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Planetary Variables:
Quantifying a
Changing World

Article | Open Access | Published: 01 March 2023

Sub-continental-scale carbon stocks of individual trees in African drylands

Compton Tucker, Martin Brandt, Pierre Hiernaux, Ankit Kairiyaa, Kjeld Rasmussen, Jennifer Smail, Christian Igel, Florian Reiner, Katherine Yasmin Fitts, August Morin, Jorge Pinho, Kergoat, Bil-Assanou Issoufou, Patrice S.

Article | Published: 15 March 2023

The carbon sink of secondary a humid tropical forests

Viola H. A. Heinrich, Christelle Vancutsem, Ricardo Dalai, Fawcett, Celso H. L. Silva-Junior, Henrique L. G. Cassol, Frédéric Achard, Tommaso Jucker, Carlos A. Silva, Jo House, Stephen Sitch, Tristram C. Hales & Luiz E. O. Aragão

A biomass map of the Brazilian Amazon from multisource remote sensing

Jean Pierre Ometto, Eric Bastos Gorgens, Francisa Rocha de Souza Pereira, Luciane Sato, Mauro Lúcio Rodrigues de Assis, Roberta Cantinho, Marcos Longo, Aline Daniele Jacon & Michael Keller

LETTER • OPEN ACCESS

GEDI launches a new era of biomass inference from space

Ralph Dubayah^{1,2}, John Armstrong¹, Sean P Healey², Jamis M Bruening¹, Paul L Patterson², James R Keller², Laura Duncanson¹, Svetlana Saarela³, Göran Ståhl⁵, Zhiqiang Yang²

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A National, Detailed Map of Forest Aboveground Biomass in Mexico

by Oliver Cartus 1,* & Josef Kellndorfer 1,* & Wayne V. Jesse Bishop 1, Lucio Santos 2 and José María Michel 1

1 Woods Hole Research Center, 149 Woods Hole Road, Falmouth, MA 02556, USA
2 Comisión (CONAFOR), Periférico Poniente 5360, San Juan de O

Data Descriptor | Open Access | Published: 06 April 2020

Rapid remote monitoring reveals spatial and temporal hotspots of carbon loss in Africa's rainforests

Jue De Sy, Arnan Araza & Martin Herold

Article number: 48 (2022) | Cite this article

Tyler J. Lark & Holly K. Gibbs

12 (2020) | Cite this | Altmetric | Metrics

The global forest above-ground biomass pool for 2010 estimated from high-resolution satellite observations

Maurizio Santoro, Oliver Cartus, Nuno Carvalhais, Danae M. A. Rozendaal, Valerio Avitabile, Arnan Araza, Sytze de Bruin, Martin Herold, Shaun Quegan, Pedro Rodriguez-Veiga, Heiko Balzter, João Carreiras, Dmitry Schepaschenko, Mikhail Korets, Masanobu Shimada, Takuya Itoh, Álvaro Moreno Martínez, Jura Cavlovic, Roberto Cazzolla Gatti, Polynya da Conceição Bispo, Nasheta Dewnath, Nicolas Labrière, Jingjing Liang, Jeremy Lindsell, Edward T. A. Mitchell, Alexandra Morel, Ana Maria Pacheco Pascagaza, Casey M. Ryan, Ferry Slik, Gaia Vaglio Laurin, Hans Verbeeck, Arief Wijaya, and Simon Willcock

GLOBAL FOREST WATCH

Open Data Portal Home | Datasets | Data Policy | Sign In

Aboveground Live Woody Biomass Density

Global Forest Watch (GFW)

View Map | Download | More

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Biomass Harmonization

(GEDI estimates of IPCC Tier 1 aboveground biomass)

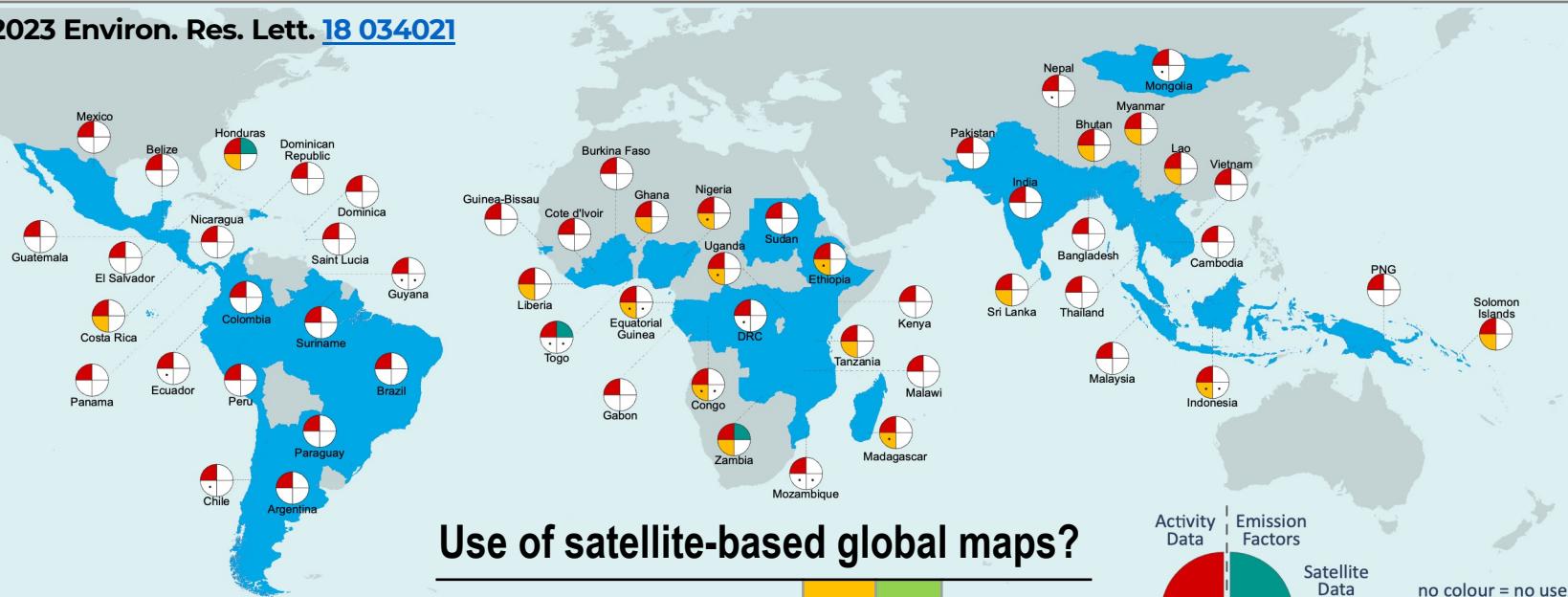
Neha Hunka, University of Maryland



Carbon estimation from space: Do we need to ‘Biomass Harmonize’?



Melo et al 2023 Environ. Res. Lett. [18 034021](#)



Use of satellite-based global maps?

Global product	AD	EF	Indirectly
Global forest change (GFC)	16	-	14
MODIS Fire (BA, AF)	2	-	1
Saatchi et al (2011)	-	-	3
Baccini et al (2012)	-	-	2



Satellite-based global maps are rarely used in forest reference levels submitted to the UNFCCC

Joana Melo^{4,1} , Timothy Baker¹ , Dirk Nemitz², Shaun Quegan³ and Guy Ziv¹

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Environmental Research Letters, Volume 18, Number 3

Citation Joana Melo et al 2023 *Environ. Res. Lett.* **18** 034021

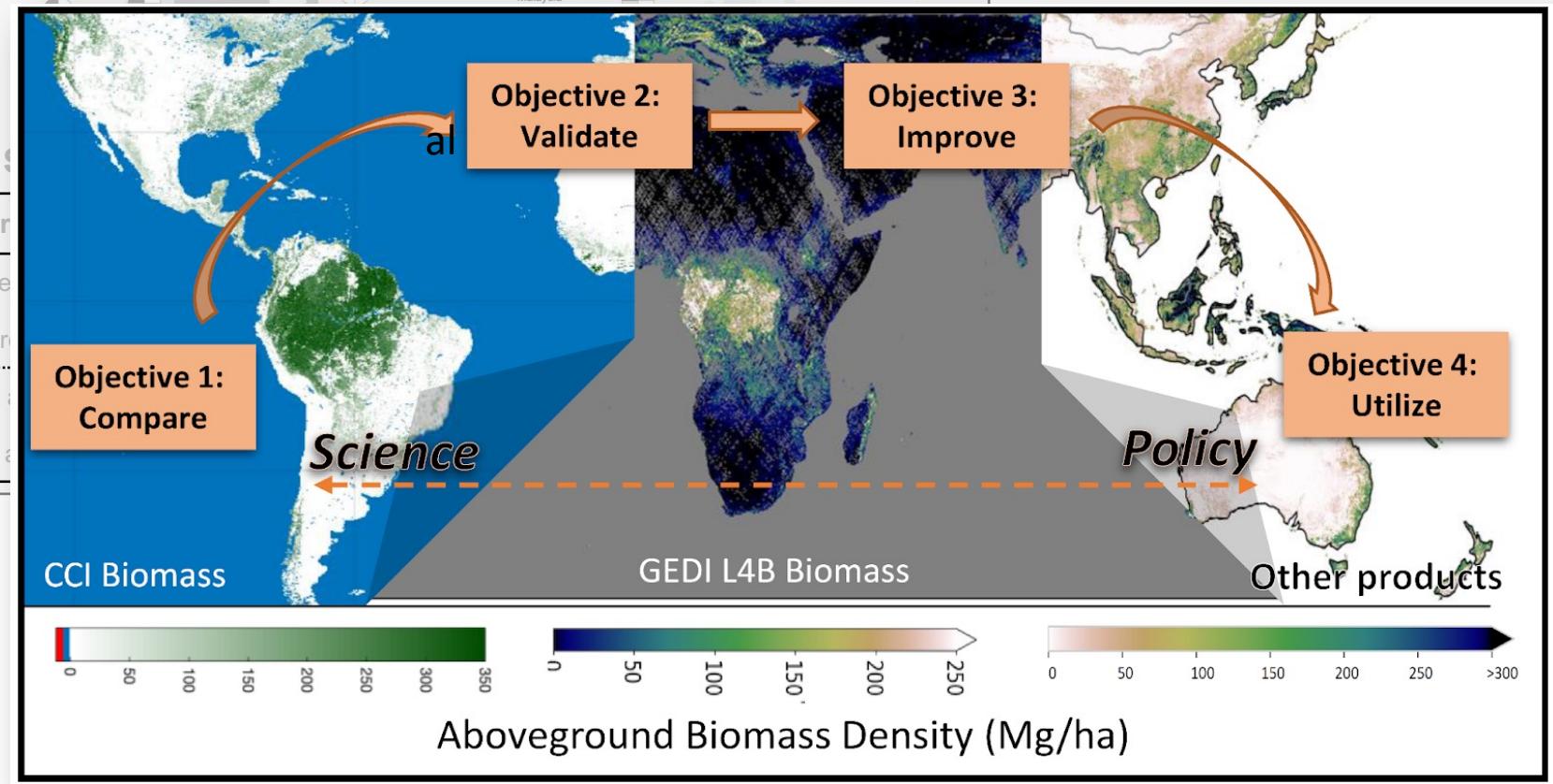
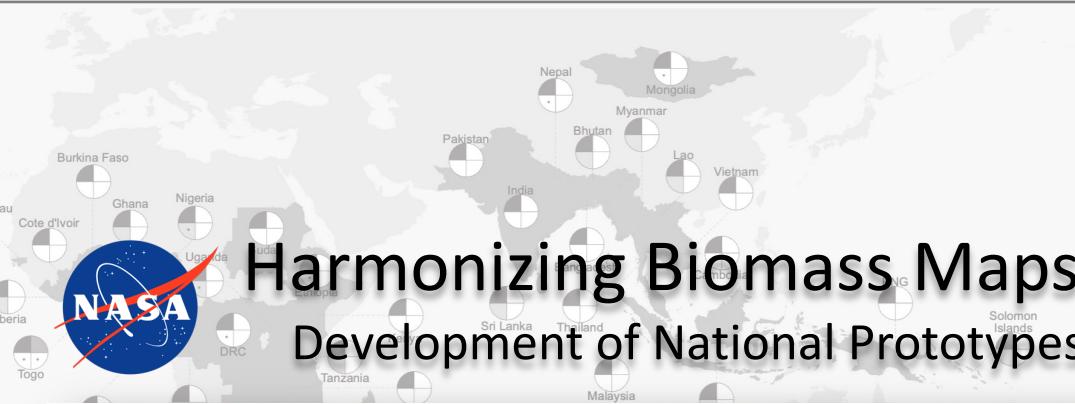
DOI 10.1088/1748-9326/acba31



Carbon estimation from space: Do we need to ‘Biomass Harmonize’?

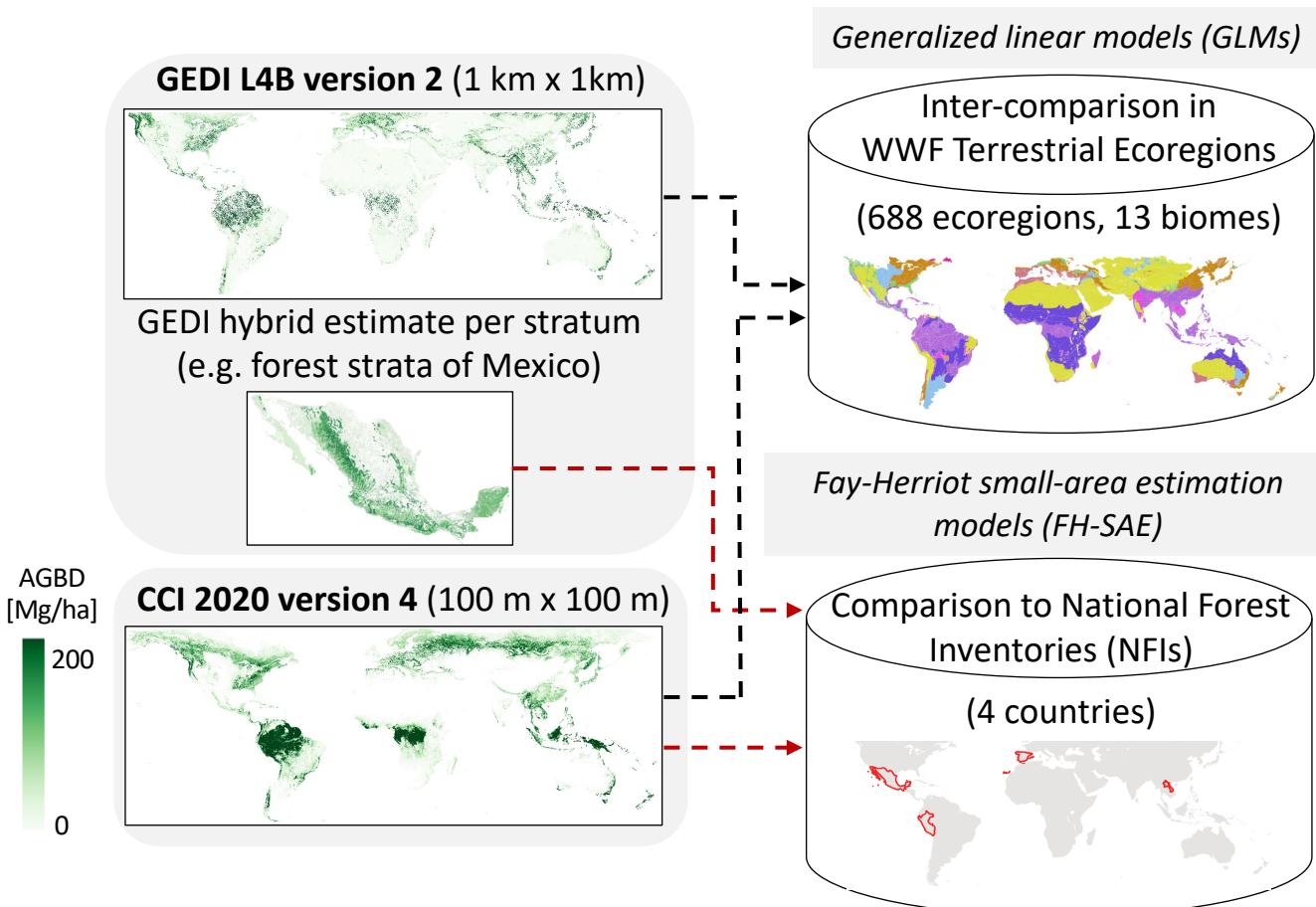


Melo et al 2023 Environ. Res. Lett. 18 034021



Intercomparing EO-derived AGB map products

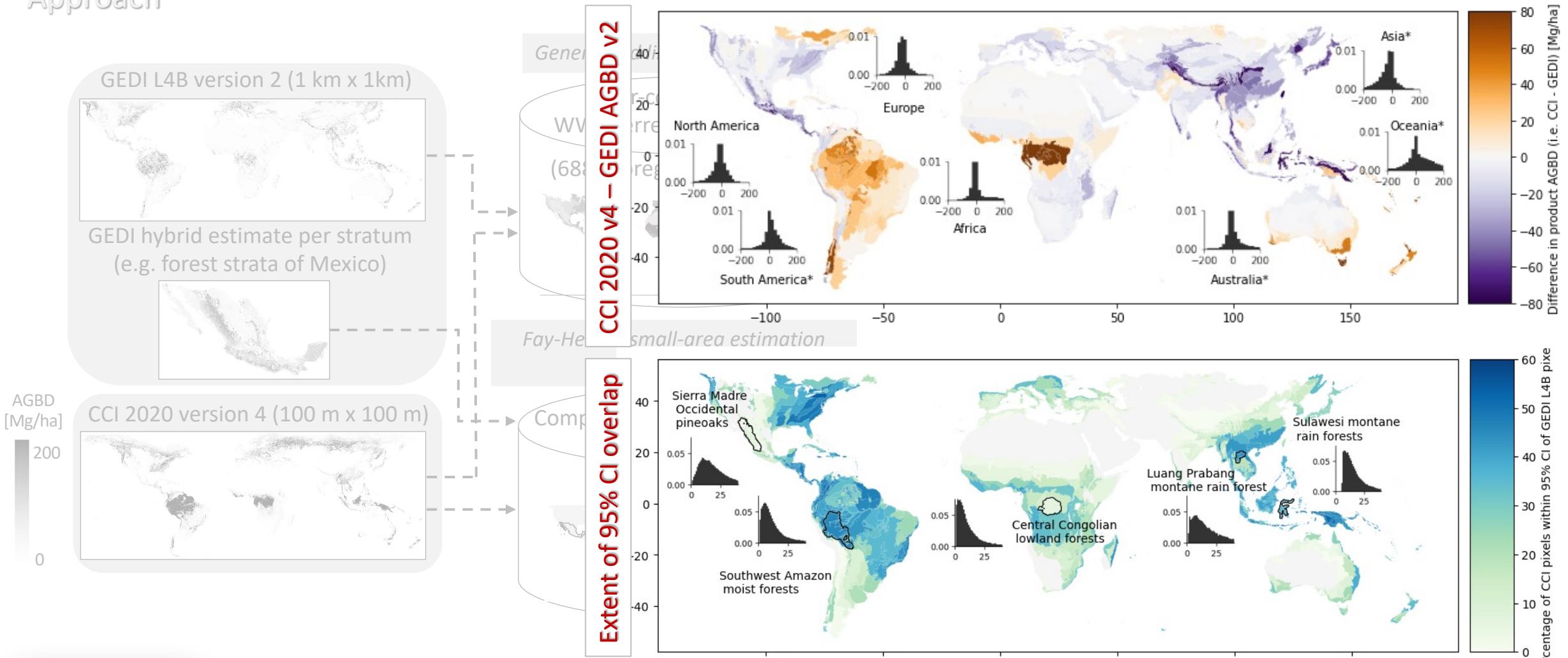
Approach



Intercomparing EO-derived AGB map products

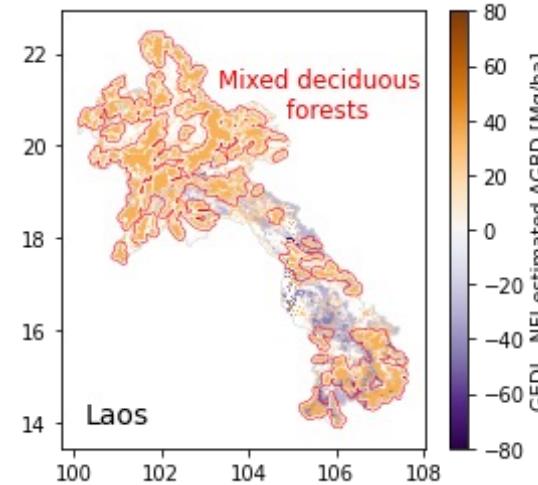
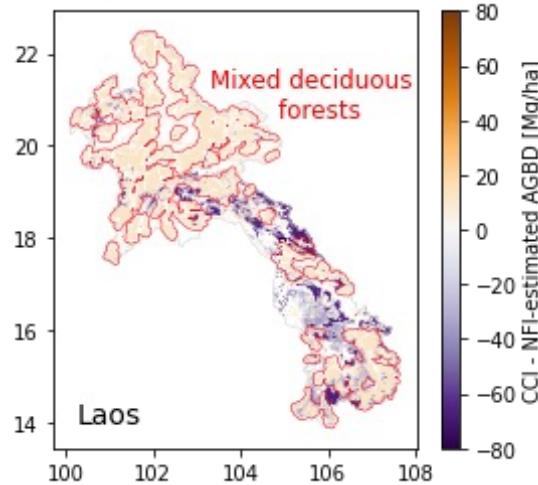
Product inter-comparison

Approach

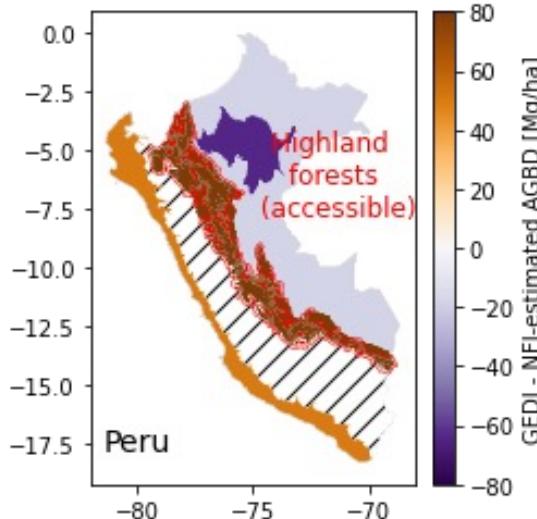
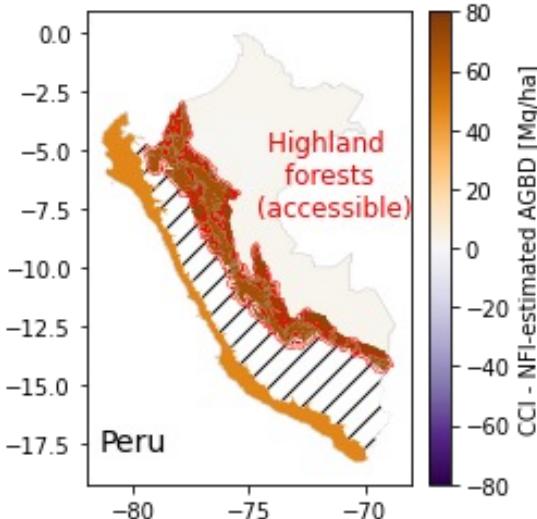


Comparing EO-derived AGB map products to National Forest Inventory estimates

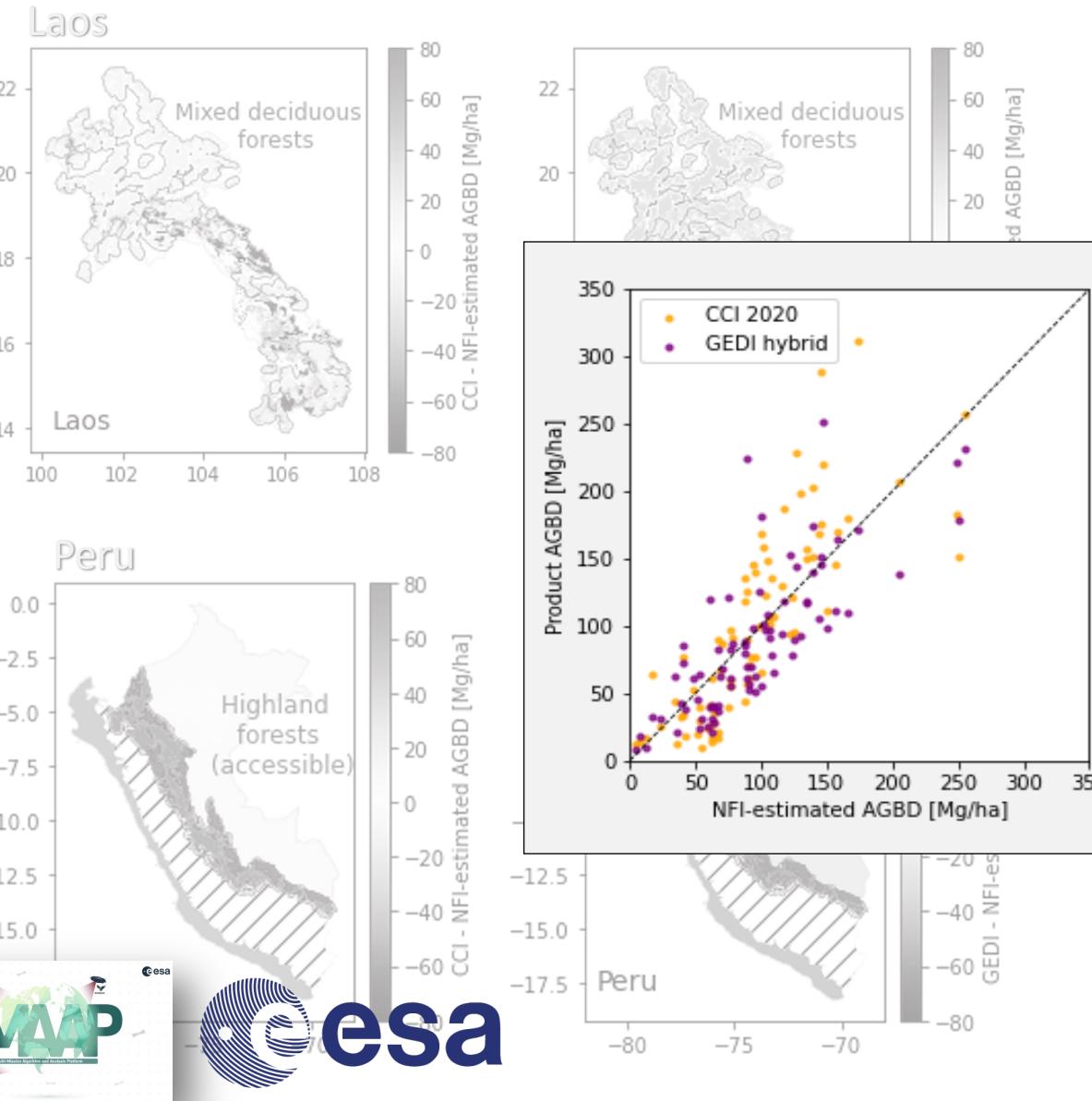
Laos



Peru



Comparing EO-derived AGB map products to National Forest Inventory estimates



The optimistic outlook

- Large differences in AGB between the two products are restricted to a few regions of the globe.
- Systematic error, compared to NFI data, in the four countries examined is non-existent.
- Few weaknesses are being worked on and provide realistic opportunities for improvements in AGB estimates in future iterations.

Aligning for uptake in the UNFCCC Global Stocktake

The “we’re working on it” outlook

- **Align uncertainty assessment frameworks:** Consistent and common analytical approach to defining and reporting information on the precision of AGBD estimates.
- **Provide source-code for large area assessments:** Transparent, well-documented and open-source code to estimate mean and total biomass stocks with associated uncertainties.
- **Provide guidance on enhancing NFIs with AGB maps:** Guidance on methods and open-source codes to enhance national-level biomass stock estimates.
- **Make documentation and usability practical for non-experts:**
 - Can map-based AGBD estimates be used in the equations recommended in IPCC Generic Methodologies to estimate carbon stock changes (Chapter 2 in IPCC 2019 Refinement Guidelines)
 - How the map-product estimates compare to the IPCC default tables for Tier 1 estimates (*Hunka et al., (in review)*) (i.e. Tables 4.7 to 4.10 in Chapter 4, IPCC 2019 Refinement Guidelines)

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GEDI estimates of IPCC Tier 1 aboveground biomass



**2019 Refinement to the
2006 IPCC Guidelines for
National Greenhouse Gas Inventories**



Chapter 4: Table 4.7

(https://www.ipcc-negip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch04_Forest%20Land.pdf)

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
Tropical	Tropical rainforest	Africa	Primary	404.2	120.4	SD
			Secondary >20 years	212.9	143.1	SD
			Secondary ≤20 years	52.8	35.6	SD
		North and South America	Primary	307.1	104.9	SD
			Secondary >20 years	206.4	80.4	SD
			Secondary ≤20 years	75.7	34.5	SD
		Asia	Primary	413.1	128.5	SD
			Secondary >20 years	131.6	20.7	SD
			Secondary ≤20 years	45.6	20.6	SD
	Tropical moist deciduous forest	Africa	Primary	236.6	104.7	SD
			Secondary >20 years	72.8	36.4	SD
			Secondary ≤20 years			9, 10, 16, 40-47
		North and South America	Primary	187.3	94.0	SD
			Secondary >20 years	131.0	54.2	SD
			Secondary ≤20 years	55.7	28.7	SD
		Asia	Primary			
			Secondary >20 years	67.7	93.4	SD
			Secondary ≤20 years			9, 10, 35, 48-50

GEDI estimates of IPCC Tier 1 aboveground biomass



2019 Refinement to the
2006 IPCC Guidelines for
National Greenhouse Gas Inventories

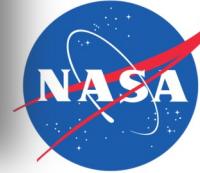
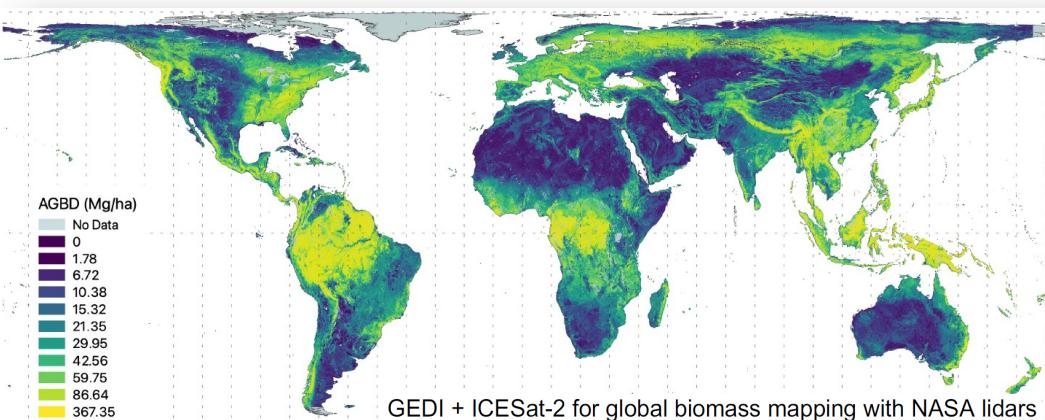


Chapter 4: Table 4.7

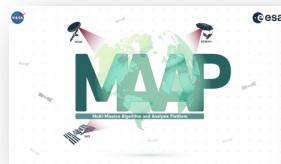
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- Countries with no other forest data use IPCC Tier 1 defaults in national/sub-national reports
- Some combinations of climate domain, ecological zones, continents, forest types, age classes etc. lack credible numbers (e.g. handful of references, default values for all forest ages)
- Can we aid UNFCCC processes by providing a ‘replica’ of IPCC Tier 1 with GEDI (& ICESat-2 + Sentinel2 for boreal) estimates?



GEDI estimates of IPCC Tier 1 aboveground biomass



2019 Refinement to the
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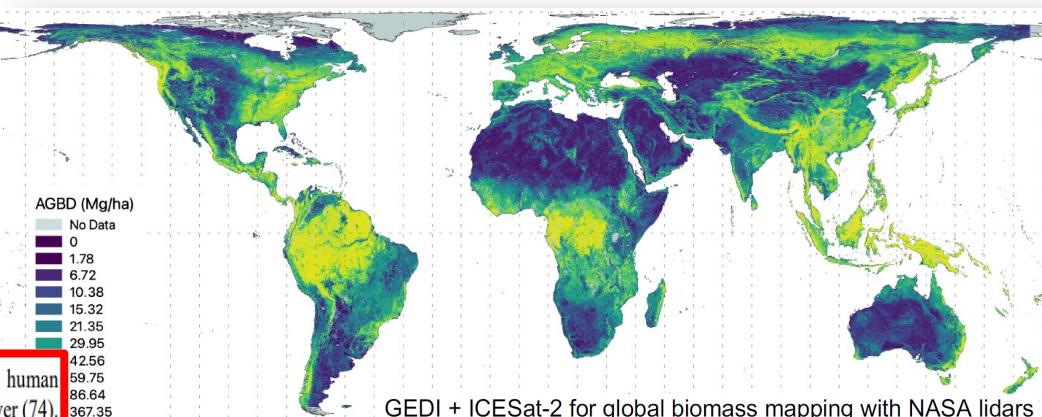


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² Some categories include sub-strata for primary forests, which are defined as old-growth forests that are intact or with no active human intervention, and secondary forests which include all other forests. The table considers a forest definition of at least 10% tree canopy cover (74).

GEDI estimates of IPCC Tier 1 aboveground biomass



CONTINENT + ECOZONE + FOREST AGE

- Global Ecological Zones (GEZ) layer ([FAO map catalogue](#))
- Global continents layer
- Forest heights 2000
- Forest heights 2020
- Forest gain
- Forest loss
- Forest Cover 2000/2020
- Forest loss year (2000-2020)
- Plantations
- ABoVE Boreal stand age
- Intact forest landscapes
- Primary forests Asia
- Primary forests S America
- Primary forests Africa
- ...and more!

Forest Height 2019 Dataset Reference
P. Potapov et al. (2020) Mapping and monitoring global forest canopy height through integration of GEDI and Landsat data. *Remote Sensing of Environment*, 112165. <https://doi.org/10.1016/j.rse.2020.112165>

Hansen, M. C et al. (2013) High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science* 342 (15 November): 850-53. Data available on-line from: <https://glad.earthengine.app/view/global-forest-change>.

Spatial Database of Planted Trees (SDPT Version 1.0)

Feng, M et al. (2022) ABoVE: Tree Canopy Cover and Stand Age from Landsat, Boreal Forest Biome, 1984-2020. ORNL DAAC, USA.

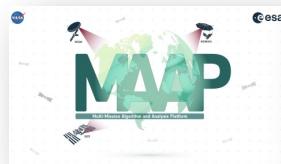
Intact Forest Landscapes
Potapov, P. et al.(2017) The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013. *Science Advances*, 2017; 3:e1600821

Primary Humid Tropical Forests Reference
Turubanova S., Potapov P., Tyukavina, A., and Hansen M. (2018) Ongoing primary forest loss in Brazil, Democratic Republic of the Congo, and Indonesia. *Environmental Research Letters* <https://doi.org/10.1088/1748-9326/aacd1c>

Global Land Analysis & Discovery



GEDI estimates of IPCC Tier 1 aboveground biomass



CONTINENT + ECOZONE + FOREST AGE

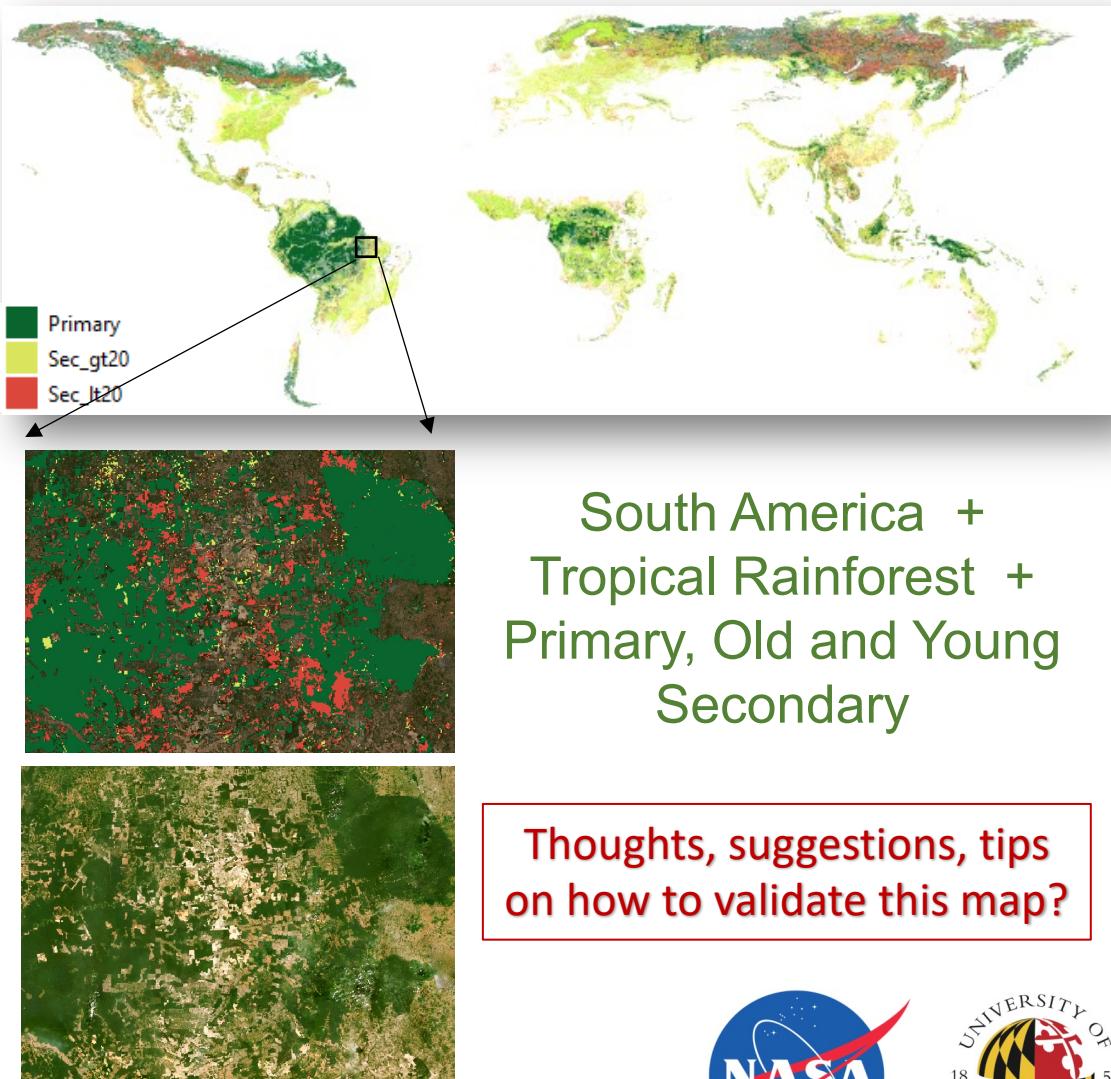
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Global Land Analysis & Discovery

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South America +
Tropical Rainforest +
Primary, Old and Young
Secondary



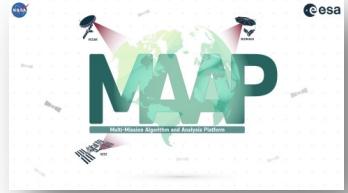
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Thanks!

