IPCC Expert Meeting on reconciling land use emissions, 9-11th July 2024, Ispra, Italy

Satellite remote sensing for land characterization

Martin Herold, GFZ Potsdam

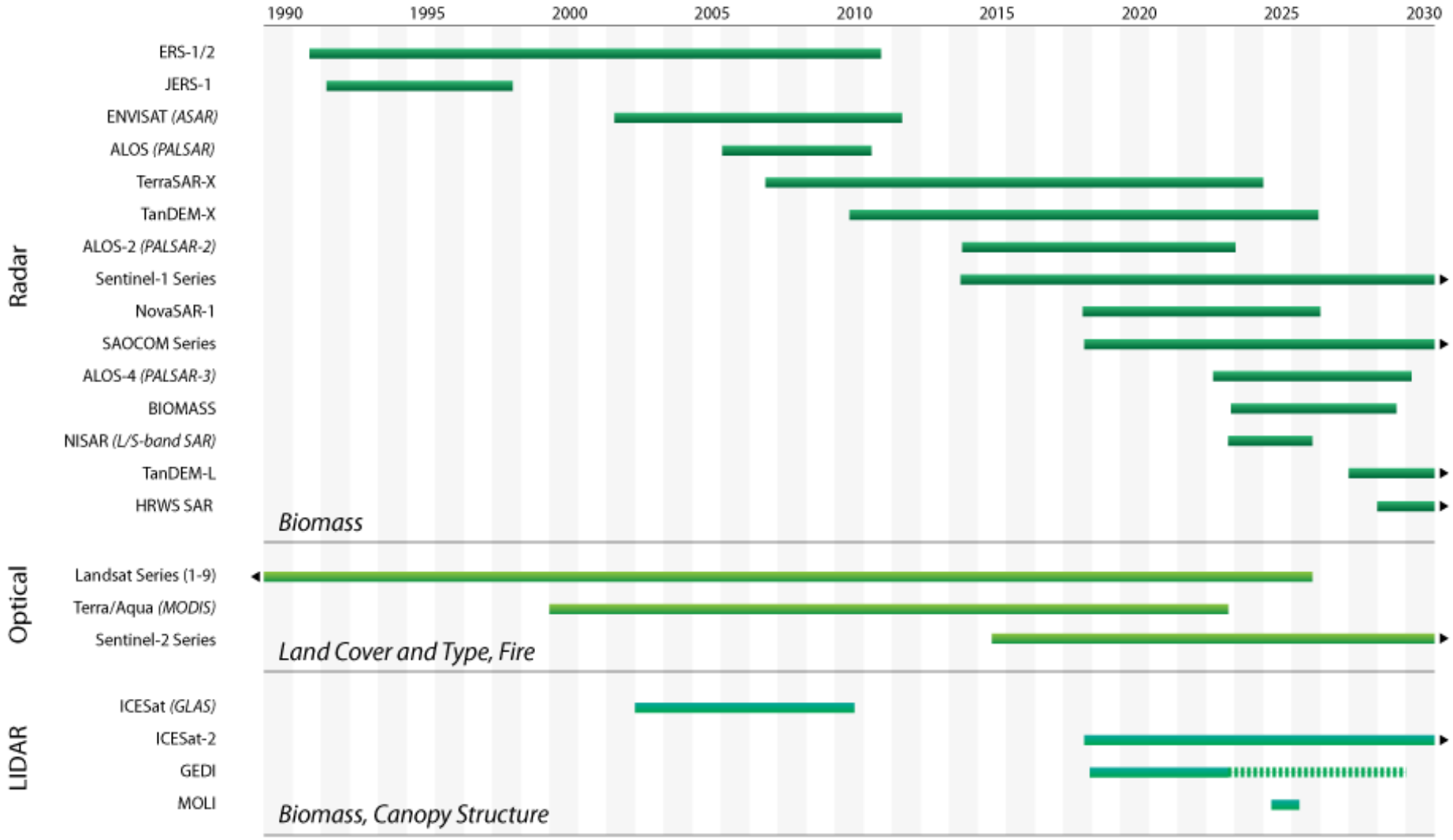
09 July 2024

INTERGOVERNMENTAL PANEL ON climate change

WMO

UN environment programme

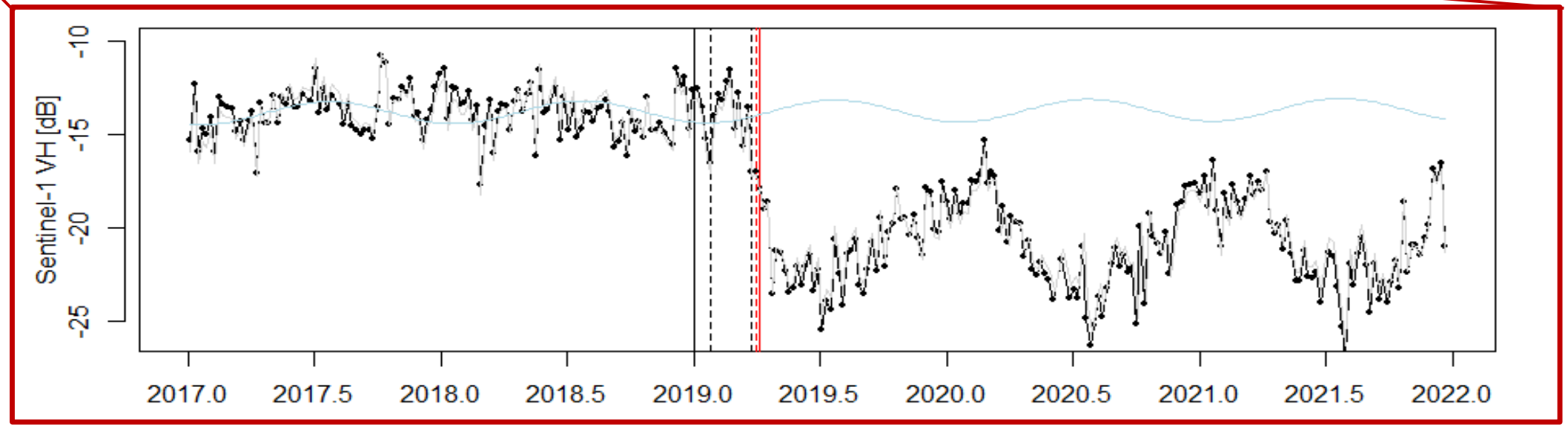
Satellite capabilities



Ochiai et al., 2023

Systematic tracking of land dynamics

- Importance of dense time series data for tracking changes and dynamics (few days repeat for all land)
- Potential for rapid detection of changes



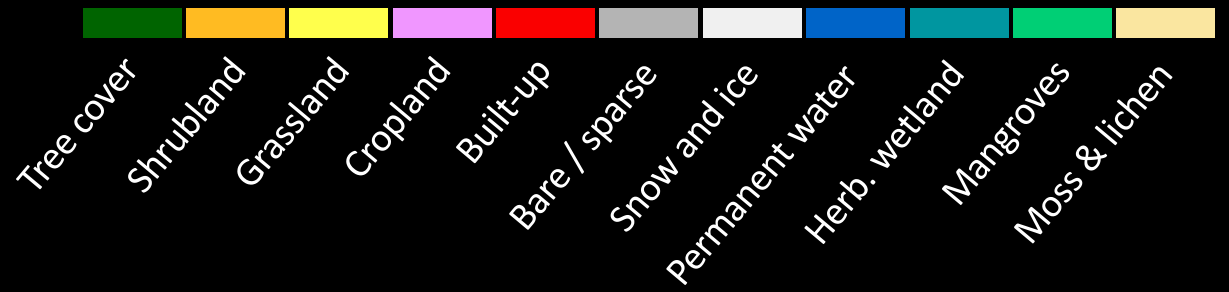
Global land cover monitoring

- Global: 10x10 meters land cover
- 2020, 2021 … now Copernicus service …
- EC's Sentinel-1 & 2
- Fast generation (towards near-real time)
- 11 thematic classes
- Independent validation: ~80% Accuracy
- Open source data and tools
- Data and information:

https://viewer.esa-worldcover.org/worldcover/

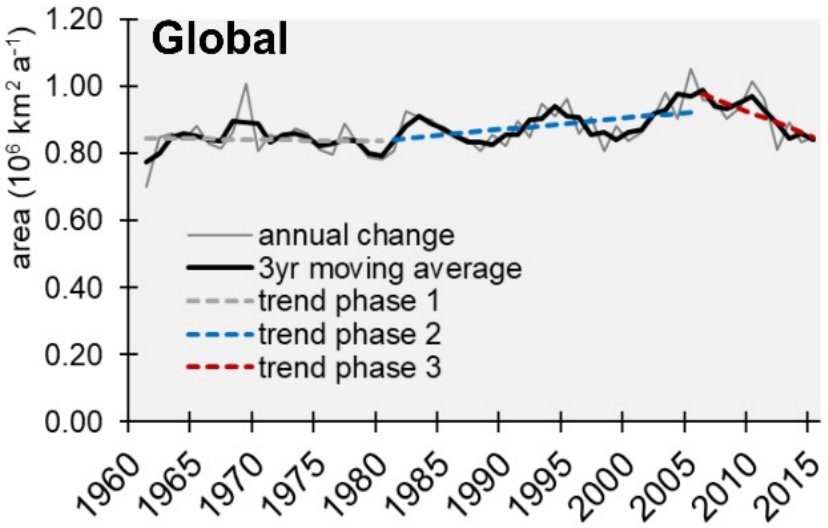
Copernicus LCFM service

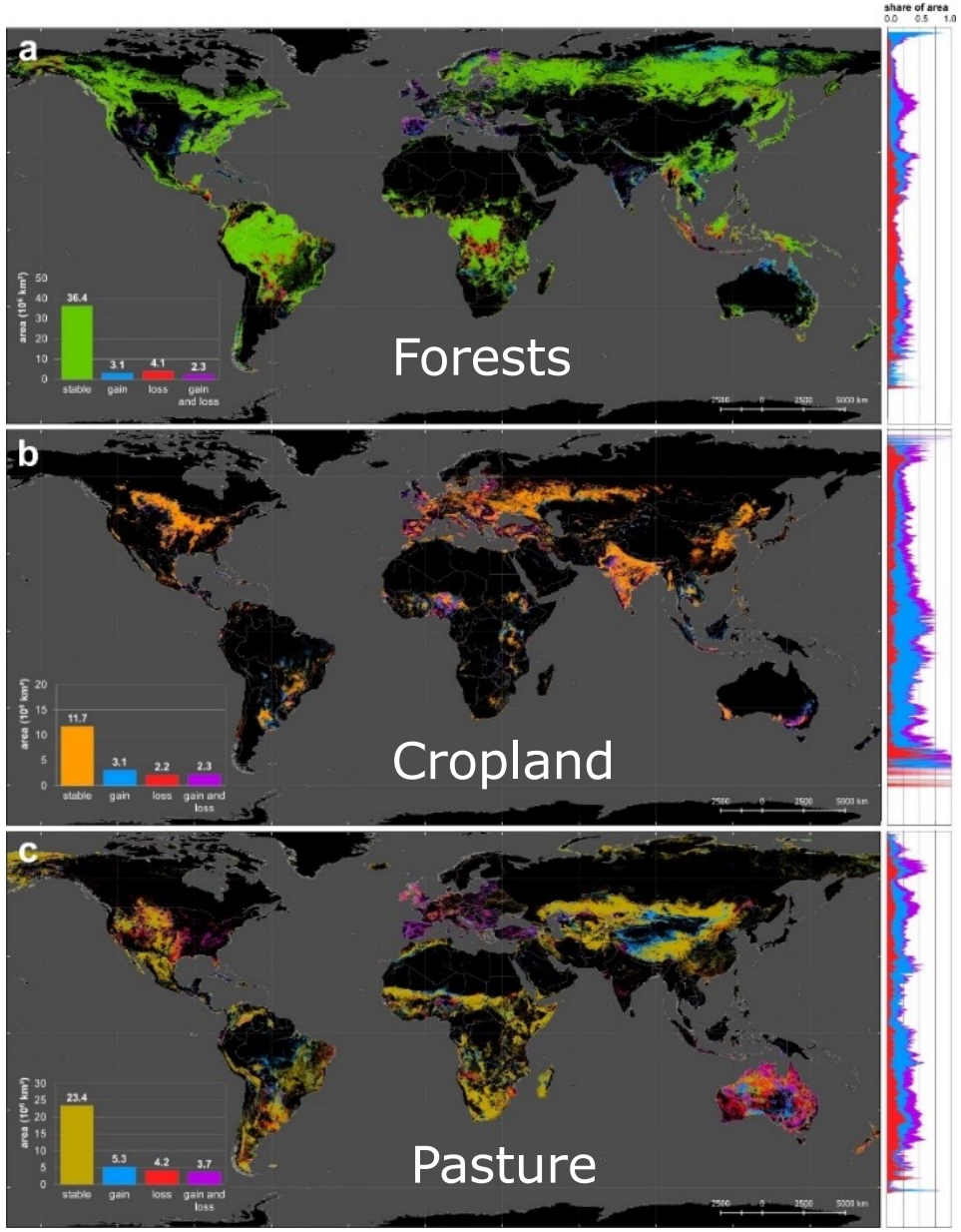
WORLDCOVER 2020/21 …



Global land cover/use change 1960-2020

- Long-time series (1x1 km resolution)
- Space-time tracking of key land changes
- Increasing detail: 4-times more change
- Combination of EO data and statistics





Winkler et al., (2021), Nature Com.

http://radd-alert.wur.nl

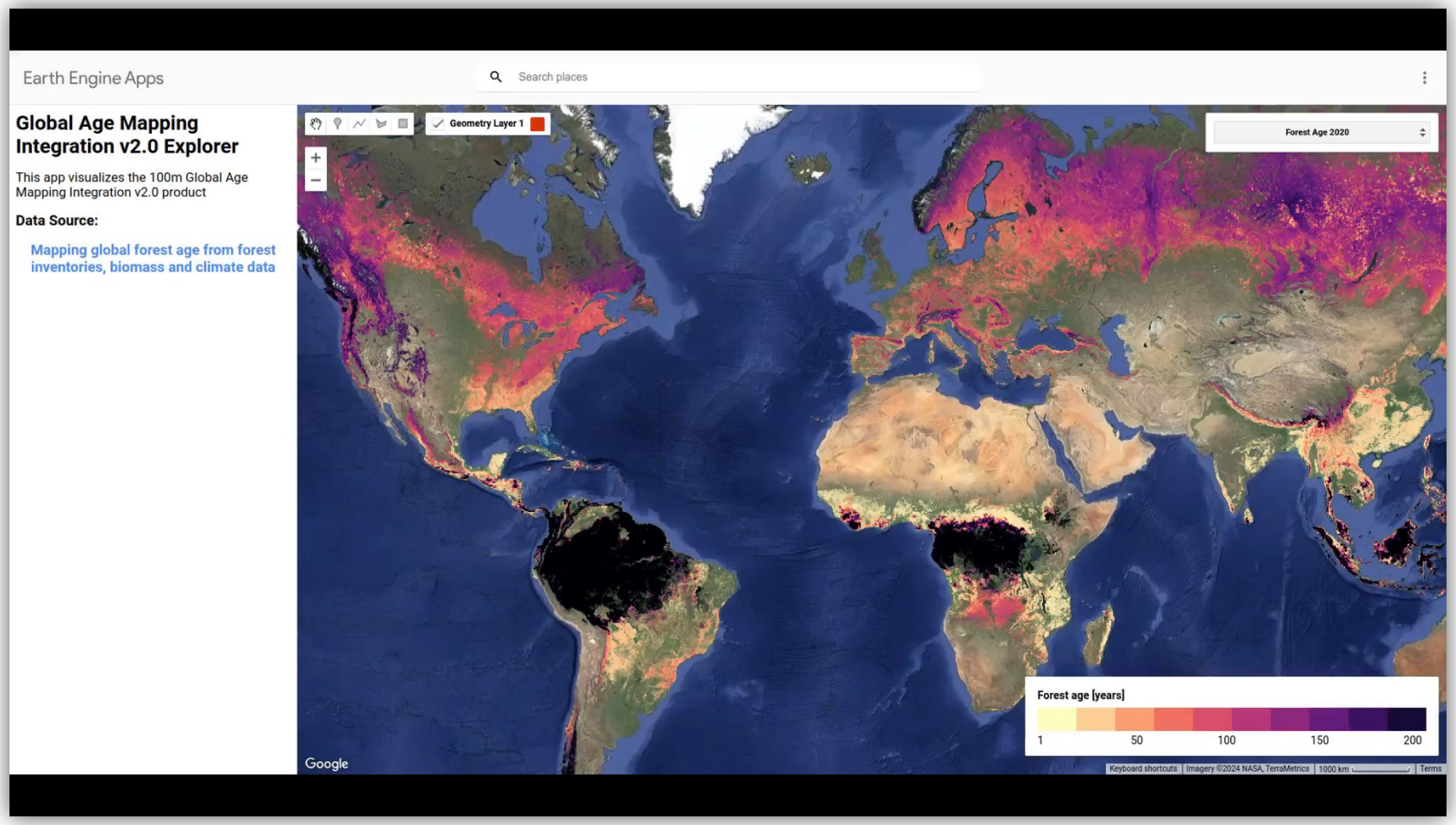
WAGENINGEN
UNIVERSITY & RESEARCH

Selective tree logging
(Central African Republic)

Forest Age and forest age shift mapping

GAMI v2.0, Besnard et al. (2024, GFZ data services)

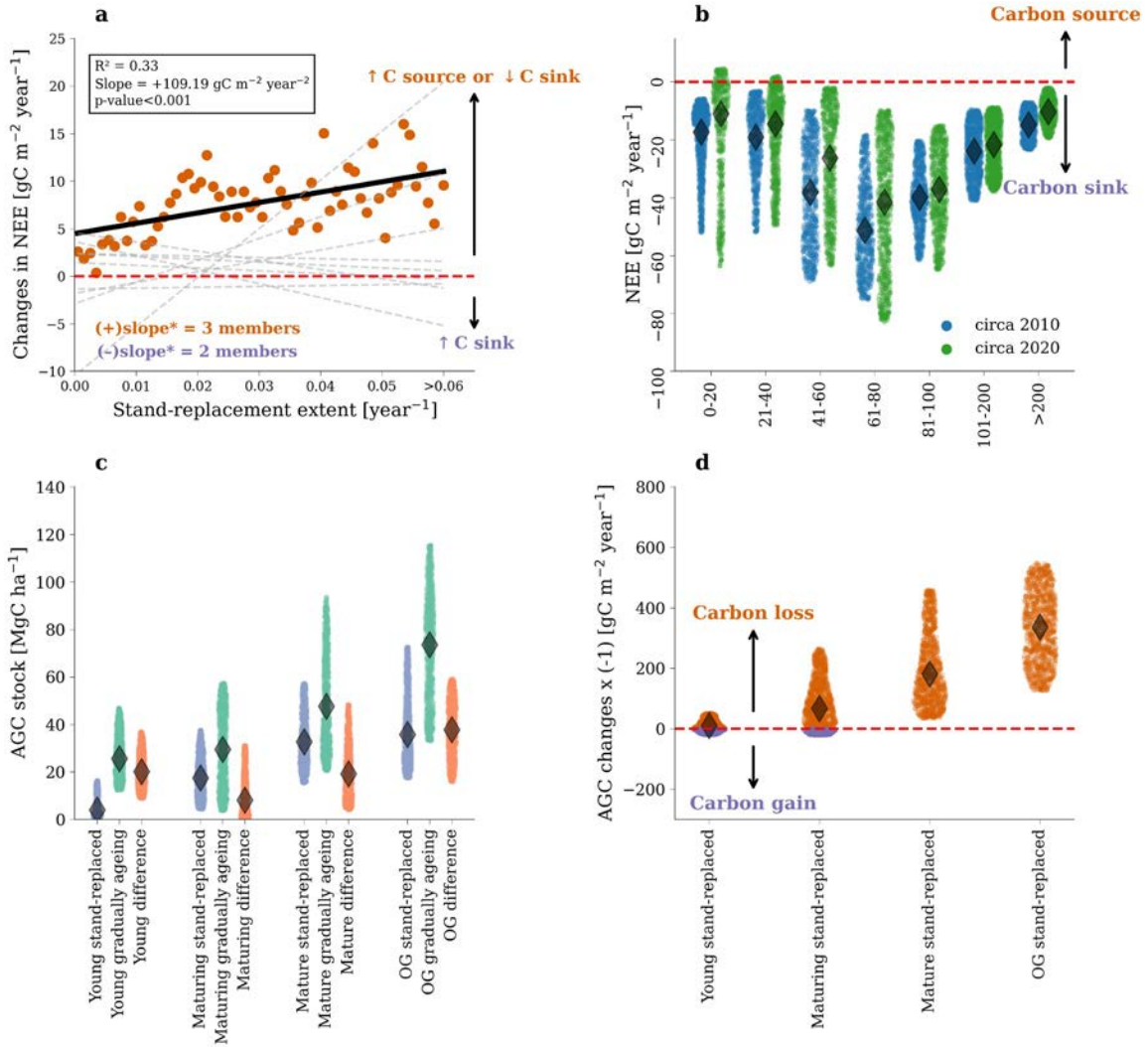
- Update of the forest age MPI-BGC data (Besnard et al., 2021, ESSD);
- Fusion between Landsat-based stand-replacement data and ML-based forest age estimates;
- 100m pixel size and years 2010 and 2020; and
- Aleatoric (data) and epistemic (model) uncertainties are provided



https://besnardsim.users.earthengine.app/view/globalforestage

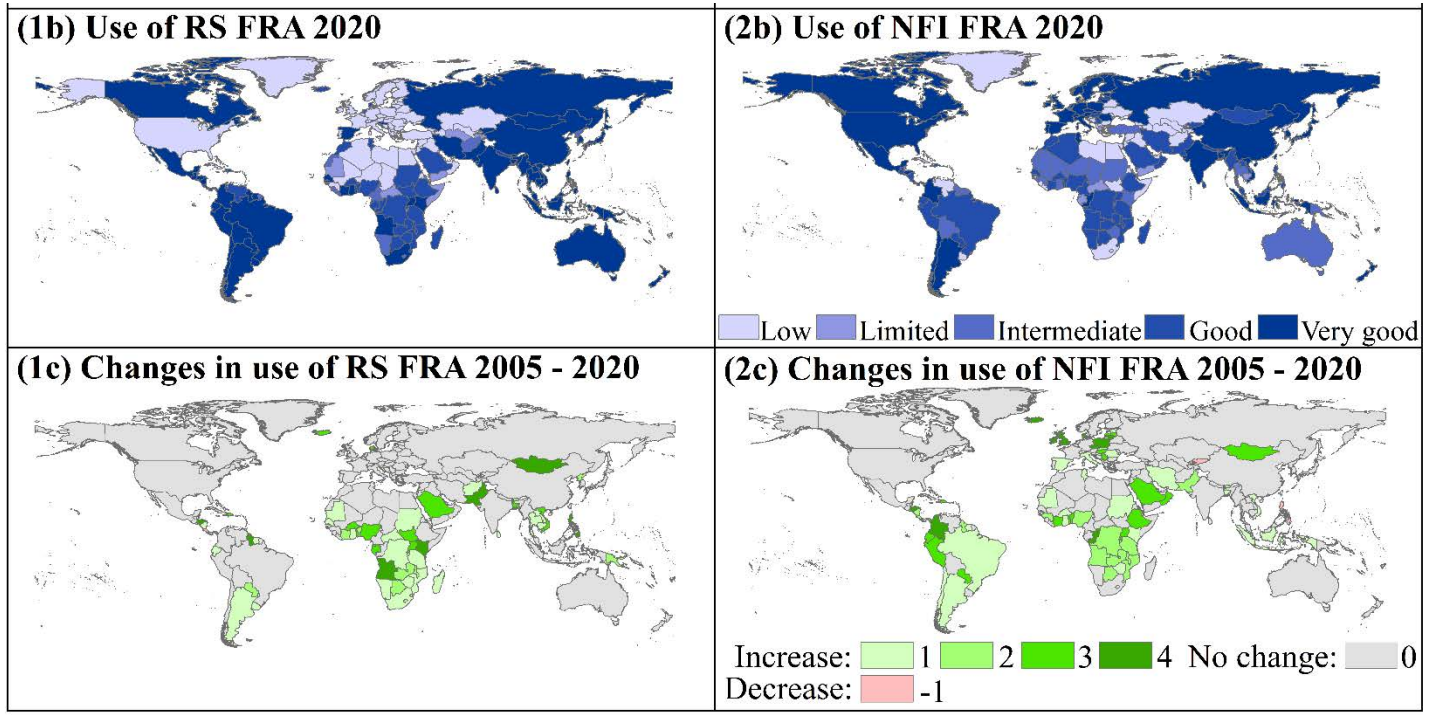
Linking forest age shift data with inversion models

Global covariation of forest age transitions with the net carbon balance Besnard et al. (submitted, Nature)



- Significant correlation between stand-replaced forest fraction and the 2010-2020 trend in carbon sink strength
- Transition from carbon-rich old-growth forests to young stand-replaced forests resulted in a net AGC loss of +0.15 [+0.12–+0.18] PgC year^{-1}
- When accounting for all stand-replaced forests, this net loss increases to +0.43 [+0.39–+0.52] PgC year^{-1} (i.e, approximately 1.6% of the total forest biomass (around 270 [221–327] PgC in 2020)

EO-data uptake in national GHG inventories



National Forest Monitoring/Data Assessment (based on FAO's FRA 2020)

- Continuous improvement in the use of RS for area change estimation
- NFI data improvements widespread in tropics, mostly one-time NFI's
- Importance of both international support and countries own investments
- Key issues for future:
  - Sustain this progress
  - Fill remaining gaps
  - Respond to evolving needs

Nesha et al., 2021. An assessment of data sources, data quality and changes in national forest monitoring capacities in the Global Forest Resources Assessment 2005–2020, ERL

Improved guidance to countries

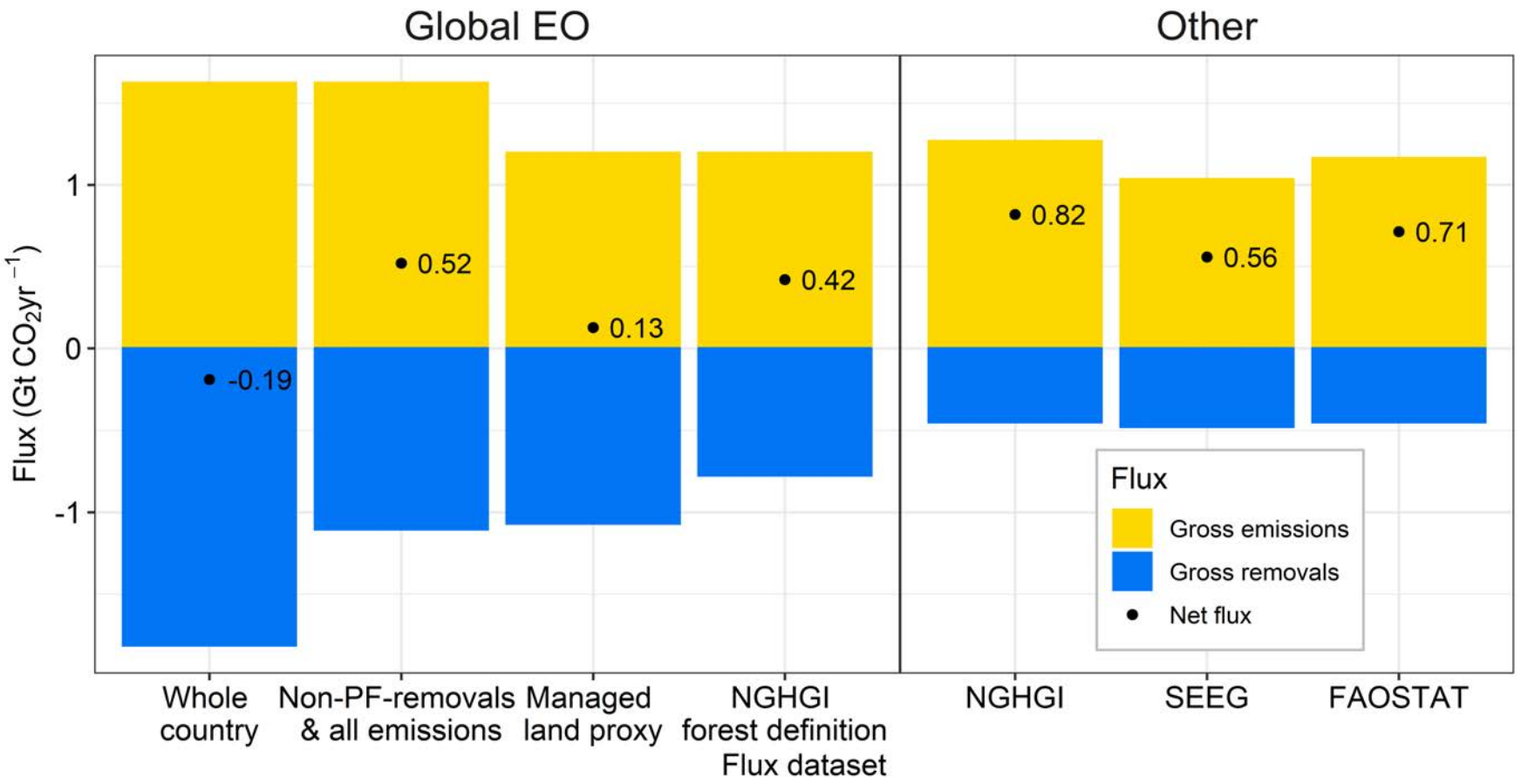
- Common **reporting and estimation** framework
- Using Earth observations to monitor **land use and forest changes**
- **Stratification** of LU categories to facilitate the estimation of carbon emissions and removals
- Use of **biomass density maps**
- **Estimation of uncertainties**
- Approaches to deal with **evolving technologies**

[GFOI Methods and Guidance Doc (v3)]

Global Forest Observations Initiative

See poster session – Requena et al.,

Reconciling national and global estimates



Reconciling differences:

- Primary forests and managed land proxy
- Forest definition
- Different ways of consider forest regrowth
- Data sources and uncertainties?
- …

Adjustments to the Global Earth Observation (EO) forest-flux estimate to increase comparability with the definitional approach of other flux datasets, including National Greenhouse Gas Inventory (NGHGI) for Brazil. Bars denote the average annual gross emissions/removals and black points and associated text denote the net forest carbon fluxes over the period 2001 to 2020. The left panel shows the impact of adjustments made to the Global EO dataset [16] when considering managed forest/land. Non-PF refers to Non-Primary Forest. Right panel shows other flux datasets, namely the NGHGI of Brazil [23], SEEG-Brazil [24] and FAOSTAT [29] for Brazil. Note the original time-period for NGHGI was 2002 to 2016, and values have been adjusted to reflect the period 2001 to 2020 (see Methods). Uncertainty measures have been excluded from the figure for clarity due to the high uncertainty associated with all flux datasets. Credit: Viola Heinrich

Heinrich et al., 2023, CBM – see poster session

Earth Observations for land monitoring

Area of EO application	Typical use	Typical resolutions	Example initiatives/data/actors
Global climate/earth system models	Parameterization, calibration and validation of models	1 km (or coarser), global 30+ years annual	HILDA+ LUH-2
AFOLU/LULUCF GHG inventories	Statistical estimates of forest/land area changes	10-30 m, National 10-15 years (or longer), annual	National bodies, Global Forests Observations initiative (GFOI)
Data-driven assessments (research)	Monitoring of land (use) emissions and removals	10m – 1 km, global/regional 5-25 years (sub-)annual, rapid	UMD-GLAD, Copernicus-LCFM WRI-AFOLU, Commercial
Climate actions	Performance, Enforcement & Accountability of land use mitigation activities/projects	1-30 m, (sub-)national, local 5-10 years Near-real time to annual	Climate policy bodies, Implementers, NGOs

Thank you

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Post-Vacancy (4 years):

Researcher in Data Science and Forest Disturbance Monitoring

https://www.gfz-potsdam.de/en/career/job-offers/details/9522