Estimation of Biomass from Space

EO for Monitoring, Reporting, and Verification of Carbon Removals
Copenhagen, 8-11 October 2024

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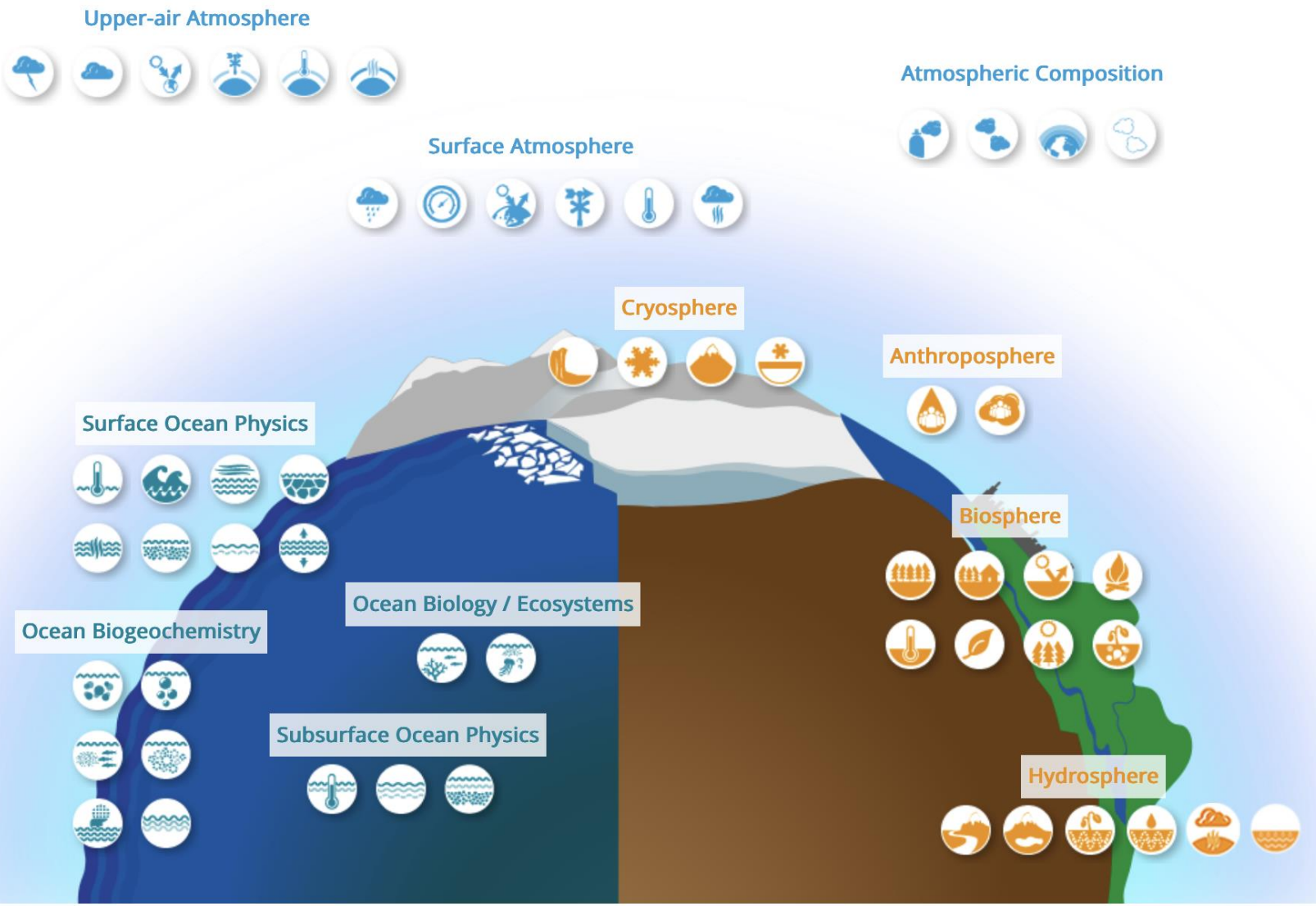
Earth Observation Directorate

09/10/2024

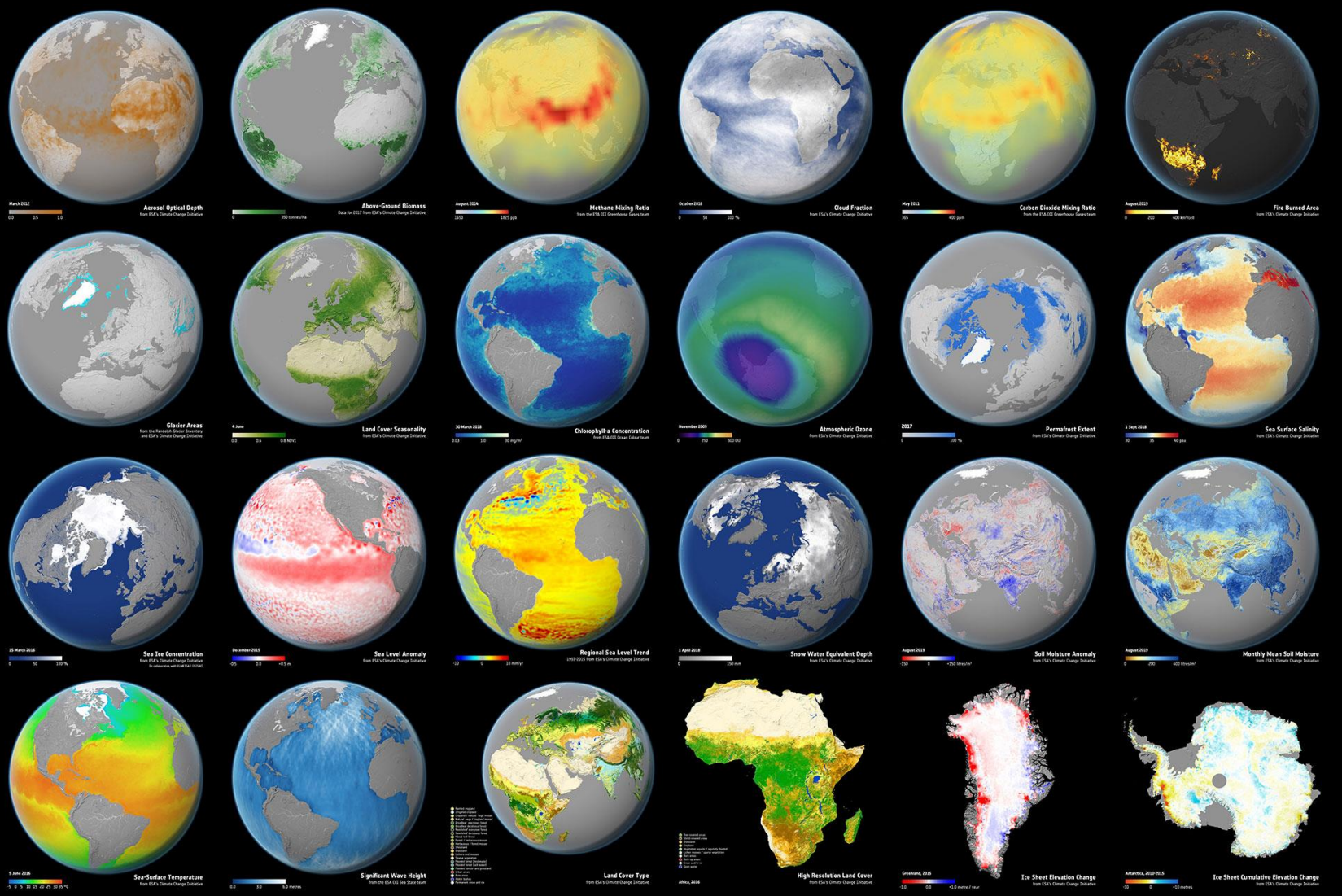
Essential Climate Variables



GCOS

WMO IOC International Science Council UN environment

Climate Change Initiative



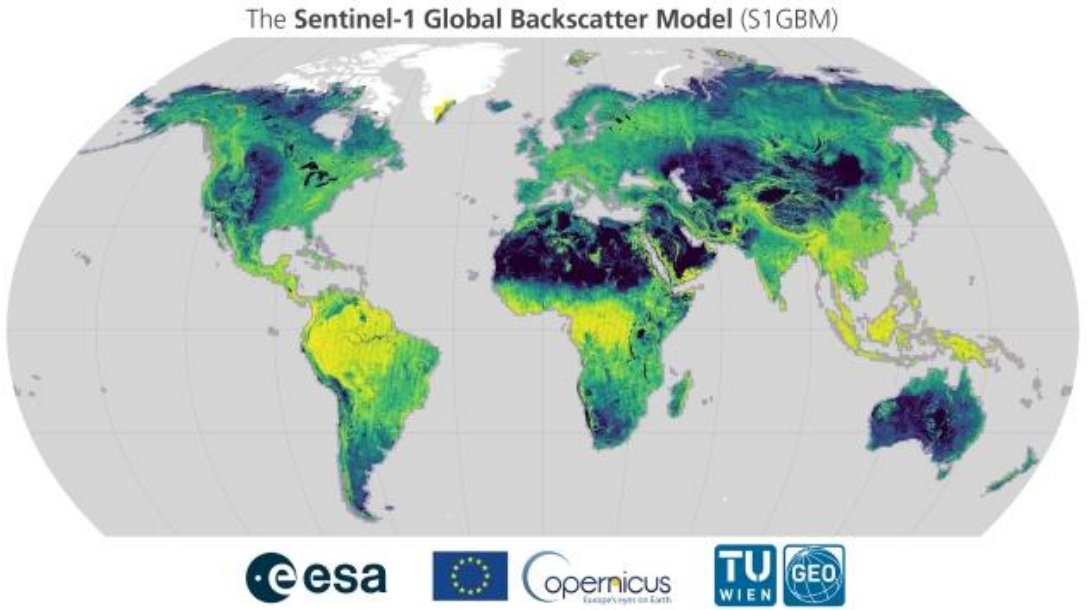
https://climate.esa.int

Biomass from Space

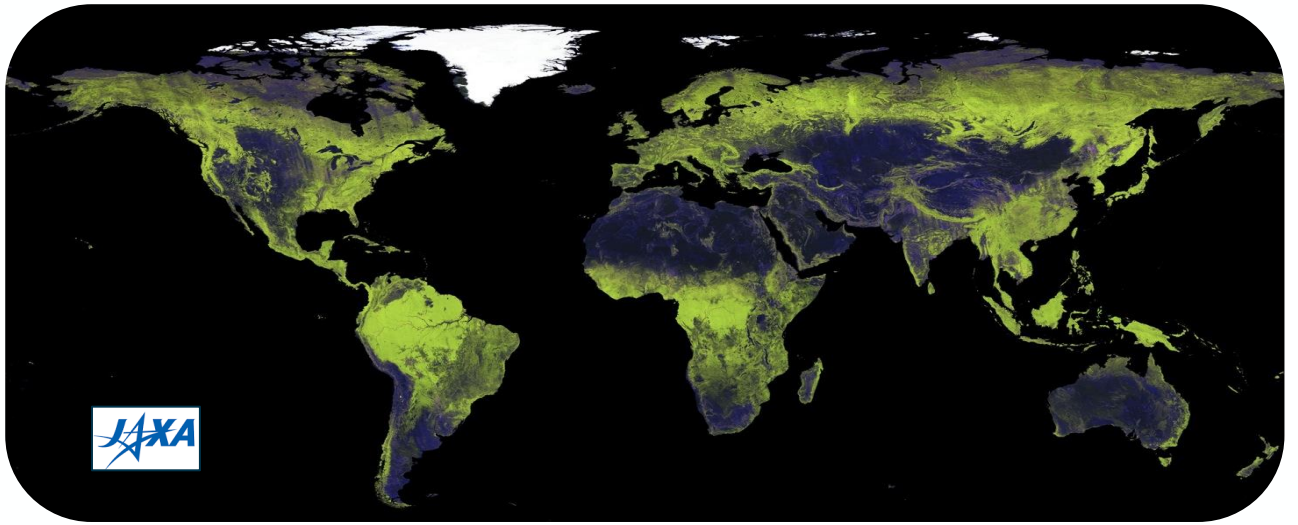
- Version 5 with global AGB maps in 2010 and annually from 2015 to 2021 in cooperation with JAXA
- Consistency: a decade of change

Synthetic Aperture Radar (SAR) Time-Series

Copernicus Sentinel-1 C-band SAR

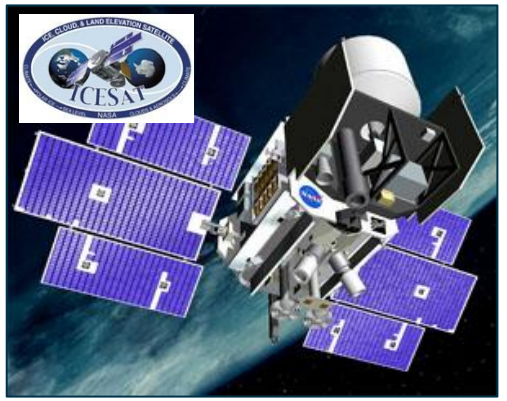


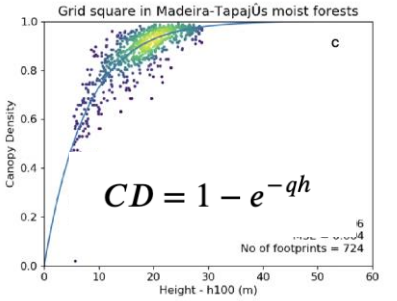
JAXA ALOS-1/-2 L-band SAR



(FBD and ScanSAR; refined datasets)

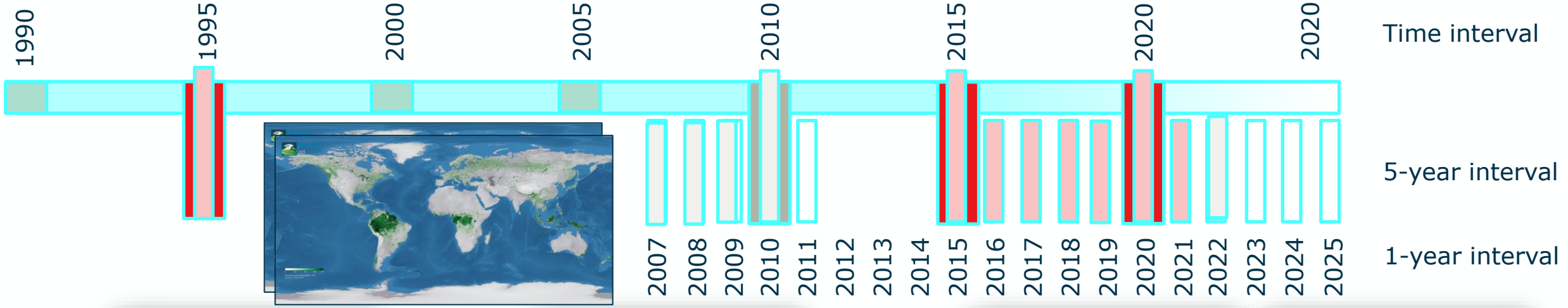
NASA Spaceborne LIDAR





Kay et al. (2022)

The Importance of Time



Loss of forest extent (and fast loss of all woody biomass)

Deforestation

Gain in forest extent (and slow gain in woody biomass)

Colonisation/resprouting

Forest extent remains the same (progressive slow gain in woody biomass)

Growth

No loss of forest extent (progressive often slow loss of biomass)

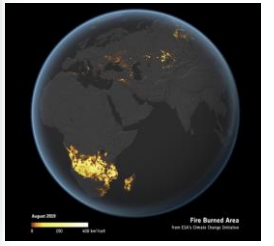
Dieback or damage

Time factors to consider:

Occurrence
Lag
Manifestation
Duration

No loss of Forest extent Disruptive natural event (fire) or human activity (thinning)

Fire



CCI FIRE

CCI Data Portal - Biomass

CEDA Archive

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Dataset

View XML

ESA Biomass Climate Change Initiative (Biomass_cci): Global datasets of forest above-ground biomass for the years 2010, 2015, 2016, 2017, 2018, 2019, 2020 and 2021, v5.01

Update Frequency:	Not Planned
Status:	Completed
Online Status:	ONLINE
Publication State:	Citable
Publication Date:	2024-07-29
DOI Publication Date:	2024-08-22
Download Stats:	last 12 months
Dataset Size:	8.98K Files | 618GB

Permitted Use: Any | Open Access | Download | See Related Documents

Abstract

change data layers are available at coarser resolutions (1, 10, 25 and 50km).

In addition, files describing the AGB change between two consecutive years (i.e., 2015-2016, 2016-2017, 2018-2017, 2019-2018, 2019-2020, 2020-2021) and over a decade (2020-2010) are provided (labelled as 2015_2016, 2016_2017, 2017_2018, 2018_2019, 2019_2020 and 2020_2010). Each AGB change product consists of two sets of maps: the standard deviation of the AGB change and a quality flag of the AGB change. Note that the change itself can be simply computed as the difference between two AGB maps, so is not provided directly.

Coverage

Temporal Range

Start time:	2010-01-01T00:00:00
End time:	2021-12-31T23:59:59

Geographic Extent

Help

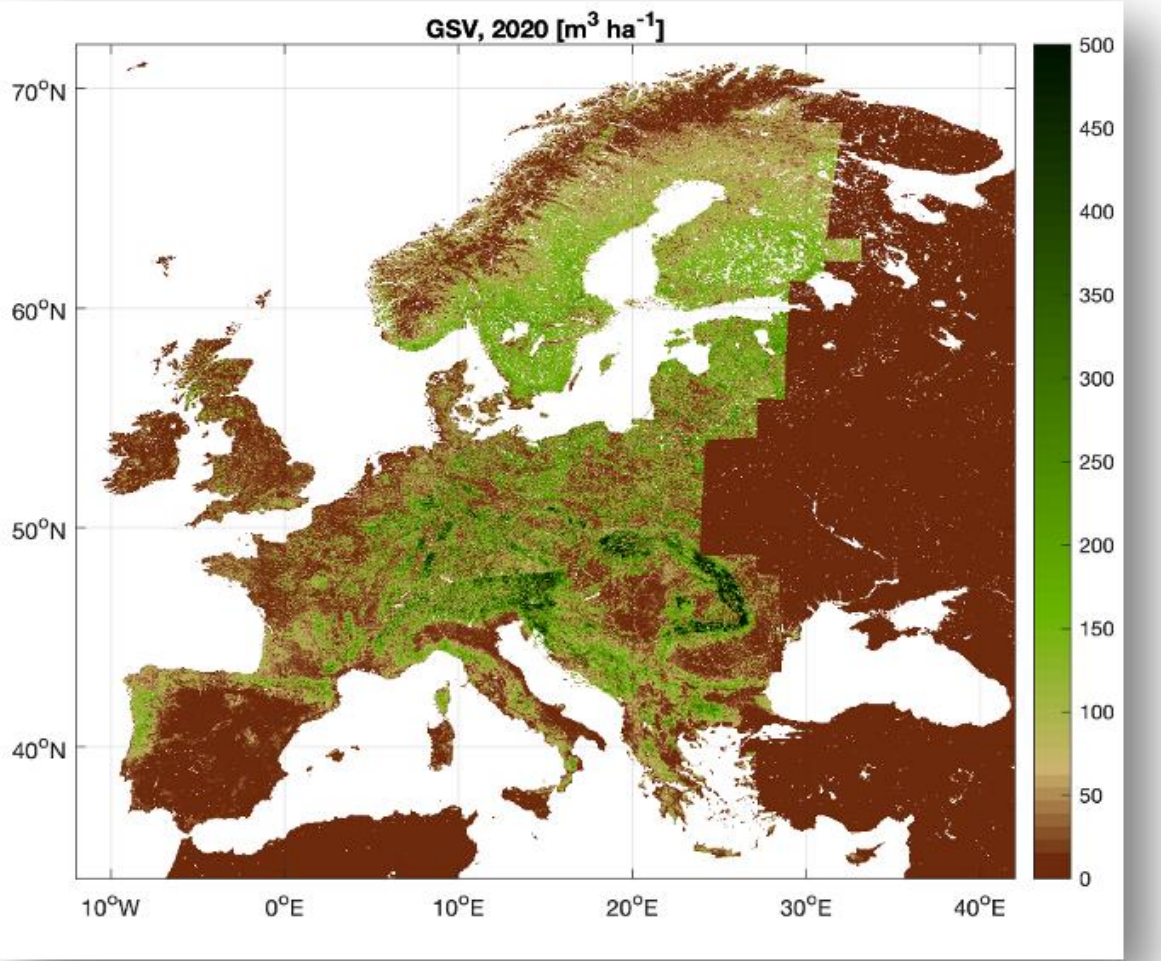
Forest Carbon Monitoring

Findings:

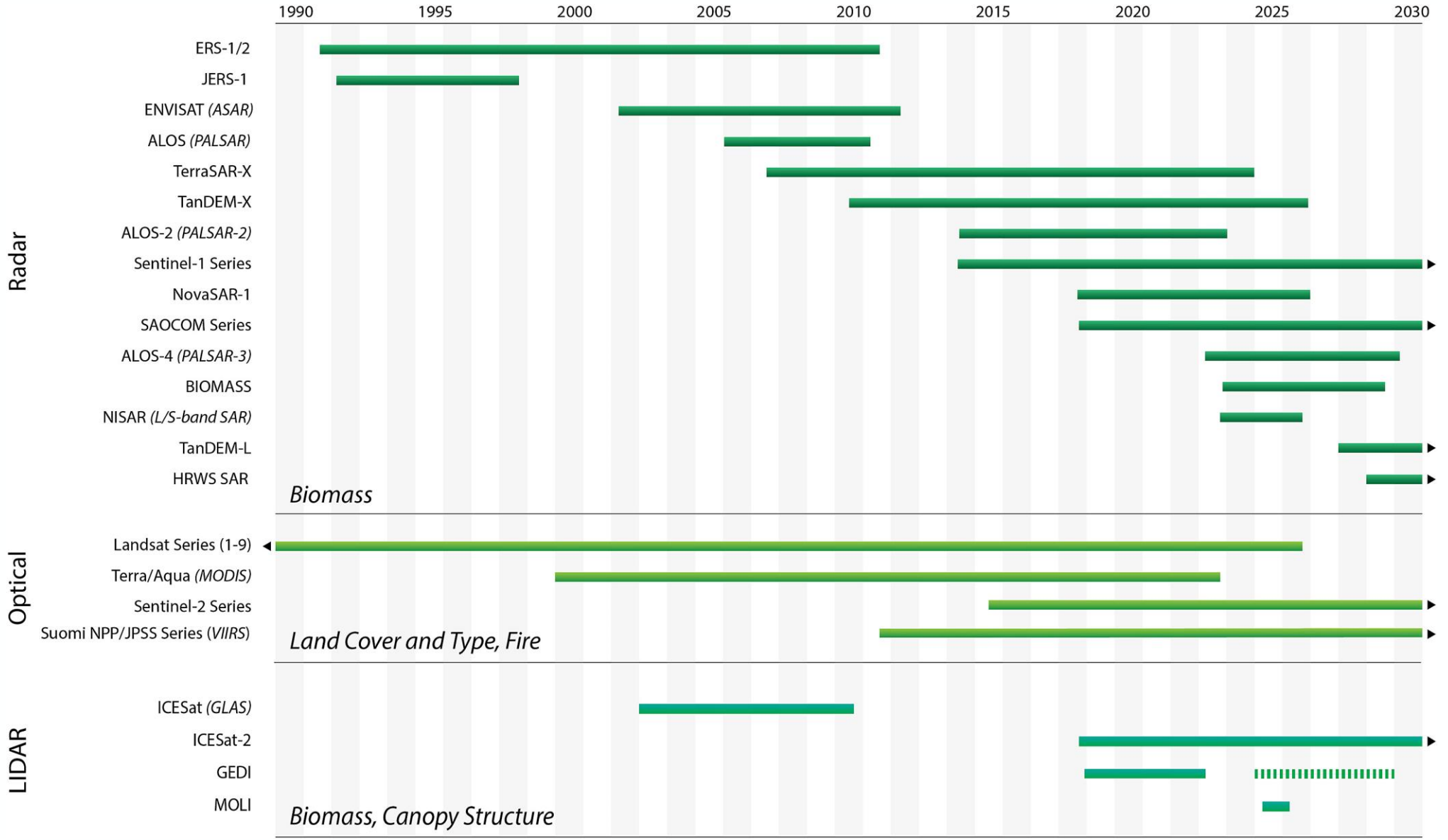
- Users generally satisfied with the demos, but accuracy (20% - 60%) was **not considered sufficient** for stand level management decisions
- The European biomass map shows reasonable agreement with different reference data sets
- Tendency of overestimation at low biomass ranges and underestimation for higher biomass ranges

Next steps:

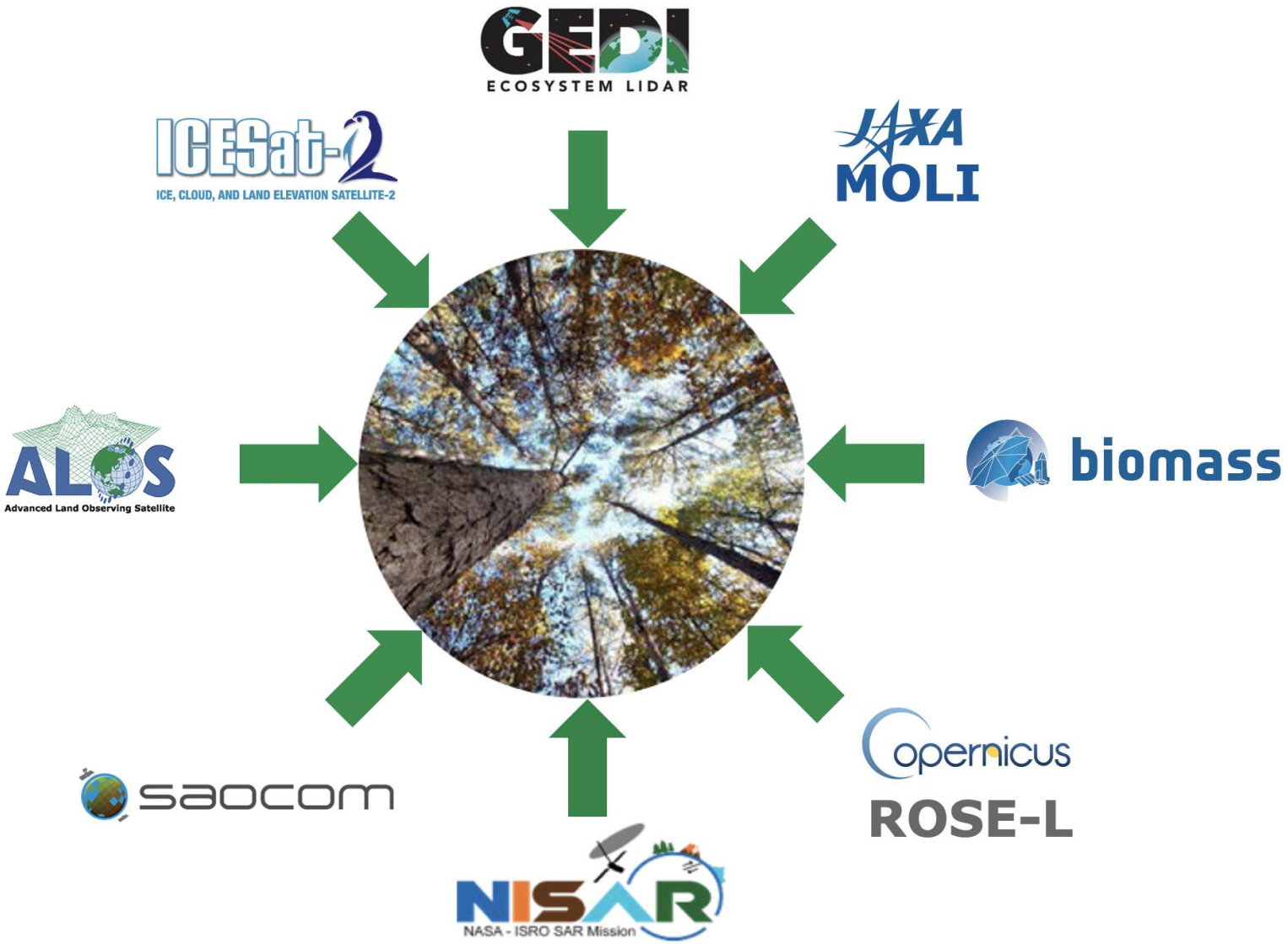
- Further automatisation of processing
- Introduce data assimilation and deep learning
- Improve uncertainty estimation and accuracy



Biomass Mission Timeline



Golden Age of Biomass missions



GEO-TREES

High-accuracy ground data for satellite-derived biomass mapping

Building a **Forest Biomass Reference System** as an equitable and sustainably-funded system of recurrent site-based measurements that will serve as a lasting interface between the Earth Observation and Ground-Based tree-by-tree measurement communities.

- Land vegetation is a **large carbon store** and represents opportunities to **sequester additional carbon**
- Many Earth Observation missions aim to estimate forest carbon from space, their **calibration and Validation** is critical
- GEO-TREES implements the recommendations of the **CEOS Aboveground Biomass Land Product Validation** protocol

➔ GEO-TREES aims to become a network of over 100 Biomass Reference Measurement sites and and 210 distributed BRM sites


Committee on Earth Observation Satellites

Working Group on Calibration and Validation
Land Product Validation Subgroup

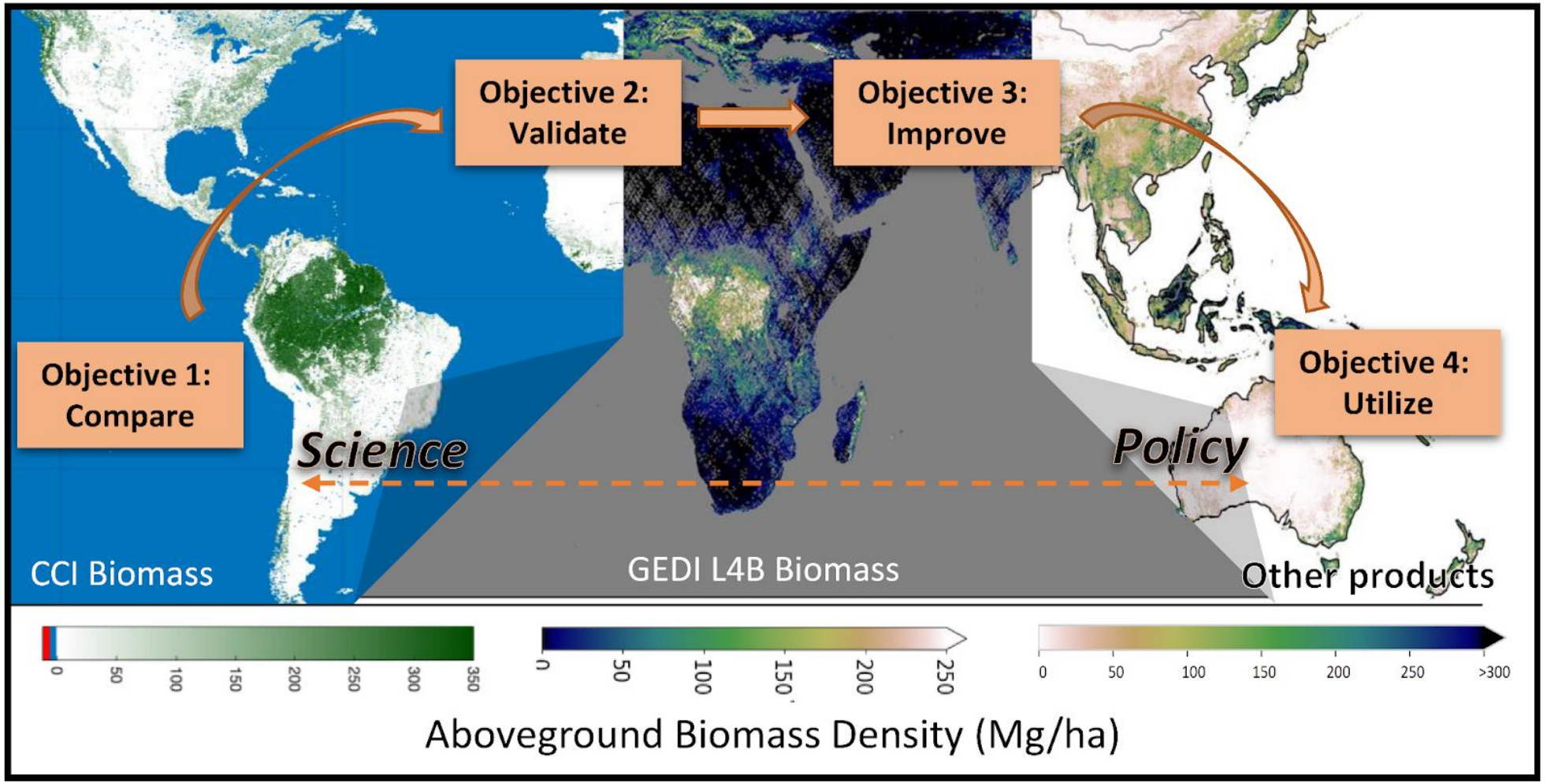
Aboveground Woody Biomass Product Validation
Good Practices Protocol

Version 1.0 – 2021

Editors: Laura Duncanson, Mat Disney, John Armston, David Minor, Fernando Camacho, Jaime Nickeson

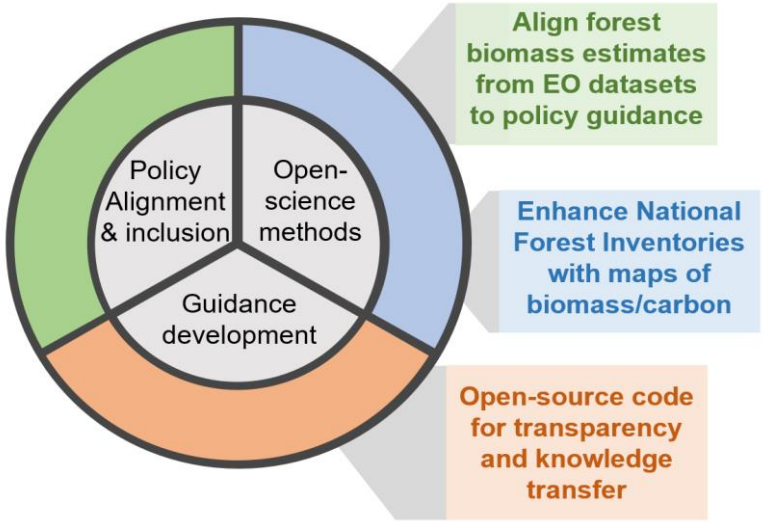
https://geo-trees.org/

Biomass Harmonization Activities in support of the Global Stocktake



Biomass Harmonization

2021 – present: CEOS Biomass Harmonization Activity
(coordination, intercomparison, uptake)



2021 – present: GEO-TREES
(global biomass reference network)

Under CEOS Biomass Harmonization, there are ongoing country case-studies on the improvement of GEDI biomass estimates and integration with NFIs
Generally, there is an increasing interest of NFI and EO integration techniques from countries
GEO-TREES will provide a global biomass reference network - this an action toward biomass product validation
CEOS Biomass Harmonization planning a submission of forest biomass estimates to IPCC Emission Factors Database (EFDB)

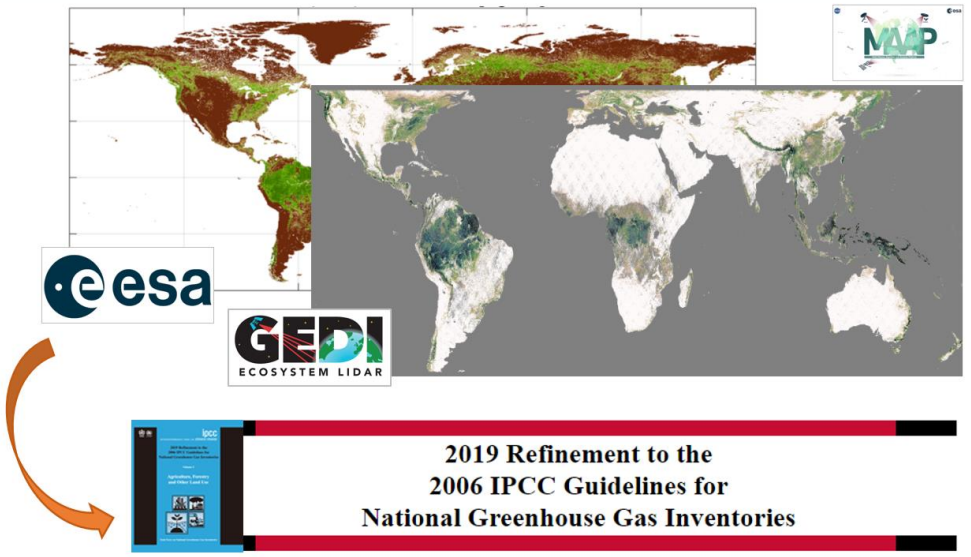
Biomass Harmonization: IPCC EF-DB

Intergovernmental Panel on Climate Change (IPCC) Tier 1 forest biomass estimates from Earth Observation

ABOVEGROUND BIOMASS | EARTH OBSERVATION | ESA CCI | IPCC | NASA GEDI | TIER 1

Neha Hunka, Laura Duncanson, John Armston, Ralph Dubayah, Sean P Healey, Maurizio Santoro, Paul May, Arnan Araza, Clement Bourgoin, Paul Montesano, Christopher S R Neigh, Hedley Grantham, Peter Potapov, Svetlana Turubanova, Alexandra Tyukavina, Jessica Richter, Nancy Harris, Mikhail Urbazaev, Adrian Pascual, Daniela Requena Suarez, Martin Herold, Benjamin Poulter, Sylvia N Wilson, Giacomo Grassi, Sandro Federici, Maria J Sanz Sanchez, Joana Melo

Pre-print available



The research generates natural forests biomass estimates in the format of Intergovernmental Panel on Climate Change (IPCC) Tier 1 values

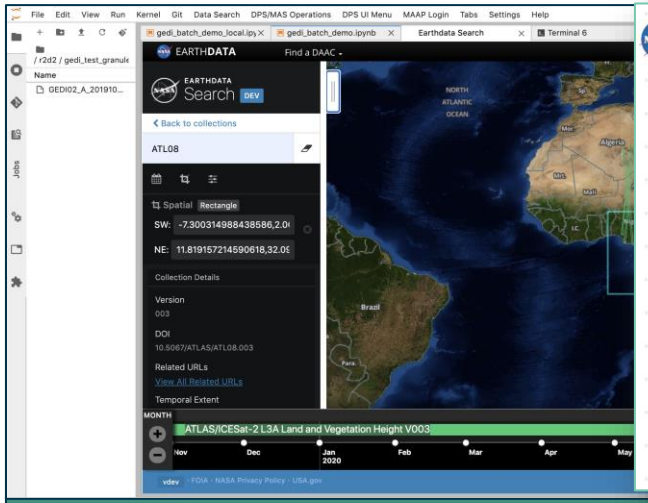
The approaches leverage strengths of various EO-derived datasets, compiled in a transparent, open-science framework

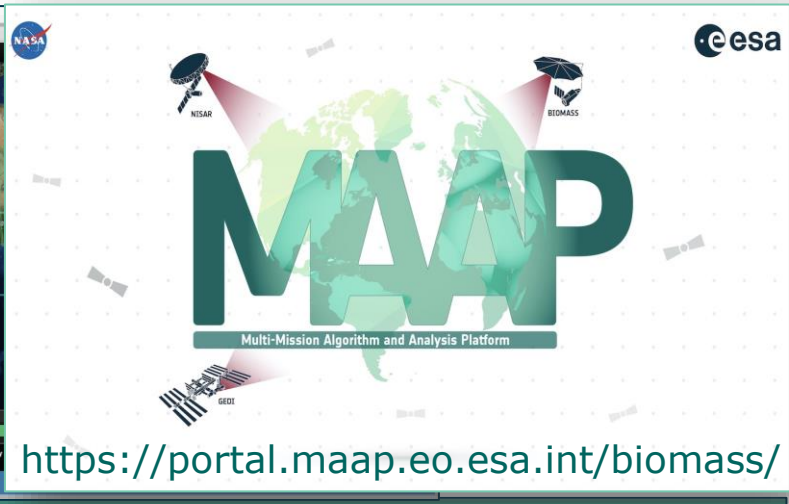
The dataset will be regularly updated as biomass maps improve in accuracy

Request for this to be a CEOS submission to the IPCC EF-DB

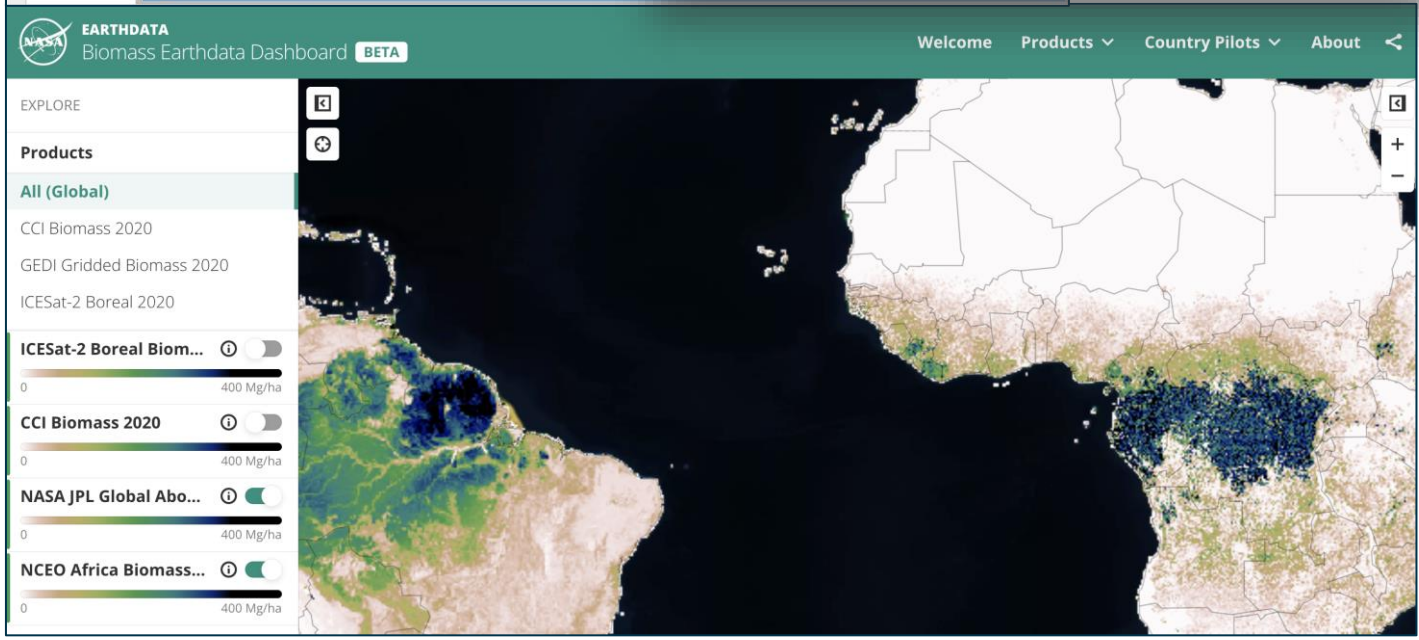
NASA-ESA Multi-Mission Algorithm and Analysis Platform

- The activity is support by the joint NASA-ESA MAAP platform:
- Open-science activity, transparent, up-to-date, public release of scripts – no black boxes
- Powered for rapid algorithm development and global-scale analysis
- Enables collaboration with partner countries
- Supports Biomass Dashboard





https://portal.maap.eo.esa.int/biomass/



The Biomass Mission

ESA's 7th Earth Explorer to be deployed in 2025

An interferometric, fully-polarimetric P-band SAR

Designed to observe forest height and biomass

Earth Explorer 7: Biomass

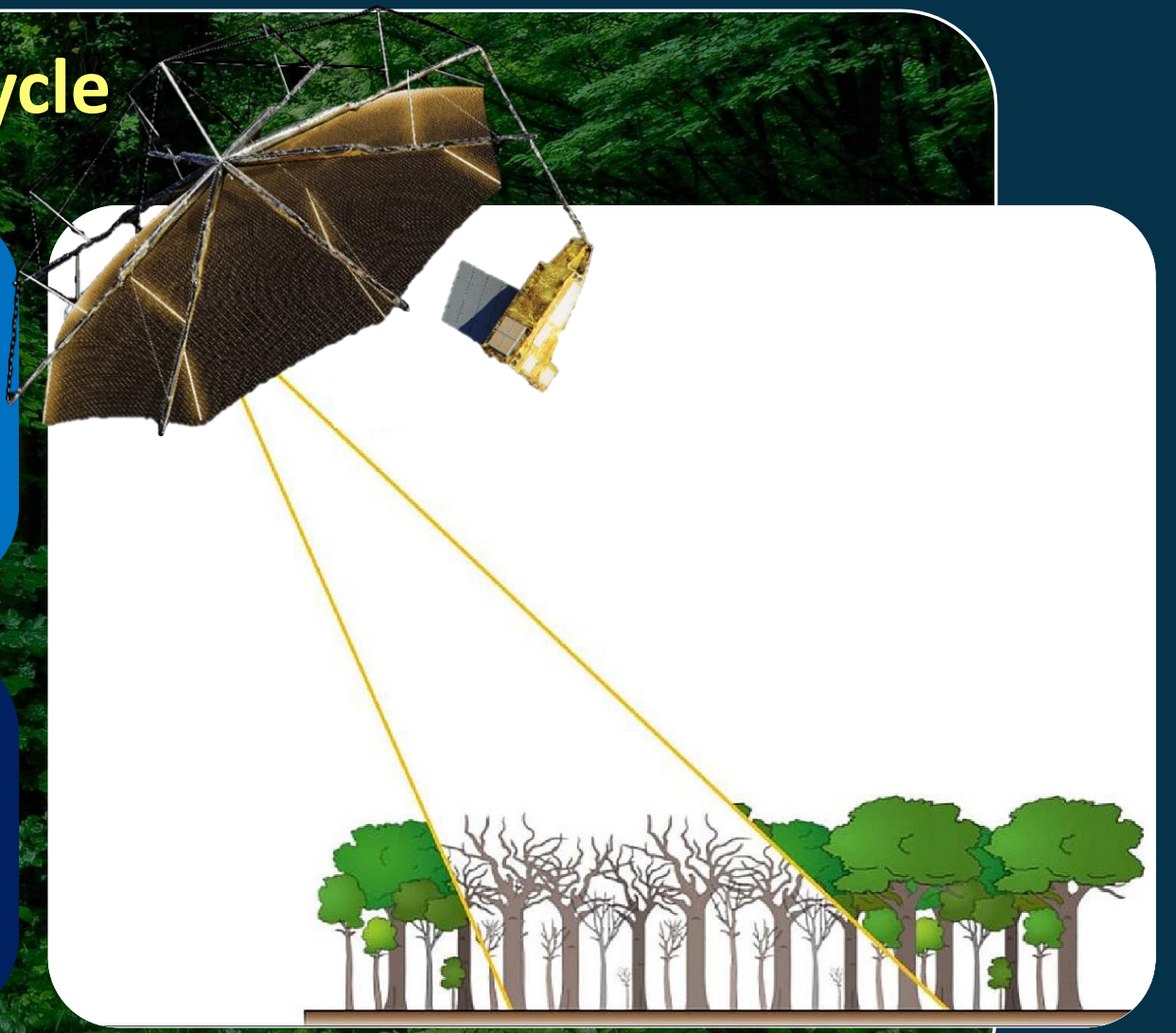
Study of the terrestrial carbon cycle

Above-ground biomass mission

- Reduce the large uncertainties in the carbon flux
- Expand understanding of land carbon cycle & dynamics
- Surface topography under densely vegetated areas
- Additionally, mapping subsurface geological features in desserts and ice sheets

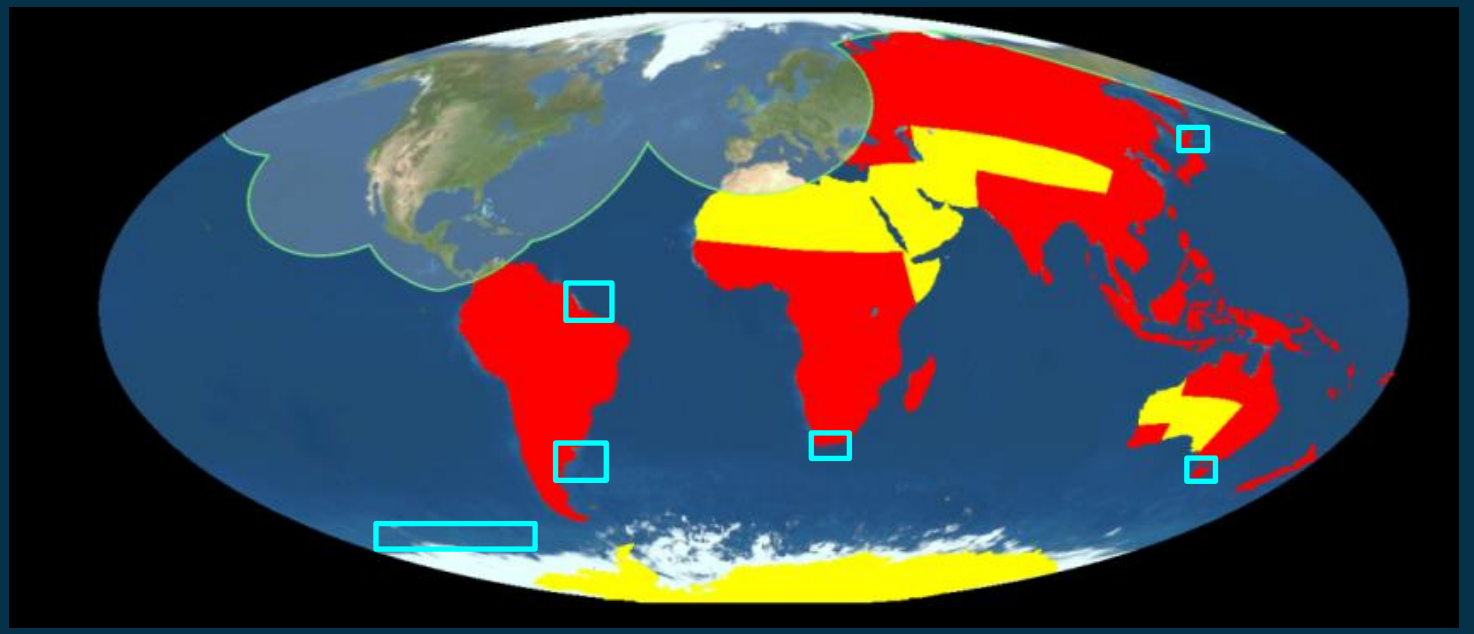
First P-band SAR for mapping of forests in four dimensions

- Horizontal mapping with PolSAR backscatter
- Height mapping with PolInSAR coherence
- 3D mapping with multi-baseline TomoSAR
- Global change mapping



Coverage

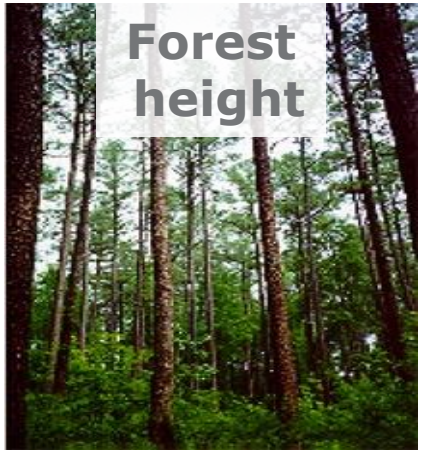
1. Systematic Acquisitions for forested land (red area) on both ascending and descending orbits
2. Global coverage in 9 months (INT phase) and 18 months (TOM phase).
3. Best effort acquisitions for non forested areas (yellow + ocean/sea ice ROIs)
4. Acquisition mask restricted by US Space Objects Tracking Radar (SOTR)



(Red = Primary objective coverage mask, Yellow = Secondary objective coverage mask)

Biomass Products

Above-ground biomass (tons/hectare)



Upper canopy height (meter)

Areas of forest clearing (hectare)

- 200 m resolution
- accuracy of 20%, or 10 t ha–1 for biomass < 50 t ha–1

- 200 m resolution
- accuracy of 20-30%

- 50 m resolution
- 90% classification accuracy

- 1 map every 9 months of all forested areas (excl. SOTR region)

Thanks for your attention!

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