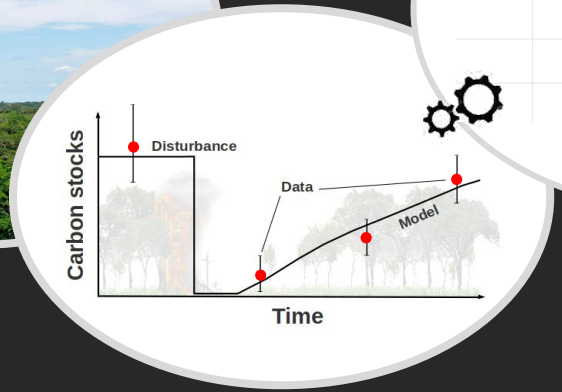
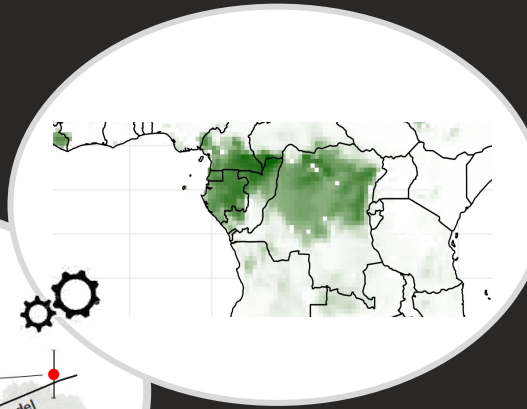
African **F**orest **Rec**O**very** and **CAR**bon **D**ynamics monitoring through remote **S**ensing

Jean-François Bastin, Marijn Bauters, Pierre Defourny, Sacha Delecluse, **Félicien Meunier**, Baudouin Michel, Sassan Saatchi, Hans Verbeeck



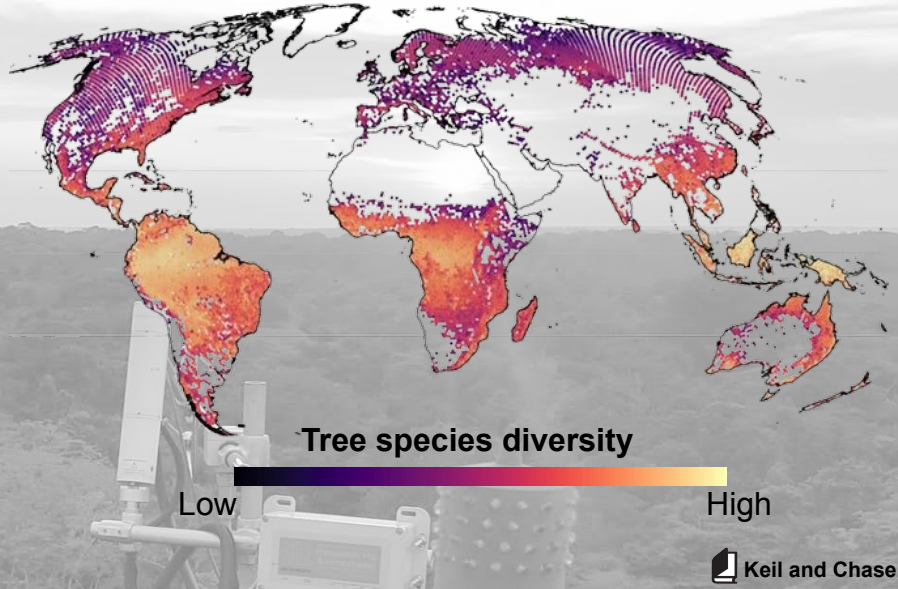


BELSPO - STEREO IV

The importance of African tropical forests

The importance of African tropical forests

Biodiversity hotspot

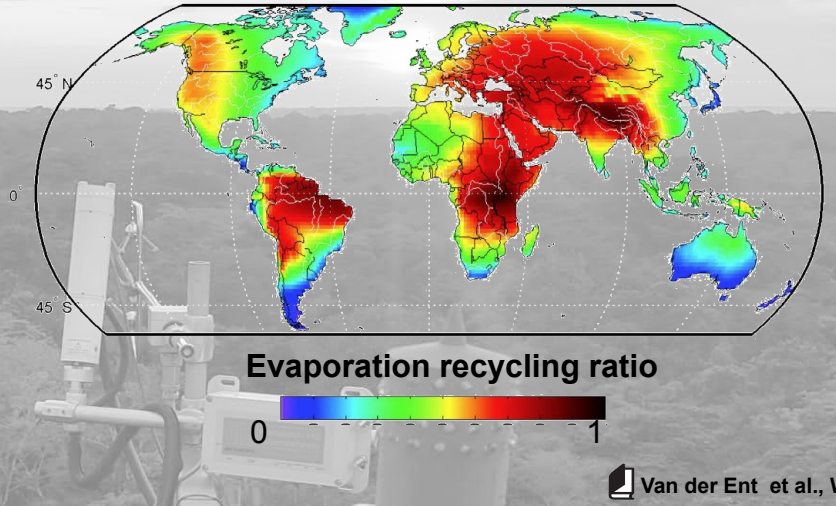


Keil and Chase, NEE, 2019

The importance of African tropical forests

Biodiversity hotspot

Engine for the regional hydrological and biogeochemical cycles



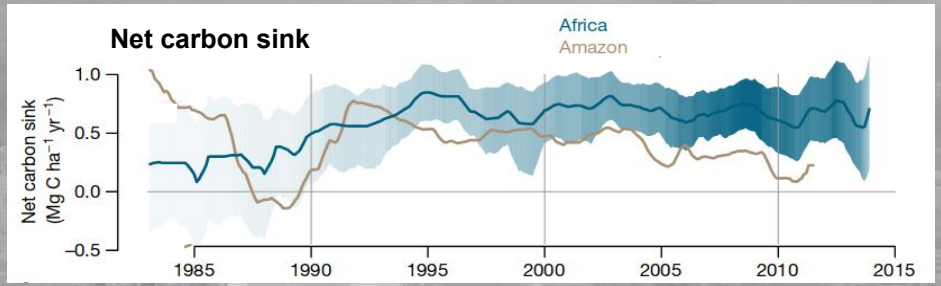
Van der Ent et al., WRR, 2010

The importance of African tropical forests

Biodiversity hotspot

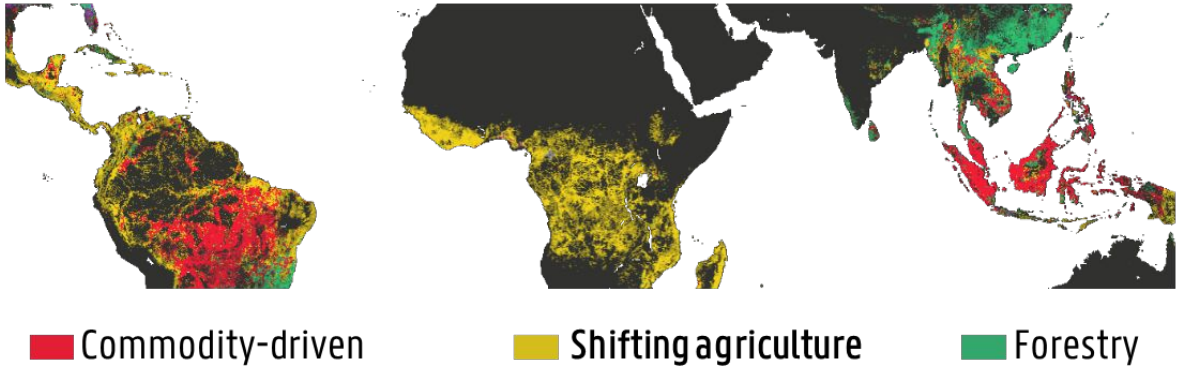
Engine for the regional hydrological and biogeochemical cycles

Important carbon stocks and sinks



Hubau et al., Nature, 2020

Problem statement



Curtis et al., Science, 2018

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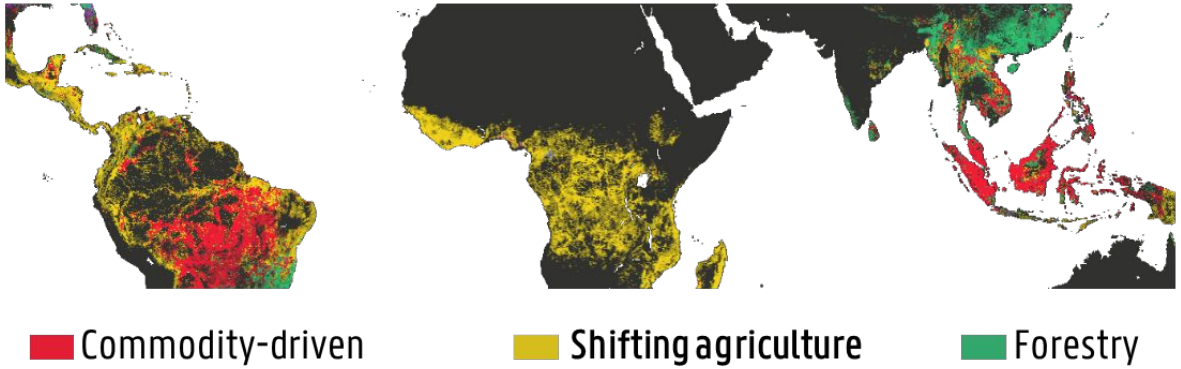
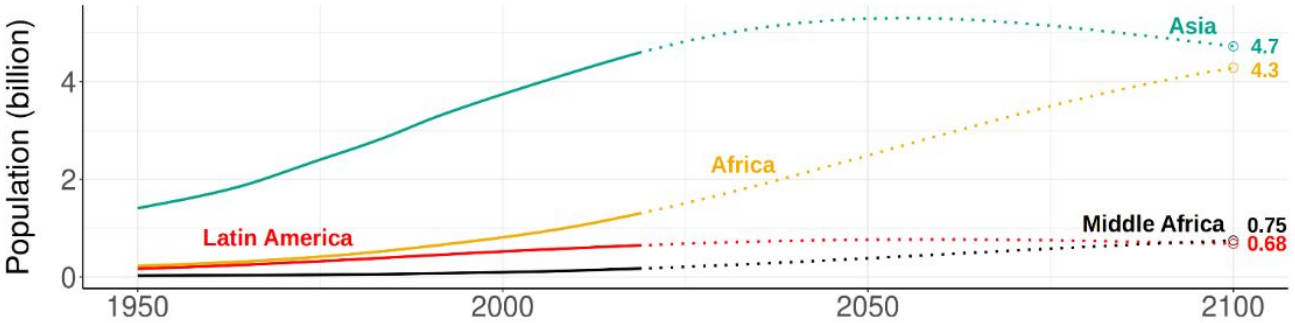
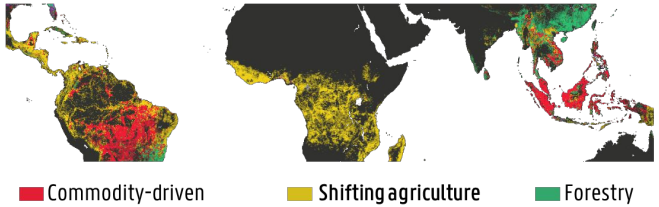


Curtis et al., Science, 2018

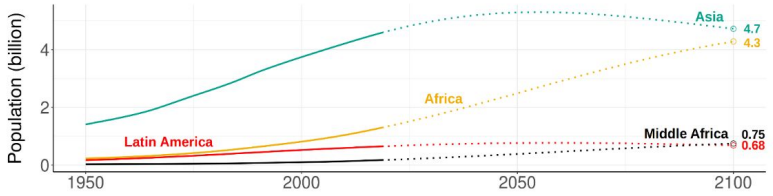


Gerland et al. Science, 2014

Problem statement

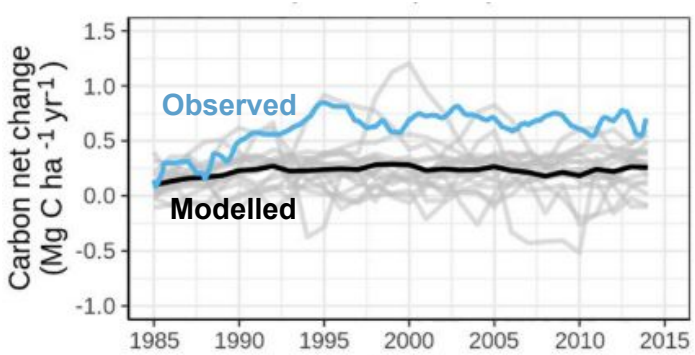


x



Problem statement

Vegetation models are not capturing present-day African tropical forest Carbon and functional diversity dynamics



Koch et al., Earth's future, 2021

Problem statement

Vegetation models are not capturing present-day African tropical forest Carbon and functional diversity dynamics

Koch et al., Earth's future, 2021

Without more data and more specialists, it is impossible to make reliable predictions of Congo Basin rainforests' responses to changes in climate and land use

Congo Basin rainforest – invest US$150 million in science

Lee J. T. White, Eve Bazaiba Masudi, Jules Doret Ndongo, Rosalie Matondo, Arlette Soudan-Nonault, Alfred Ngomanda, Ifo Suspense Averti, Corneille E. N. Ewango, Bonaventure Sonké & Simon L. Lewis

Nature, 2021

AFRO-CARDS Objectives

1. Build a reference **multiscale forest chronosequence observatory** across the Congo Basin

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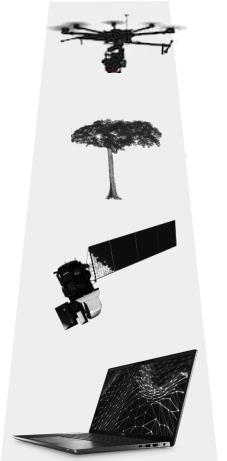
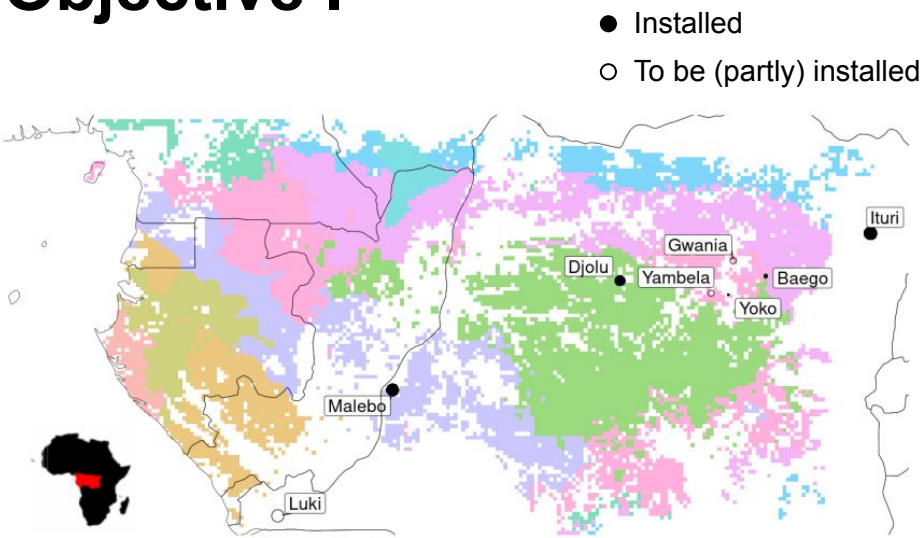


Step-change in our understanding of the current and future carbon cycle of the African tropical forests post-disturbance

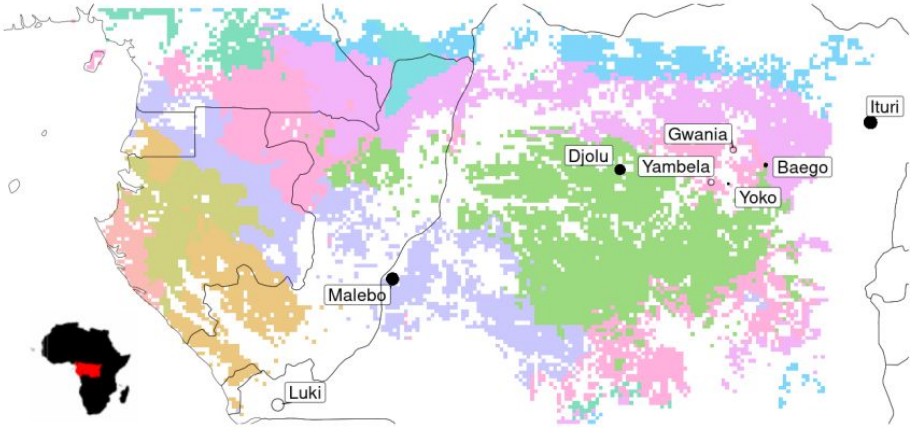
Objective I



- 50+ ha of chronosequences
- 8 sites
- 178 plots in total (0.16 - 1 ha)
- Functional/structural recovery

Objective I

- Installed
- To be (partly) installed



- 50+ ha of chronosequences
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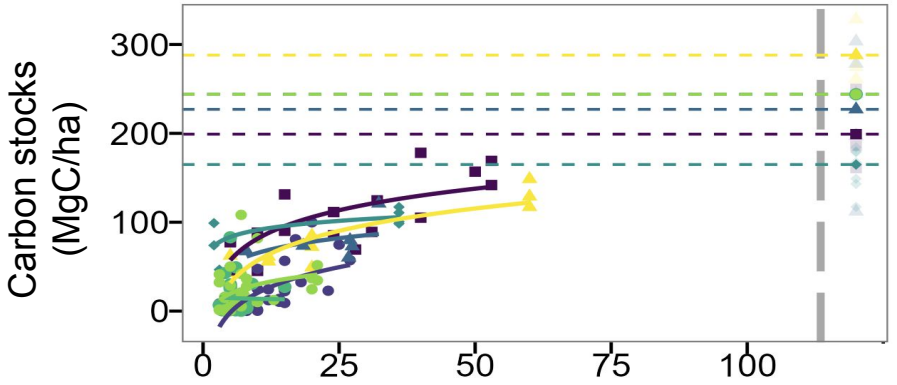
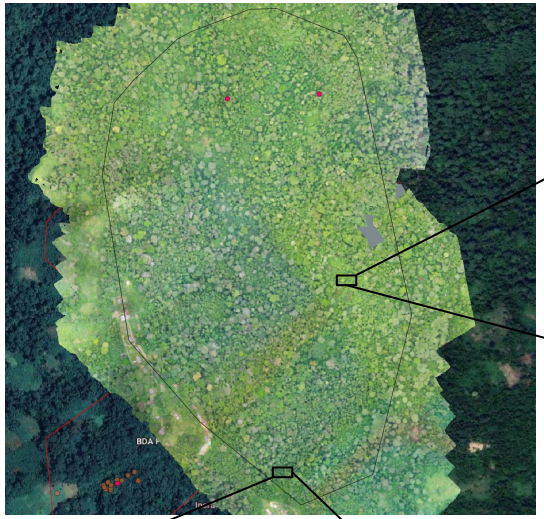
- Inventories + trait data
- Drone data acquisition

(RGB + Lidar)

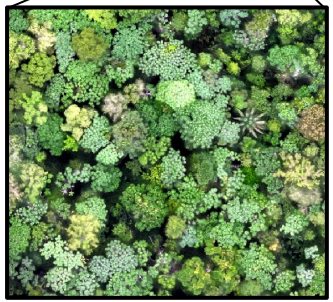
Old-growth forests



Objective I

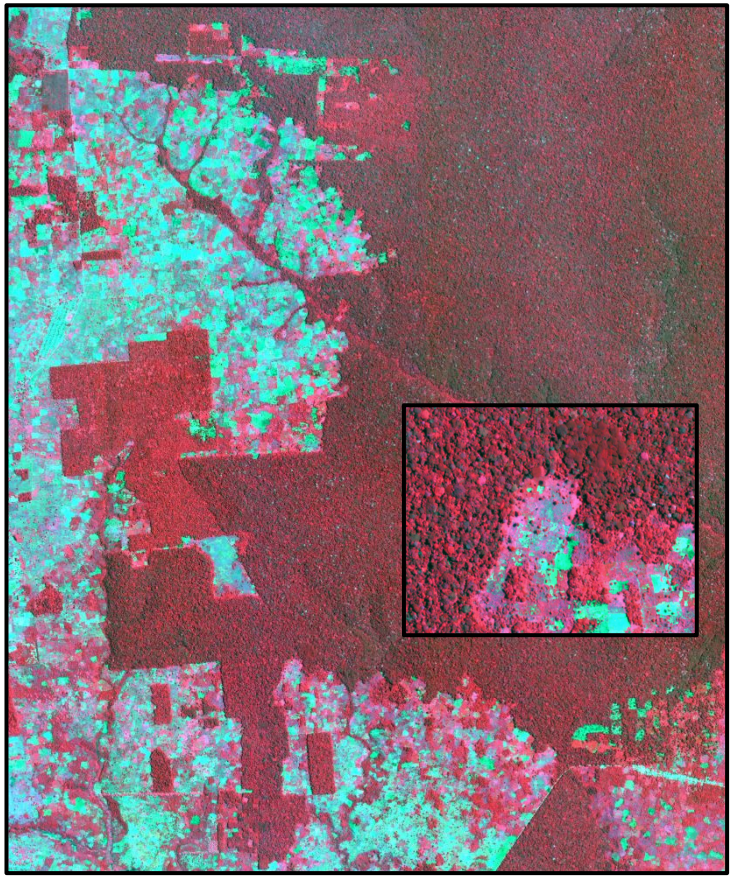


Old-growth forest patch



25yo forest patch

Objective II

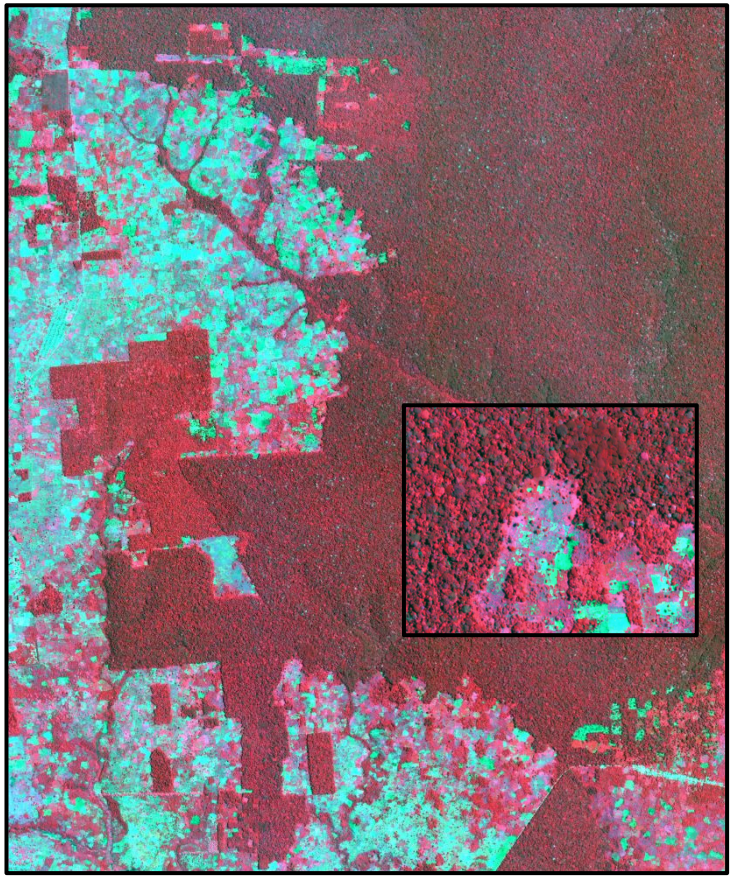


Example: Planet Image of Yangambi

DISTURBANCE:

- Sentinel 2 and Sentinel-1 time series + VHR EO opportunities (Planet, Earth Daily)
- Combined with current operational forest monitoring systems (GFC, TMF, RADD) to characterize disturbance

Objective II



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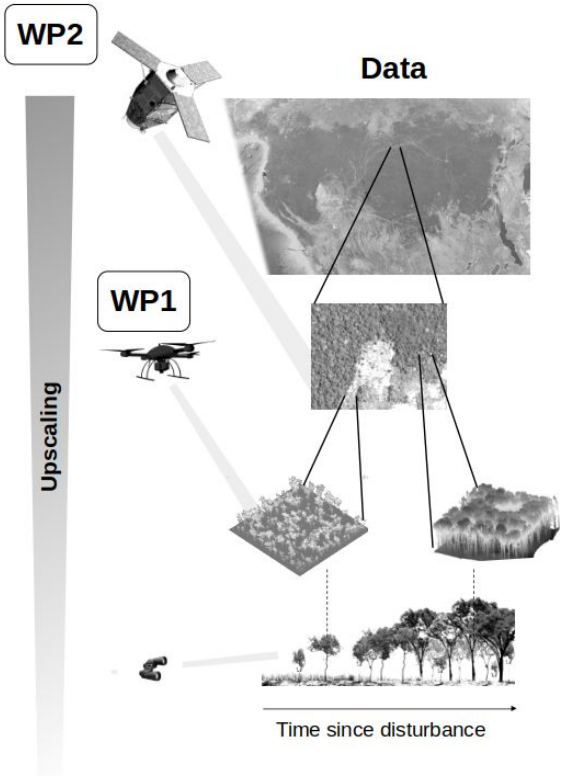
Objective III

Assimilate up-to-date observational datasets at multi spatio-temporal scales into a state-of-the-art land surface model



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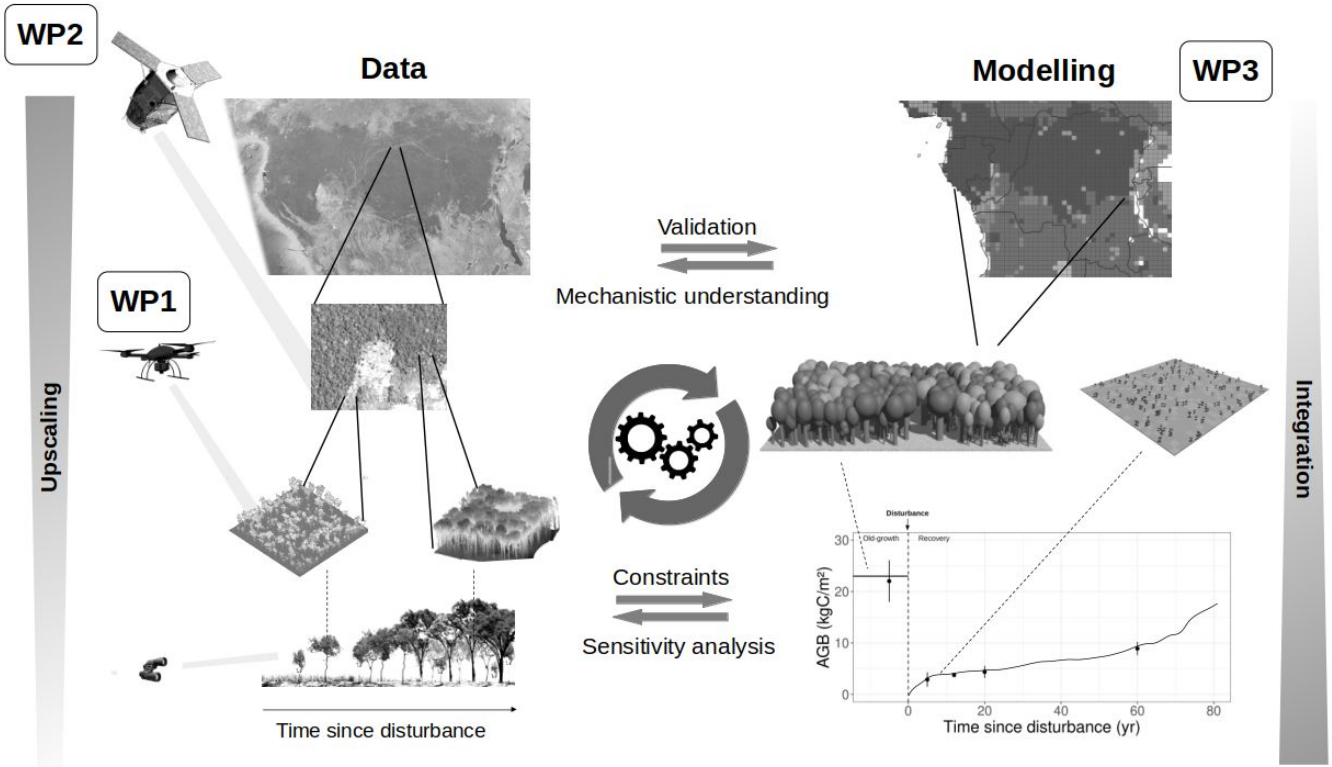


The consortium

UCLouvain

- Pierre Defourny
- **Sacha Delecluse**

GHENT UNIVERSITY

- Hans Verbeeck
- Marijn Bauters
- Félicien Meunier
- **Postdoc**

- Baudouin Michel

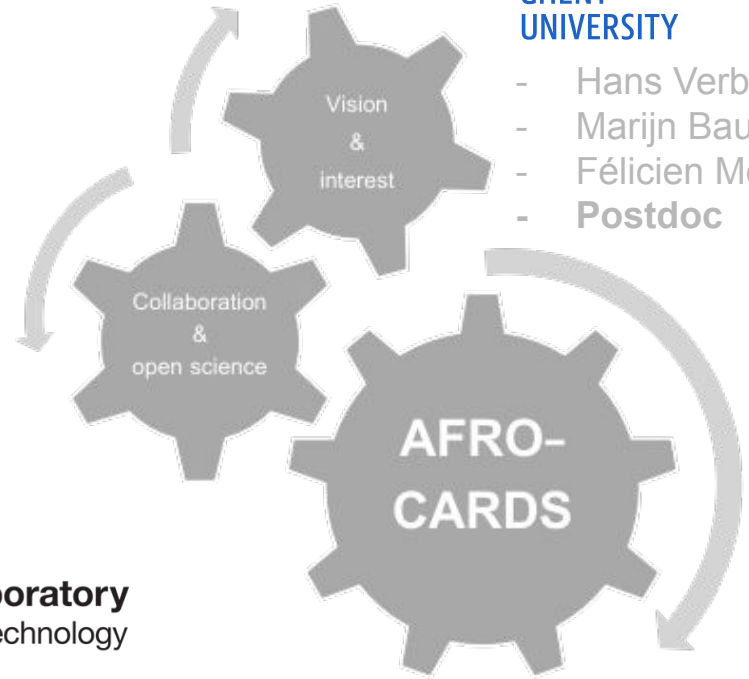
Jet Propulsion Laboratory
California Institute of Technology

- Sassan Saatchi

LIÈGE université

- Jean-François Bastin
- **PhD student 2**

The consortium



GHENT UNIVERSITY

- Hans Verbeeck
- Marijn Bauters
- Félicien Meunier
- **Postdoc**

Land surface modelling

UCLouvain

- Pierre Defourny
- **Sacha Delecluse**

Ground data collection

Earth Observations

- Baudouin Michel

NASA Jet Propulsion Laboratory
California Institute of Technology

- Sassan Saatchi

LIÈGE université

UAV monitoring

- Jean-François Bastin
- **PhD student 2**

AFRO-CARDS in a nutshell

Relevant and high impact

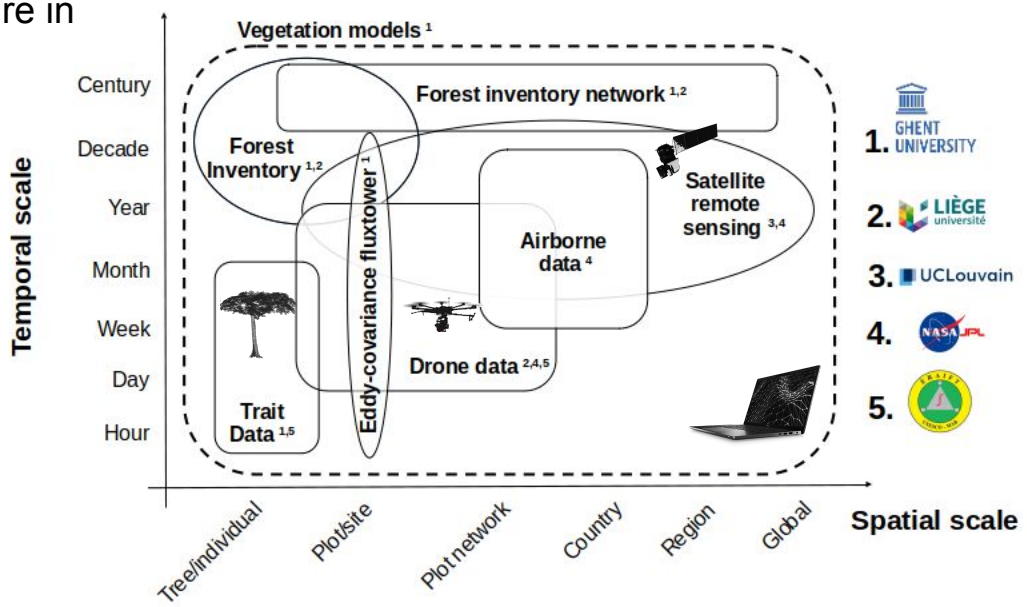
- Unprecedented advances in understanding Congo basin landscape dynamics
- Earth's region with highest expected pressure in the next decades

Experienced consortium

- Complementarity
- Strong and unique expertise in the region

Timely

- Maximizing new field data
- Maximizing recent UAV developments
- Maximizing use of new RS products



BELSPO - STEREO IV

Questions?

UCLouvain

LIÈGE université

NASA

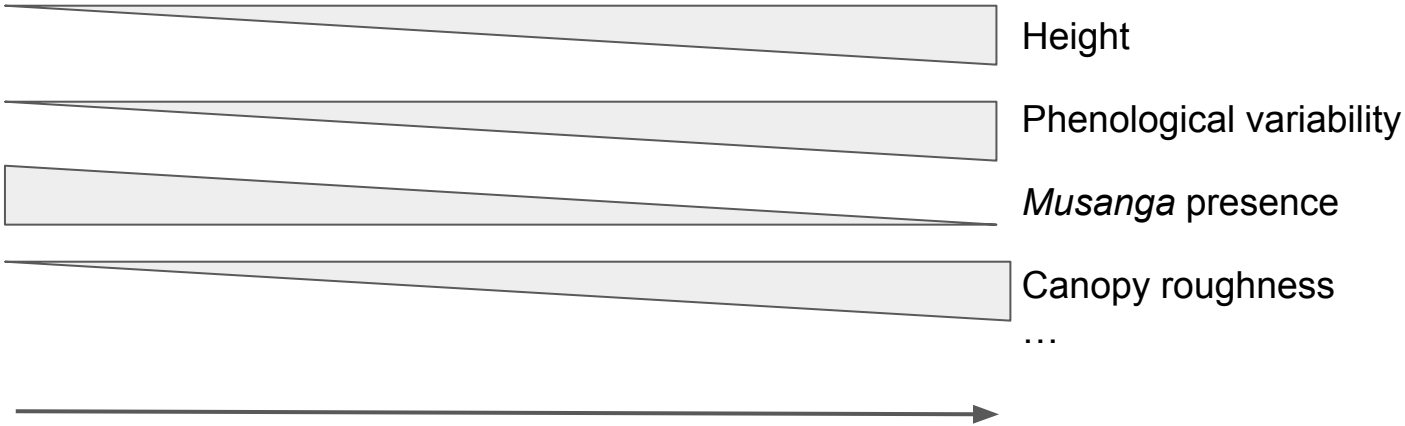
GHENT UNIVERSITY

FRAIFI UNESCO - MAB

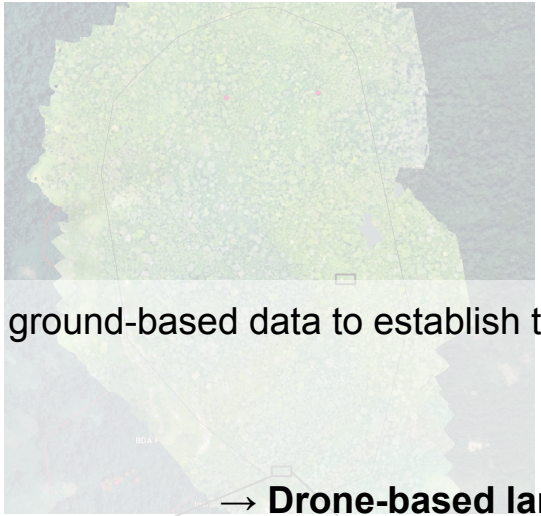
Join us!

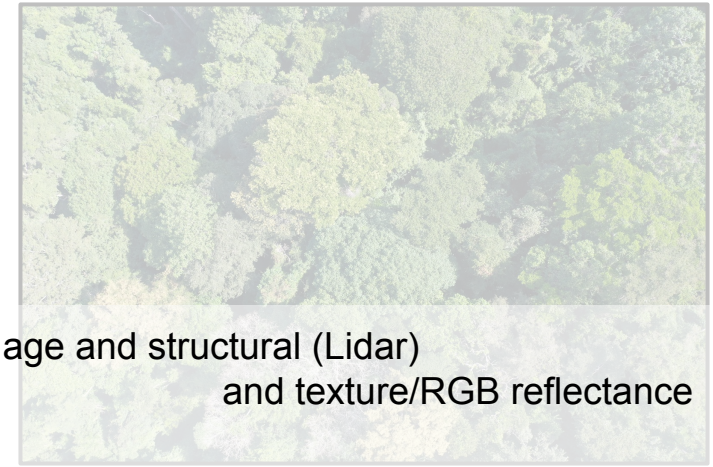
Felicien.Meunier@Ugent.be
Hans.Verbeeck@Ugent.be

Objective I


Height
Phenological variability
Musanga presence
Canopy roughness
…
Time since last disturbance

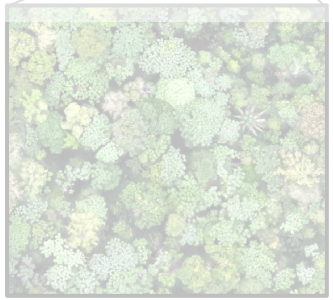
Objective I





Use ground-based data to establish the link between forest age and structural (Lidar)
and texture/RGB reflectance

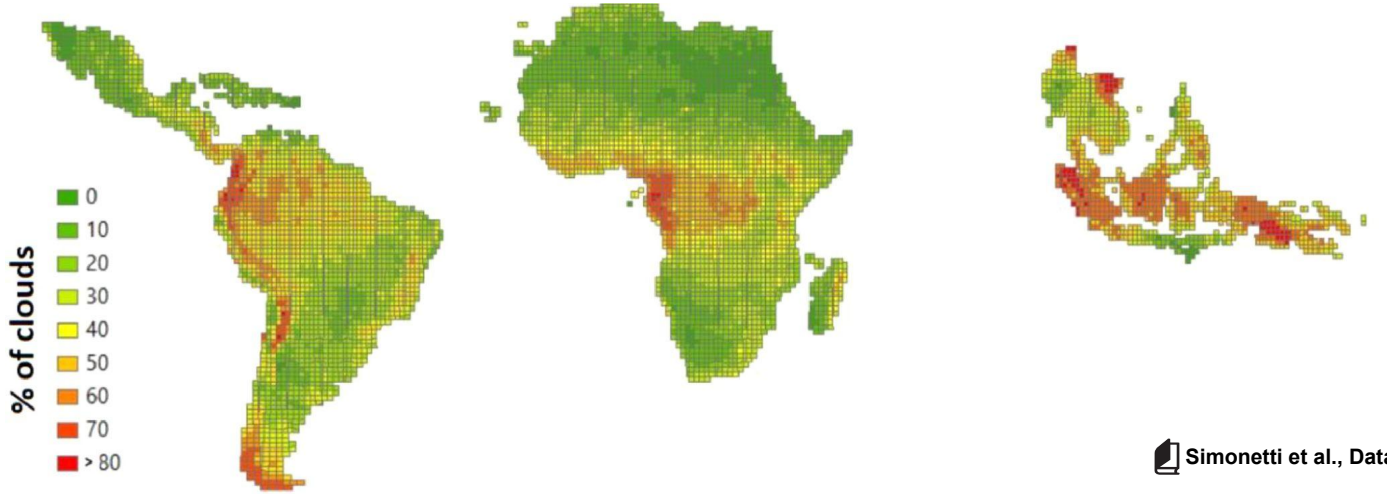
→ **Drone-based landscape scale classification of forest age**



25yo forest patch

Objective II

Cloud-rich region

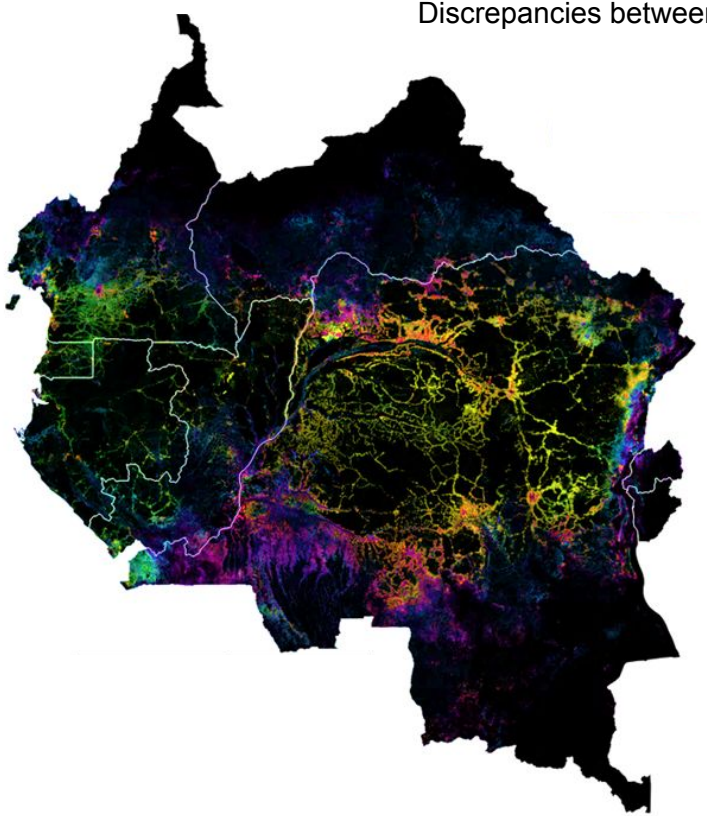


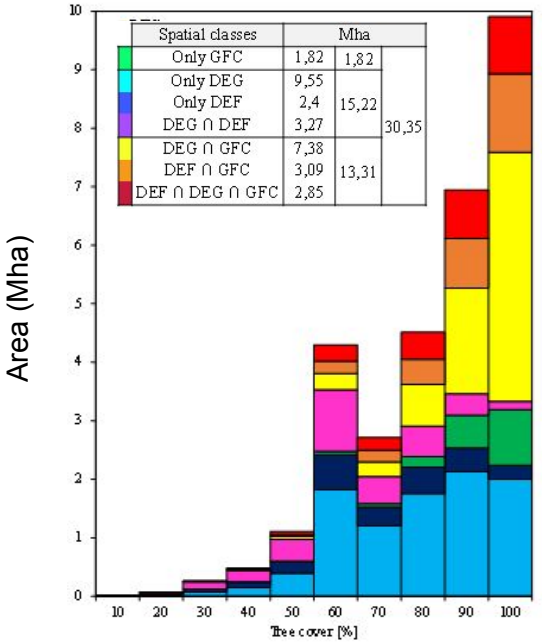
Simonetti et al., Data in brief, 2021

Objective II

Cloud-rich region

Discrepancies between Landsat-based deforestation monitoring systems





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Disturbance and Post-disturbance mapping across the Congo basin landscape.

→ **New generation EO and multi-sensor approach to improve our ability to map landscape dynamics**

POST-DISTURBANCE:

- New remote sensed features calibration on UAV images from VHR (Pleiades, Planet, Earth Daily) and on UAV lidar retrievals (BIOMASS ESA mission)
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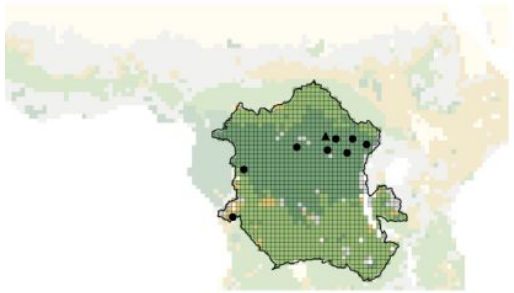
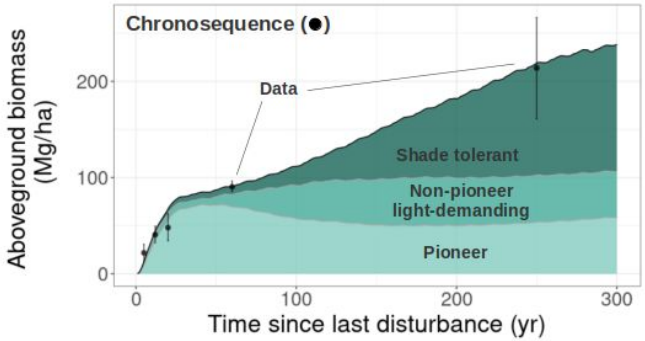
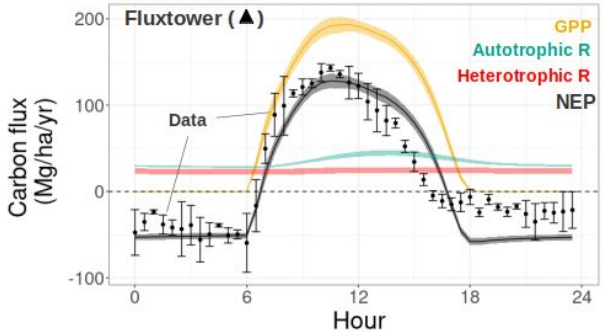
Data for model calibration/validation







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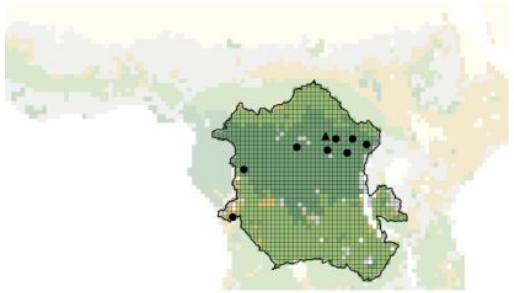
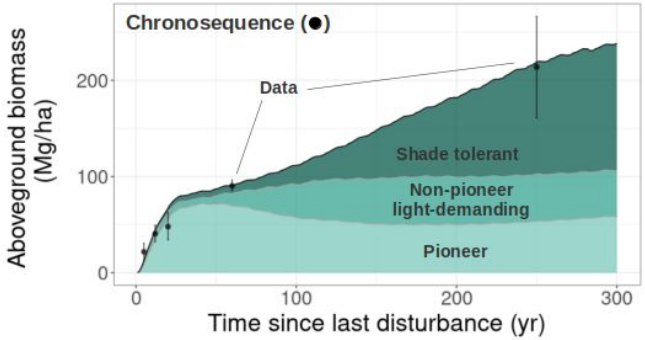
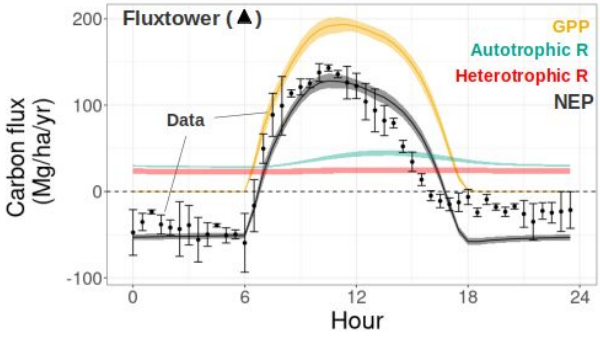
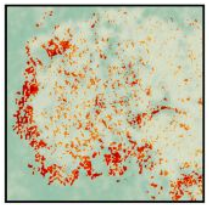


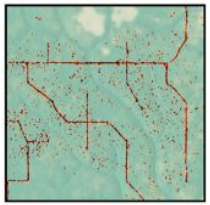




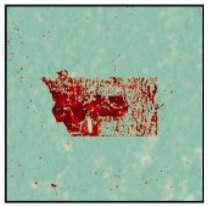
Data as model drivers



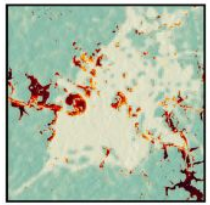
Small-scale agriculture expansion



Roads and selective logging



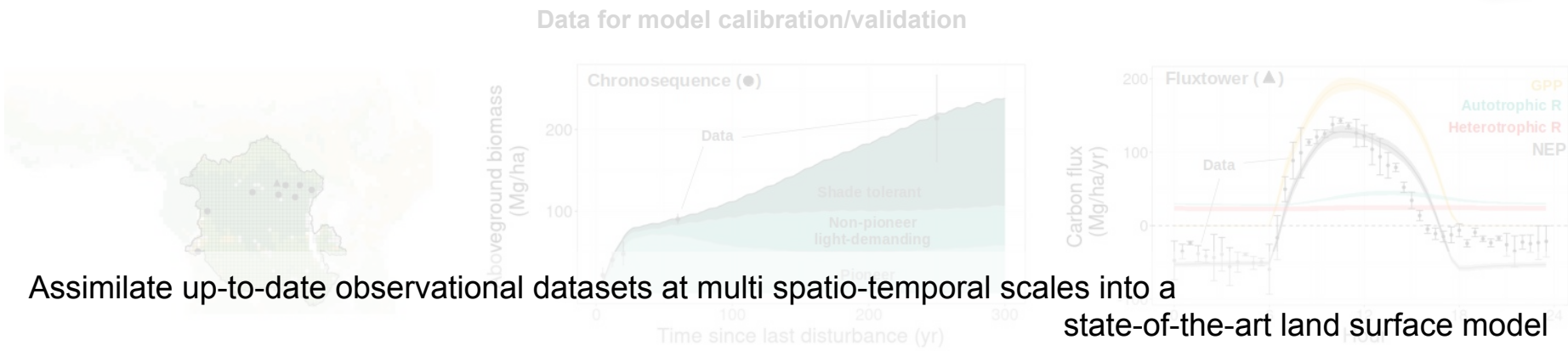
Oil palm plantation



Building a new capital city

Csillik et al., Nature Comms, 2022

Objective III



Assimilate up-to-date observational datasets at multi spatio-temporal scales into a state-of-the-art land surface model

→ Constrained projections of African tropical forest carbon cycle under various climate and land use change scenarios

Small-scale agriculture expansion

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Csillik et al., Nature Comms, 2022