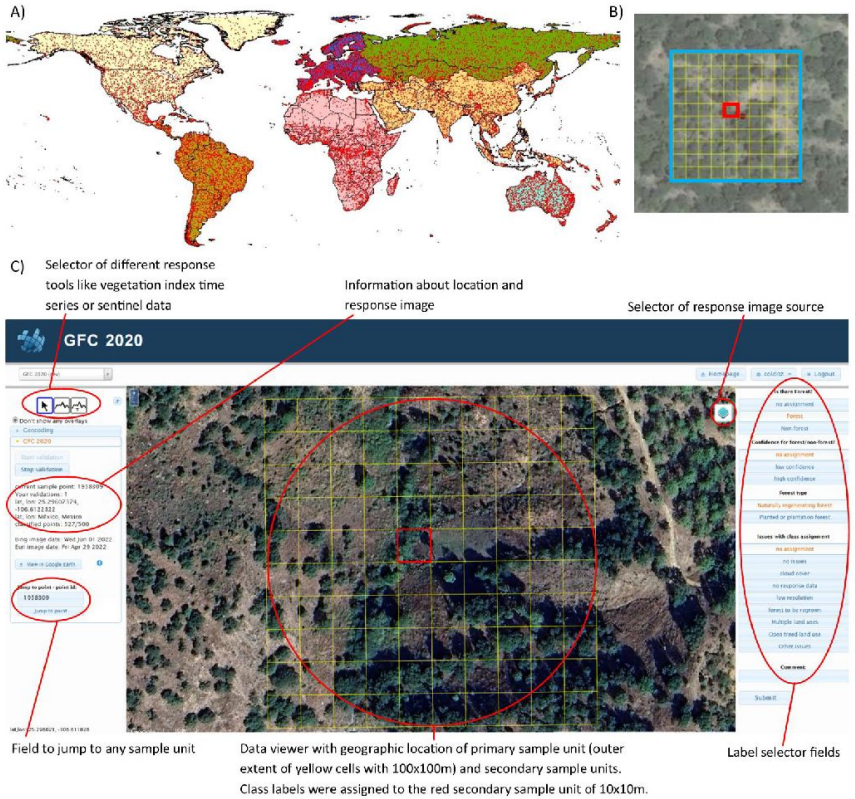
Global reference data set for land cover mapping at 10m

- Projects:
  - Copernicus Global Land Service (JRC) and ESA WorldCover
- Total 165 696 clusters, each 100 records at 10m x 10m resolution
- Distribution: systematic (~35km) + additional records in low accuracy areas
- Geo-Wiki toolbox
- Available by the end of this summer on Zenodo



LC validation dataset (forest vs. non-forest)

- JRC-Global Forest Cover
- Forest and non-forest (land use)
- Sample unit area – 10x10m



Data description paper: GFC2020: A Global Map of Forest Land Use for year 2020 to Support the EU Deforestation Regulation – ESSD – open for review