Understanding of Africa's C-cycling is improved by combining models with multi-annual EO woody biomass maps

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National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

THE UNIVERSITY of EDINBURGH
School of GeoSciences

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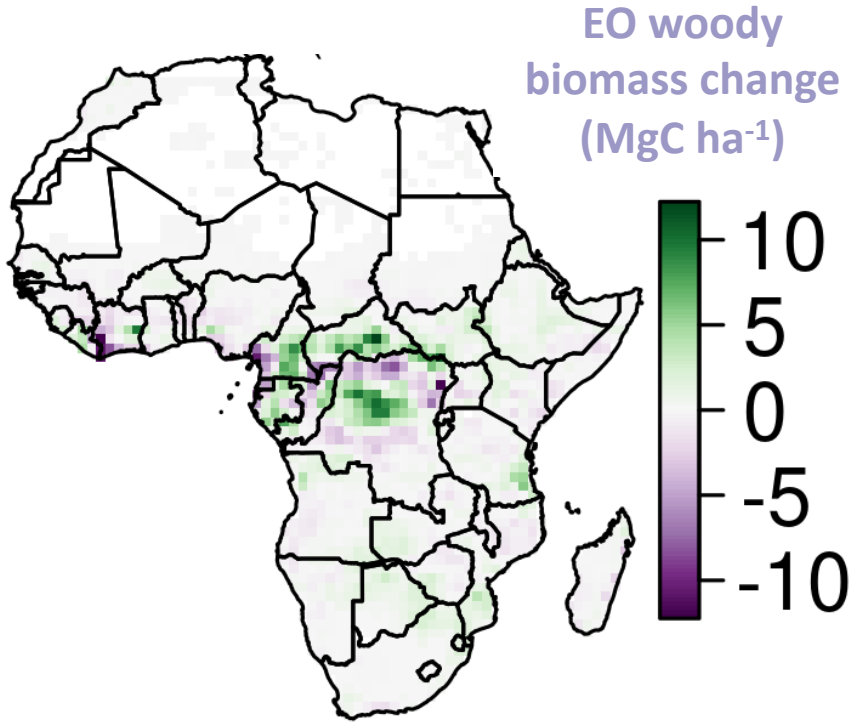
Motivation

- Africa plays a critical role in the global C-cycle
- Large, but poorly constrained, gross fluxes including fire and forest loss
- Diverse ecosystems - both dry and moist tropics
- Recent advances:
  - Xu et al., (2021) EO woody biomass
  - Multi-annual: 2000-2019
  - 10 km spatial resolution



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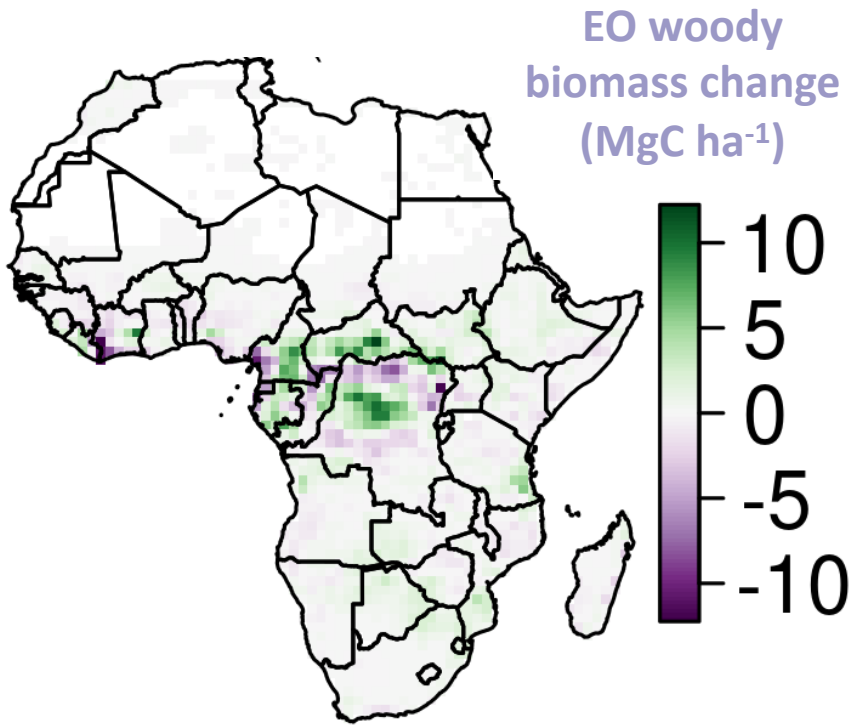
Research Questions

1. To what extent are does repeat vs single EO AGB constrain biomass stocks and change?
   - Quantify impact on magnitude and/or uncertainty
2. How is increased constraint achieved?
   - i.e. allocation of photosynthate vs residence times
3. Are gross fluxes impacted?
   - i.e. photosynthesis, respiration, fire

Our analysis:

Time period = 2003-2019, monthly time step

Resolution = 1° x 1°



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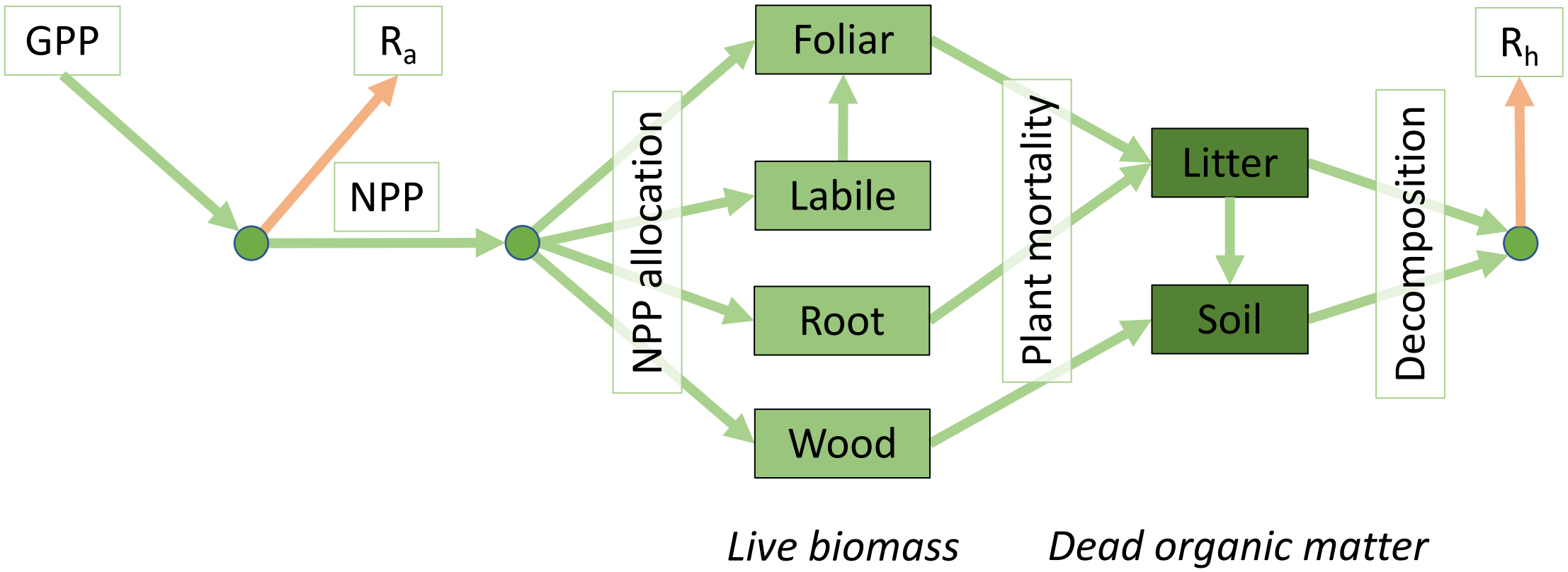
Data Assimilation Linked Ecosystem (DALEC) model



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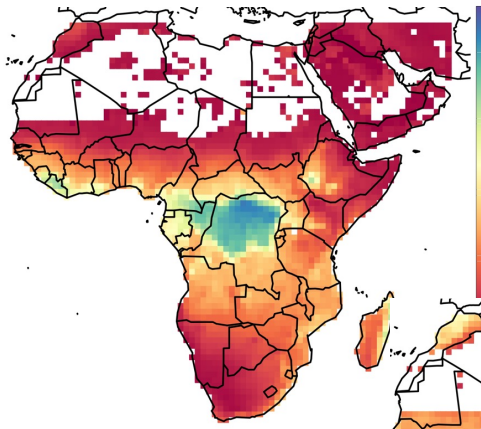
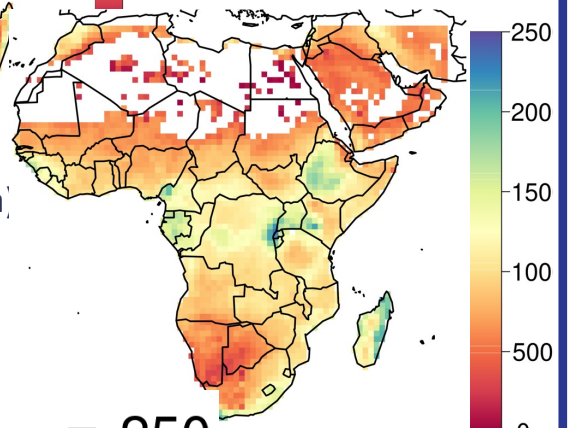
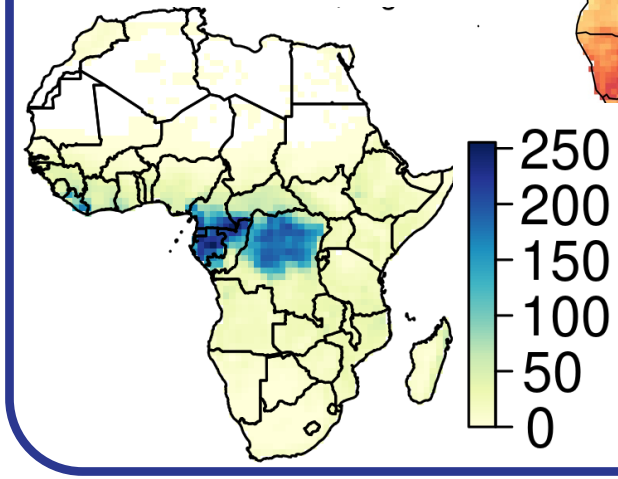
Biophysical Observations



Leaf area time series (m^2/m^2) **(MODIS)**



Soil C (MgC/ha) (SoilGrids v2)



Wood stocks (MgC/ha) **(Xu et al., 2021)**

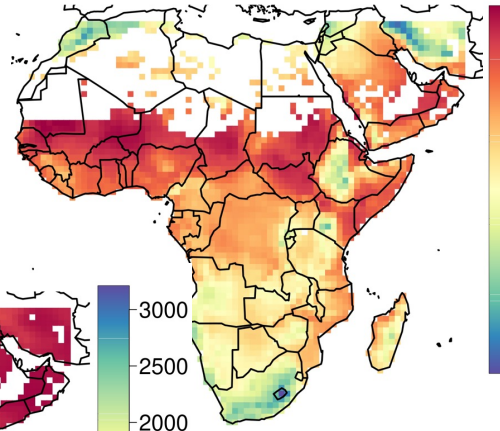
DALEC Model

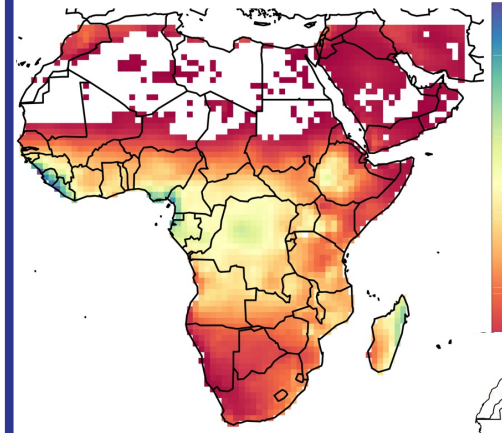
MDF algorithm

Output

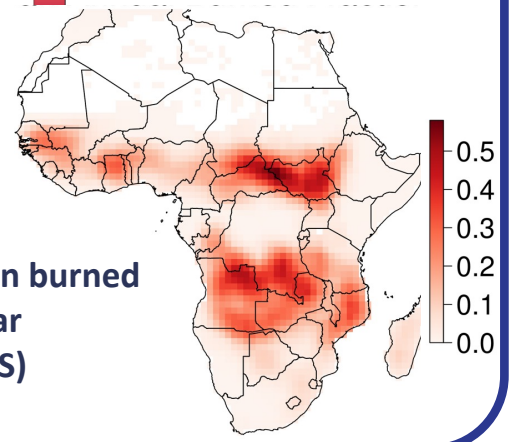
Drivers

Air Temp (C) **(Re-analysis)**





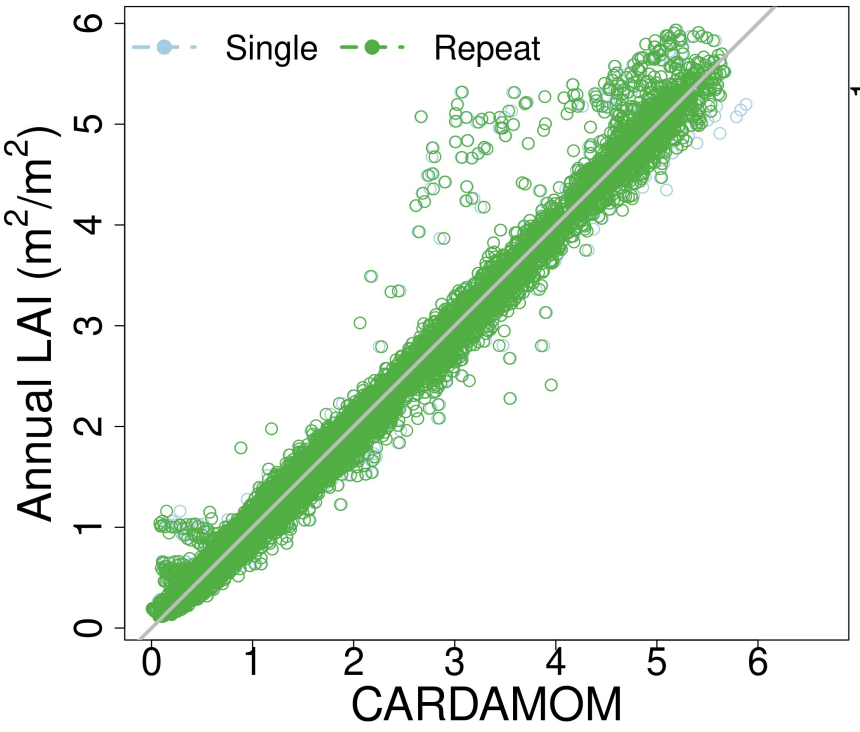
Precipitation (mm / yr) **(Re-analysis)**

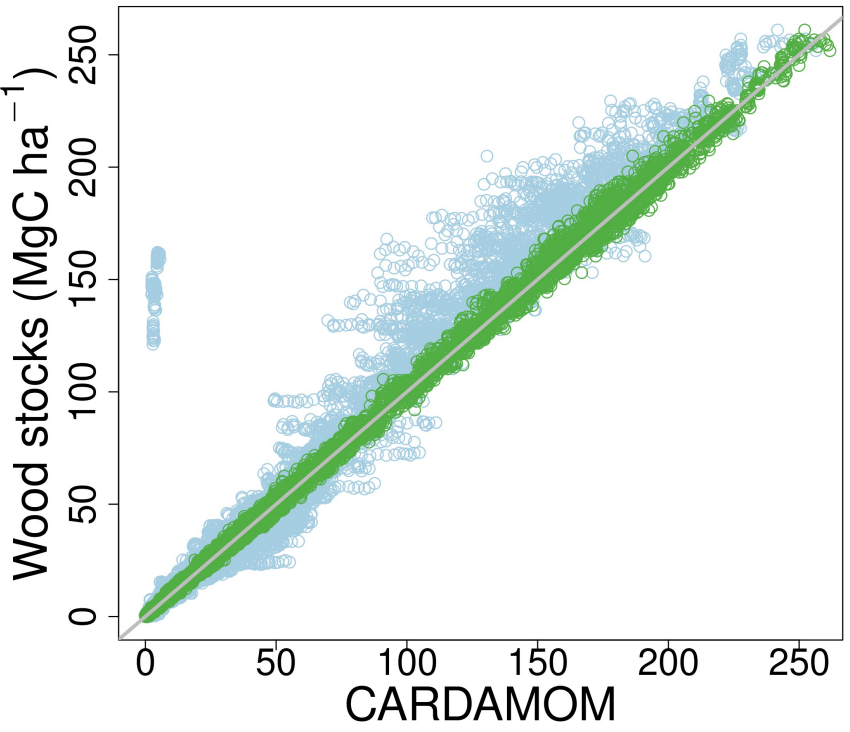


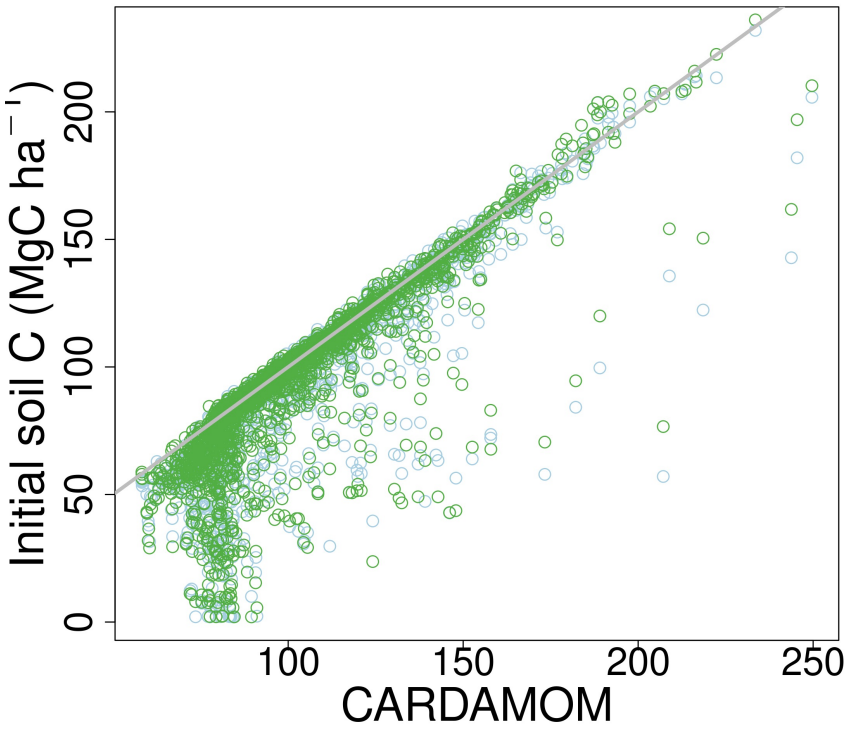
Fraction burned per year (MODIS)

RESULTS: Calibration

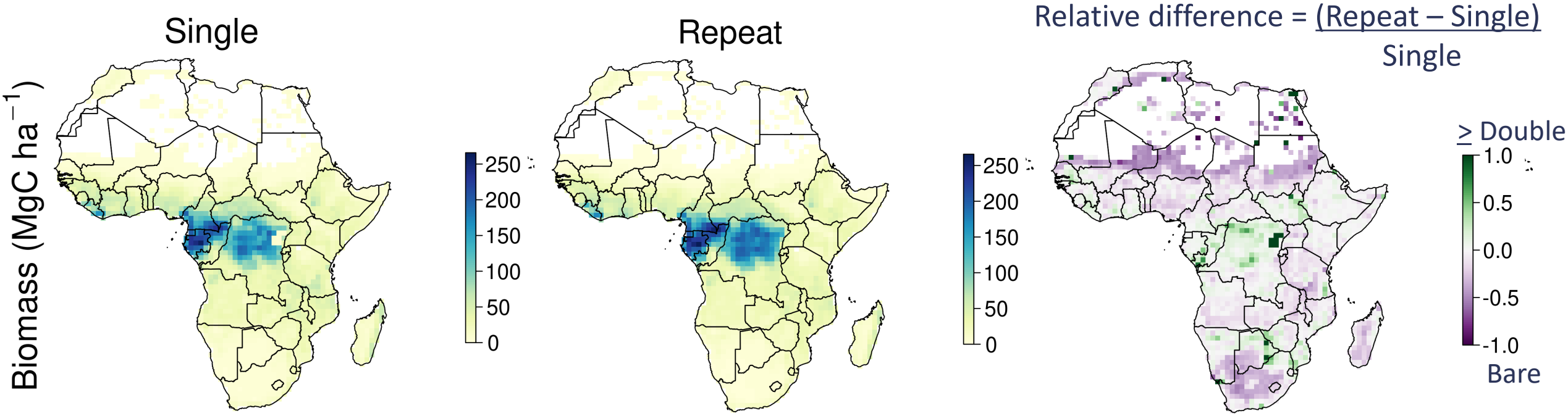
RESULTS: Diverse calibration data can be fitted



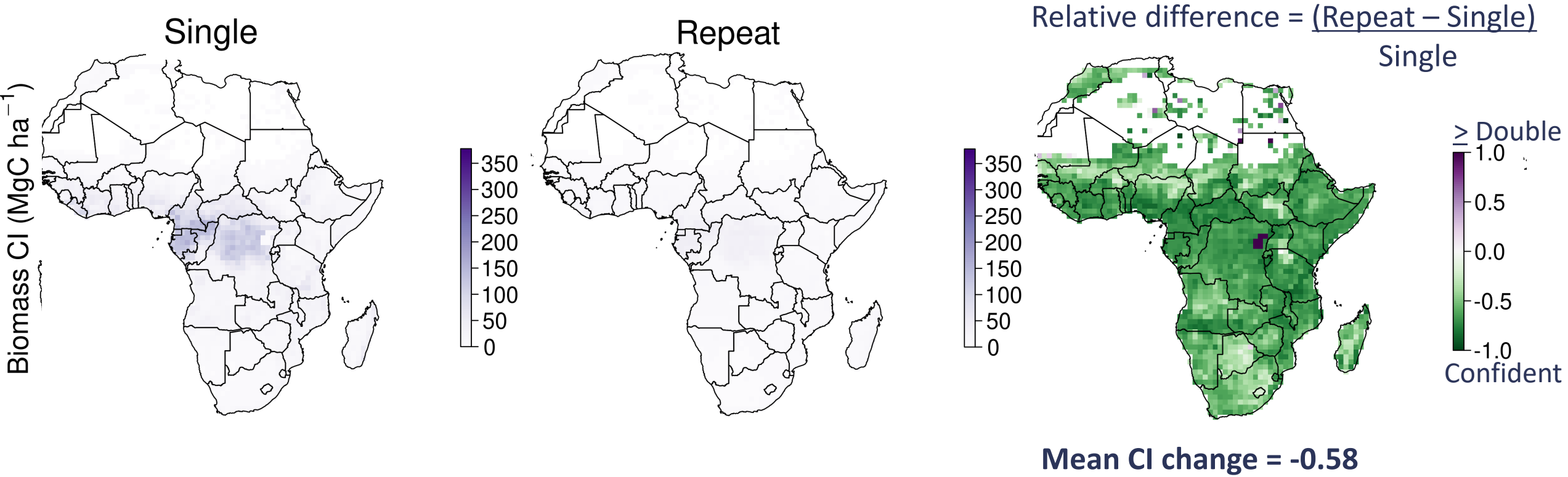




RESULTS: Is biomass stock impacted?



RESULTS: Is biomass uncertainty impacted?



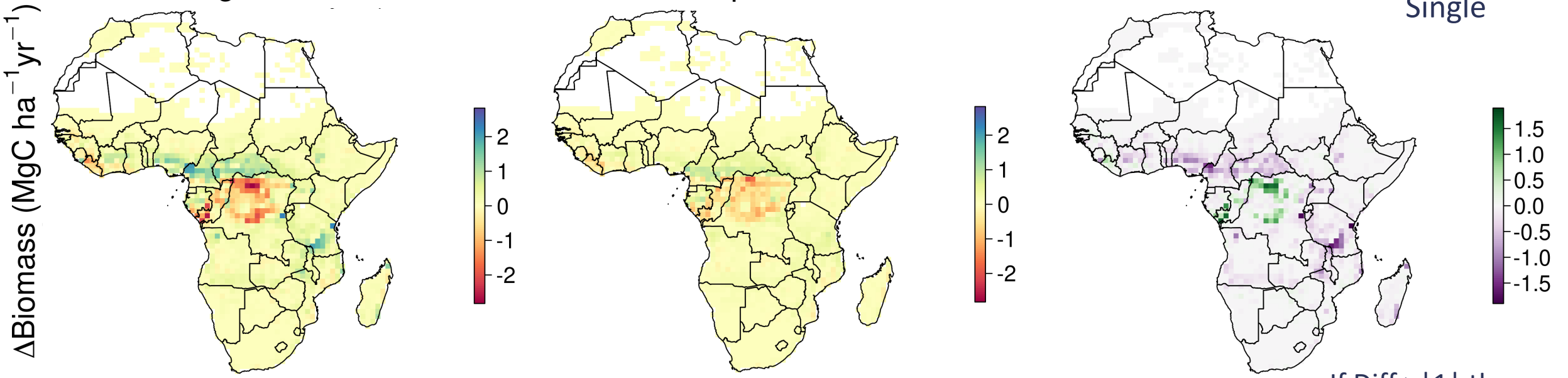
Mean CI change = -0.58

RESULTS: Is biomass stock change impacted?

Single

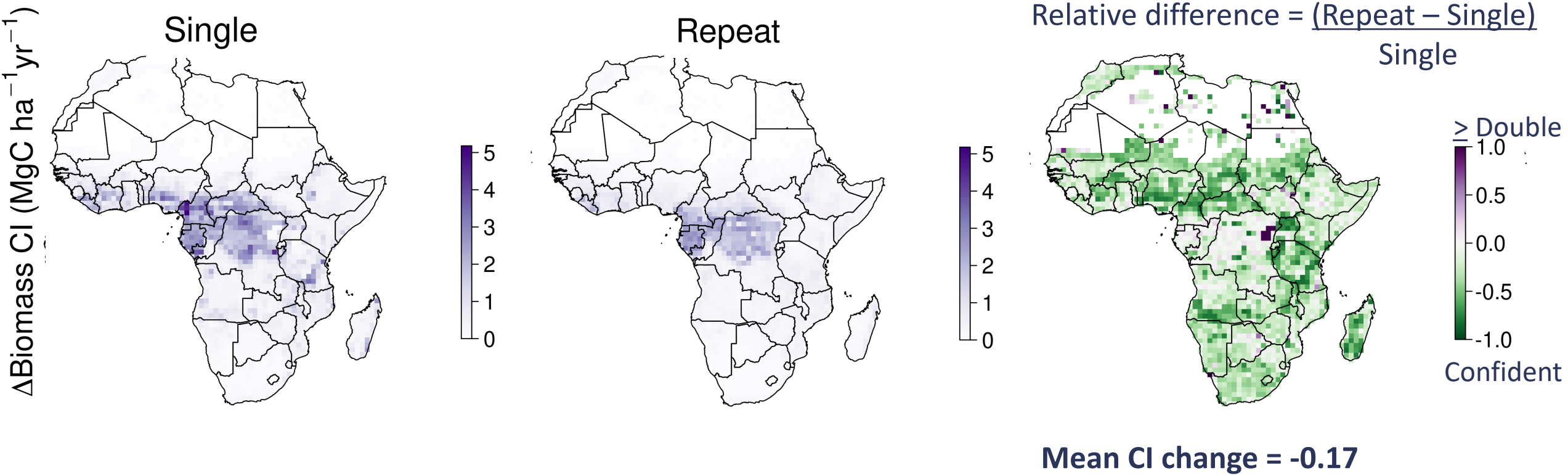
Repeat

Relative difference = (Repeat – Single) / Single



If Diff >|1| then sign change occurred

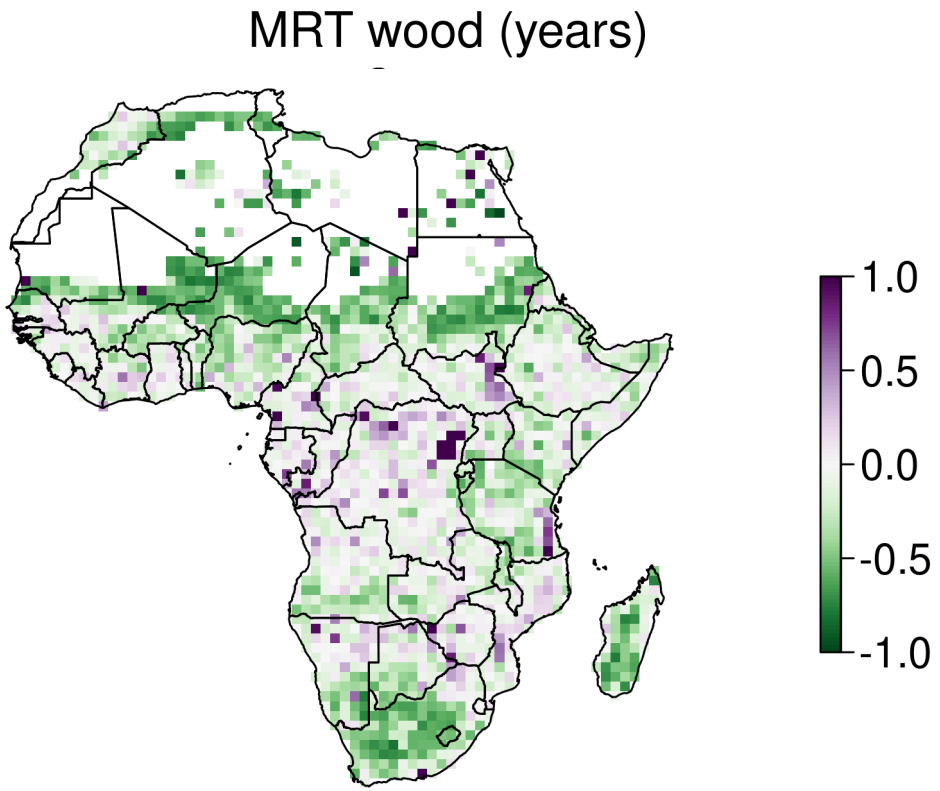
RESULTS: Is biomass change uncertainty impacted?



Mean CI change = -0.17

RESULTS: How is increased constraint achieved?

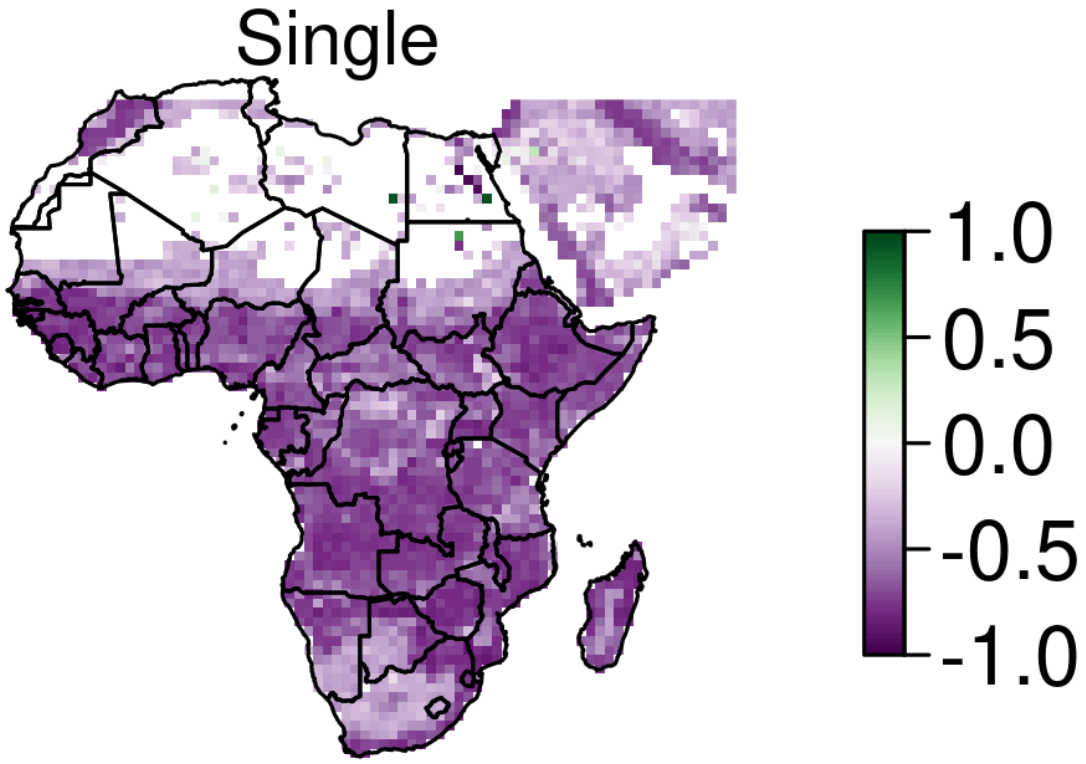
Relative difference = (Repeat – Single) / Single



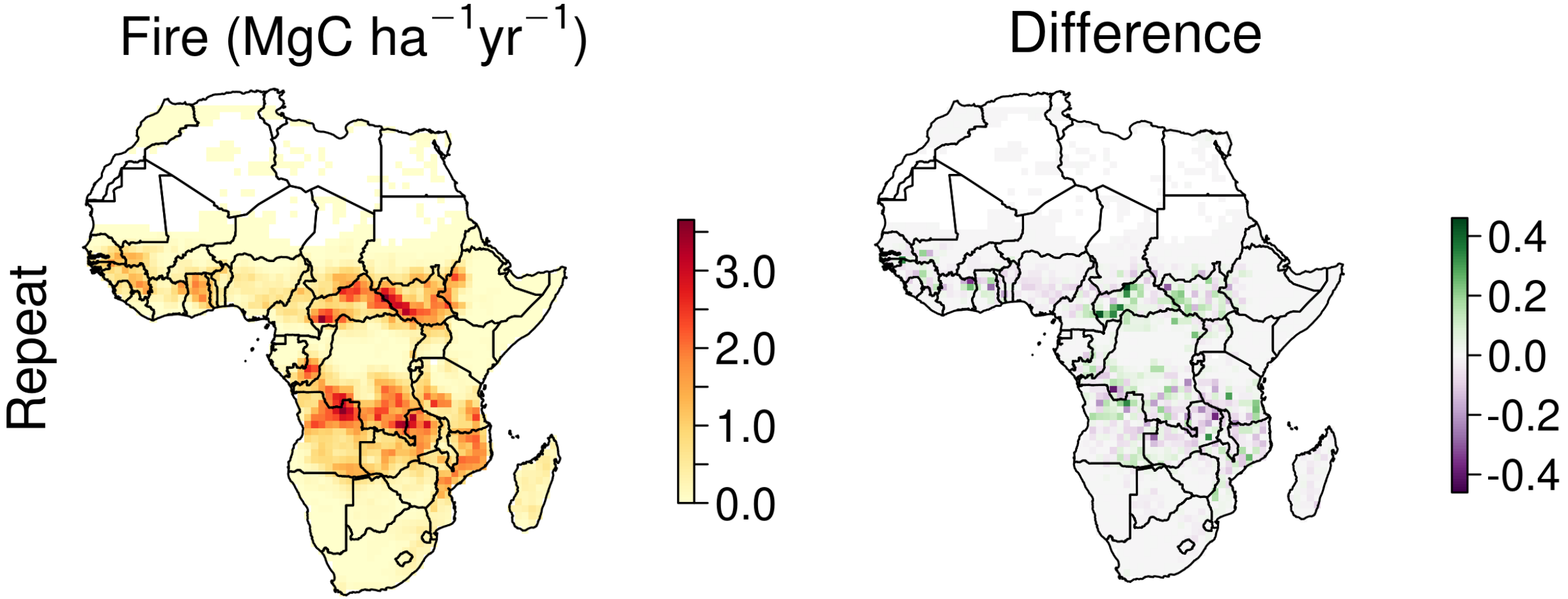
Mean CI change = -0.16

RESULTS: How is increased constraint achieved?

- Correlation between wood NPP ~ Mean Residence Time

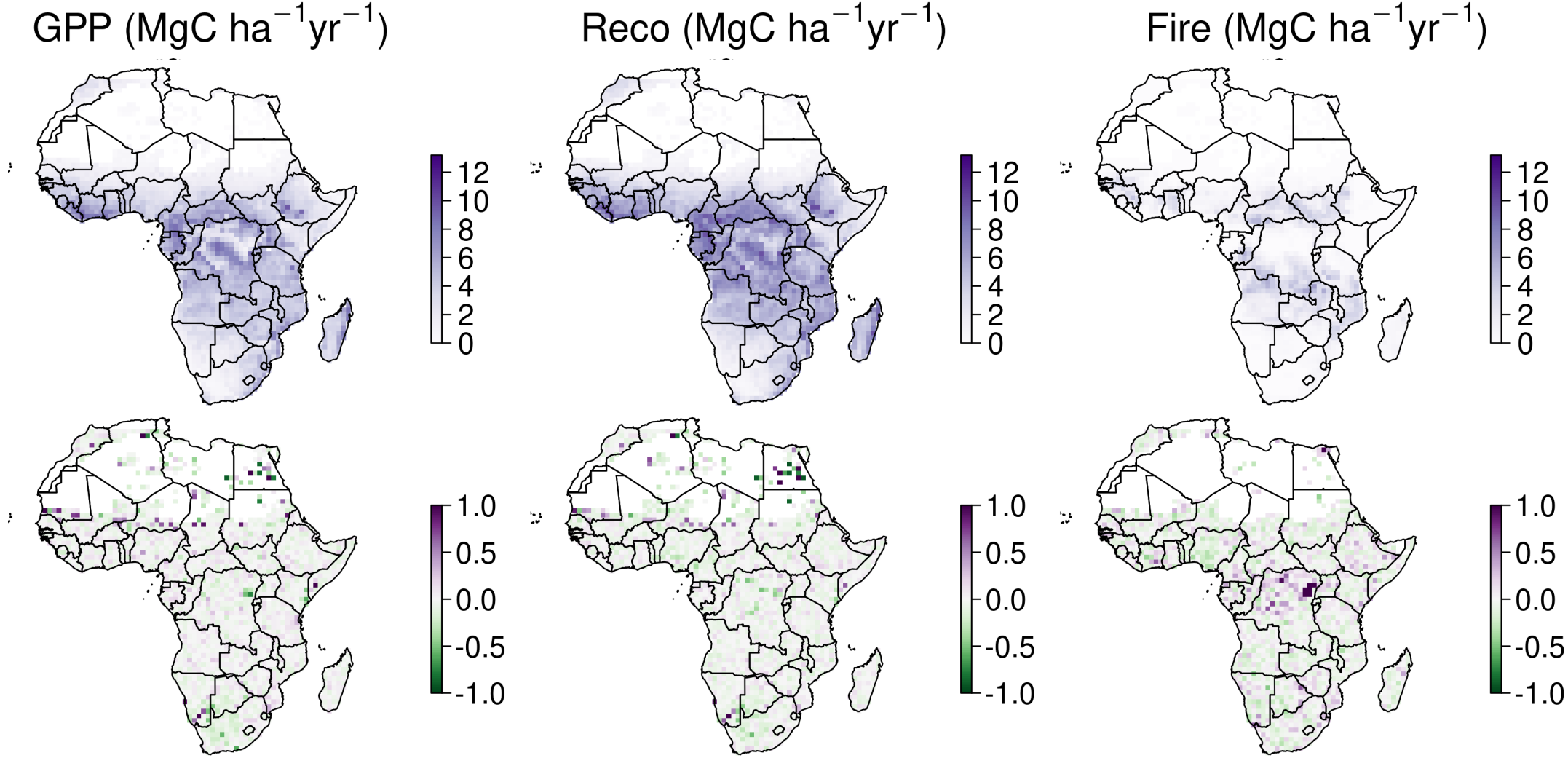


RESULTS: Impact of gross fluxes and uncertainty?



RESULTS: Impact of gross fluxes and uncertainty?

Repeat



CI change = -120 TgC yr^{-1}

CI change = -200 TgC yr^{-1}

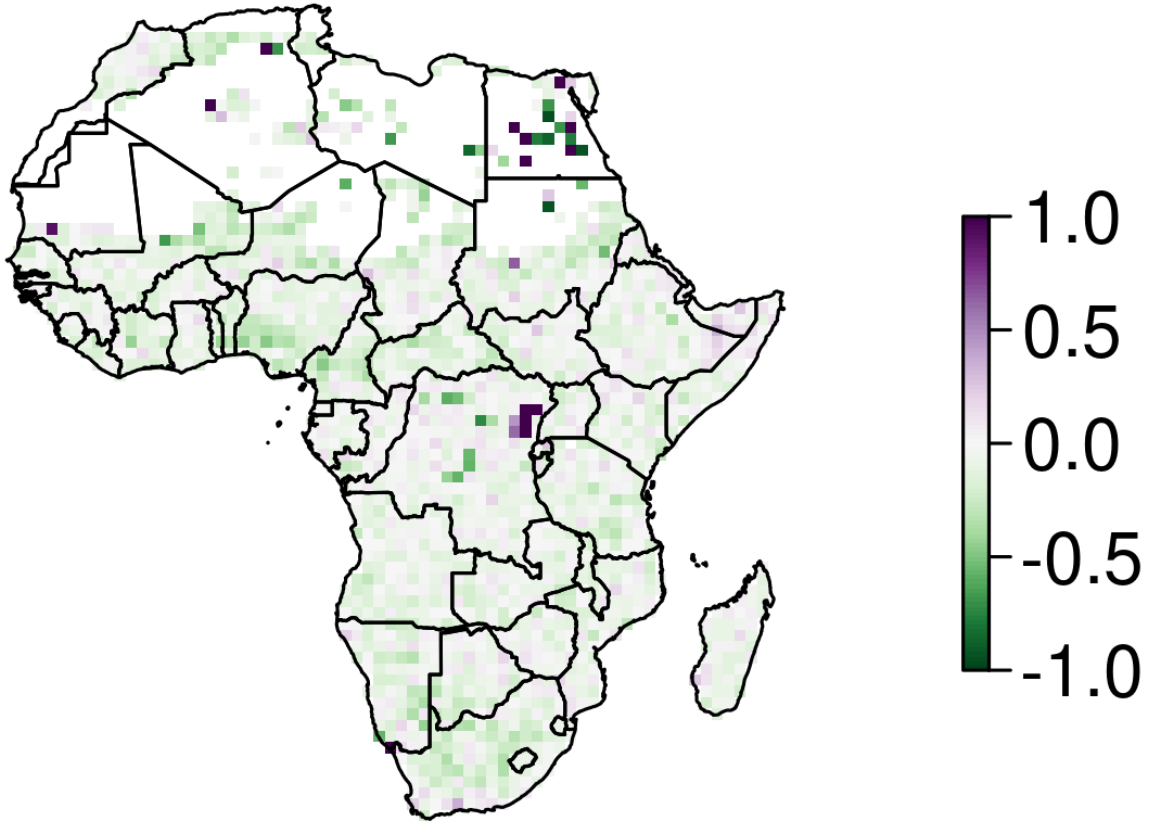
CI change = -40 TgC yr^{-1}

RESULTS: Impact of gross fluxes and uncertainty?

Net C exchange (MgC ha^{-1} yr^{-1})

Repeat

Difference



CI change = -380 TgC yr^{-1}

Summary

- Biomass stocks and uncertainties are impacted
- Change in Biomass stocks and uncertainties are impacted
- Uncertainty of NPP to wood and wood residence times are reduced
  - The impact varies in space
- Correlation between wood NPP and MRT are enhanced
- Impact on gross fluxes spatially variable but overall reduction in uncertainty

Thank you

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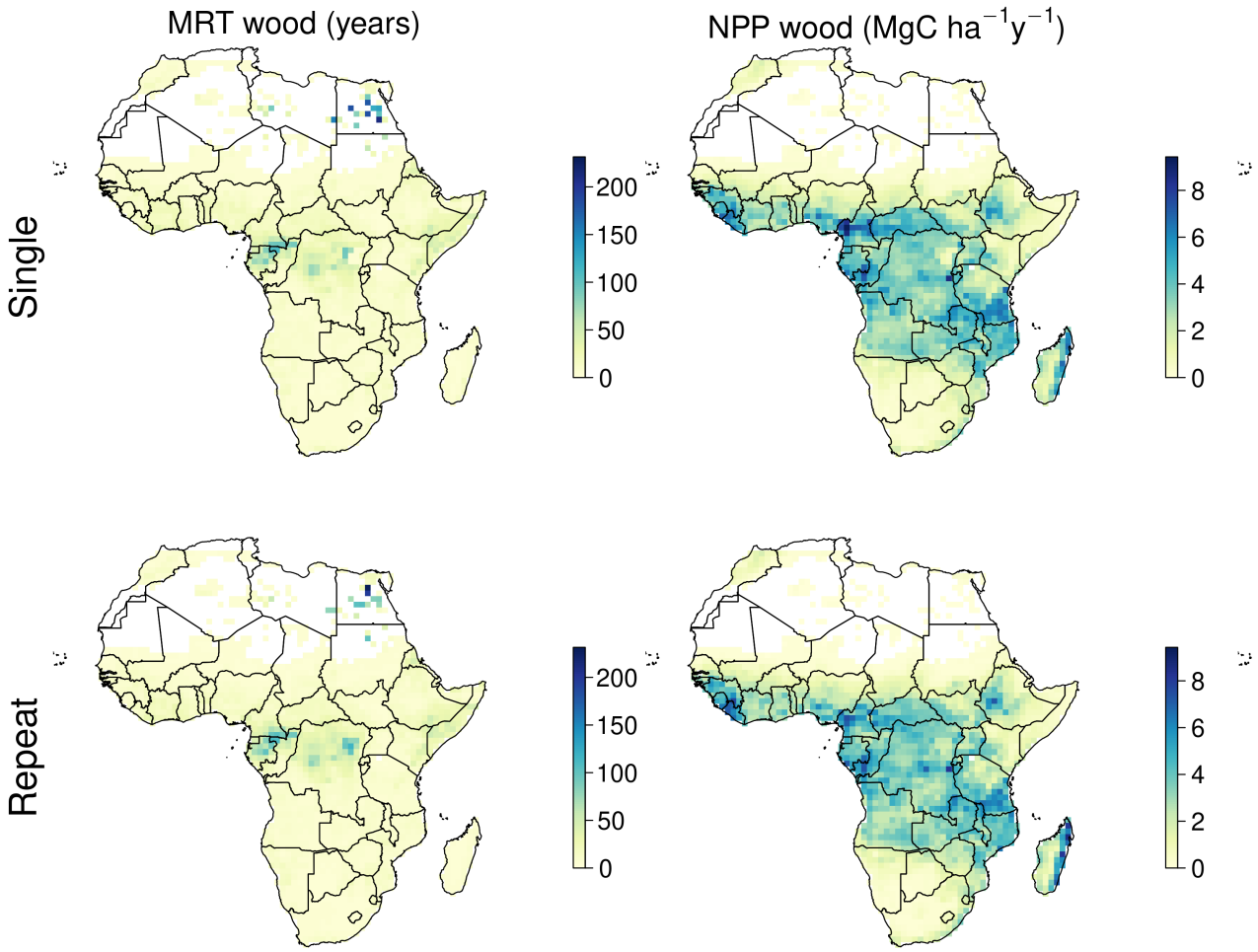
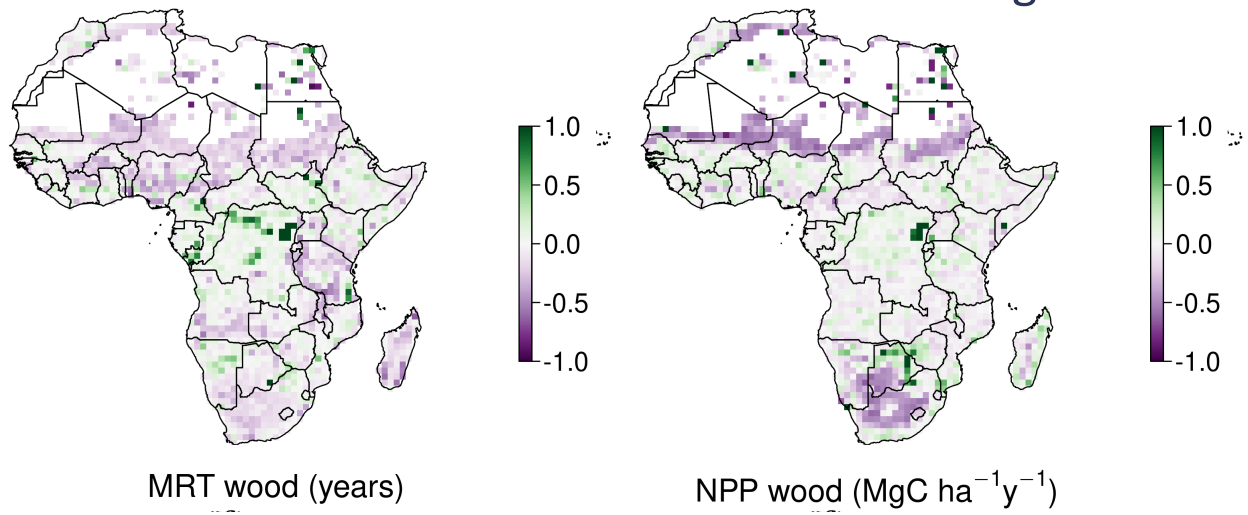
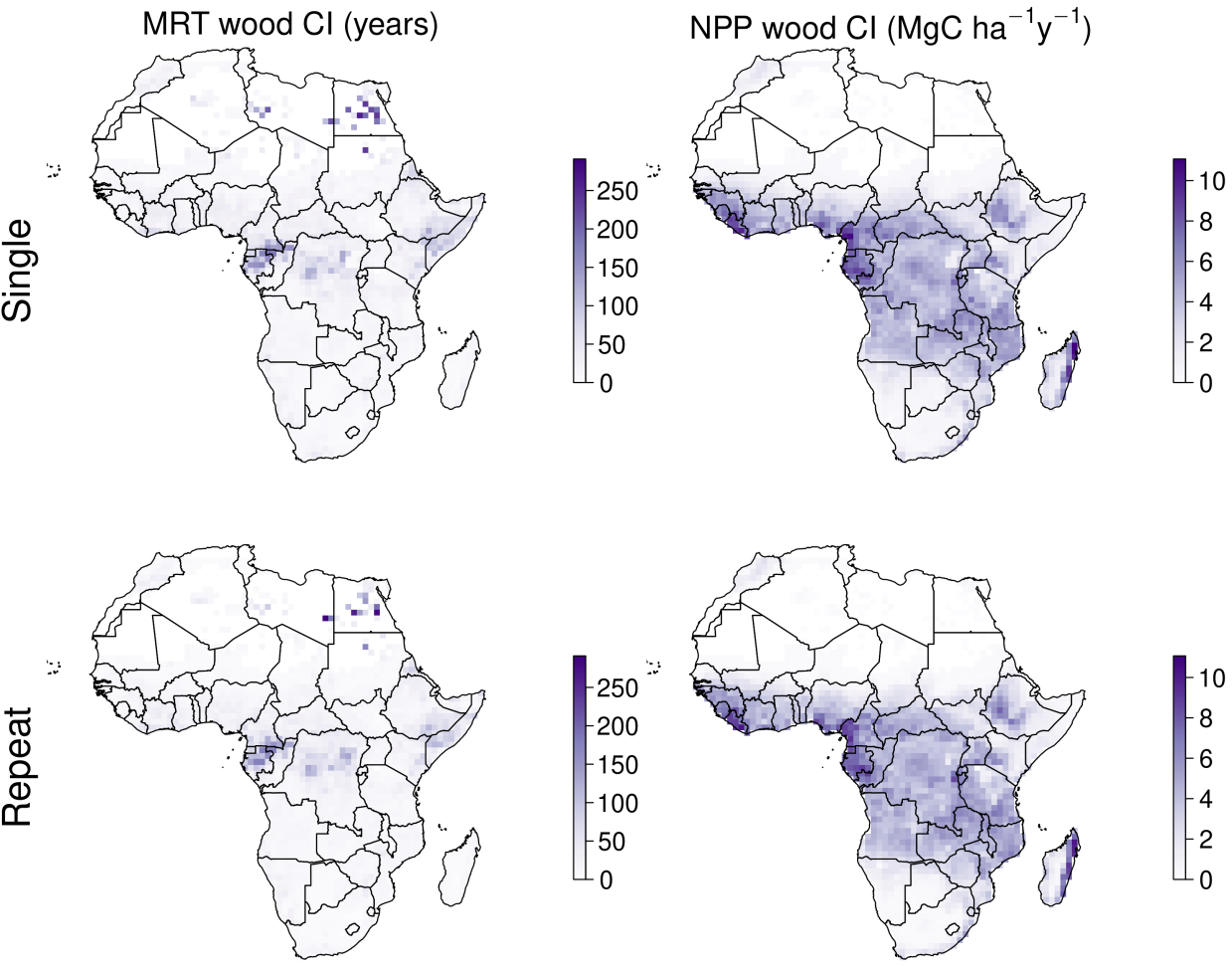
RESULTS: How is increased constraint achieved?



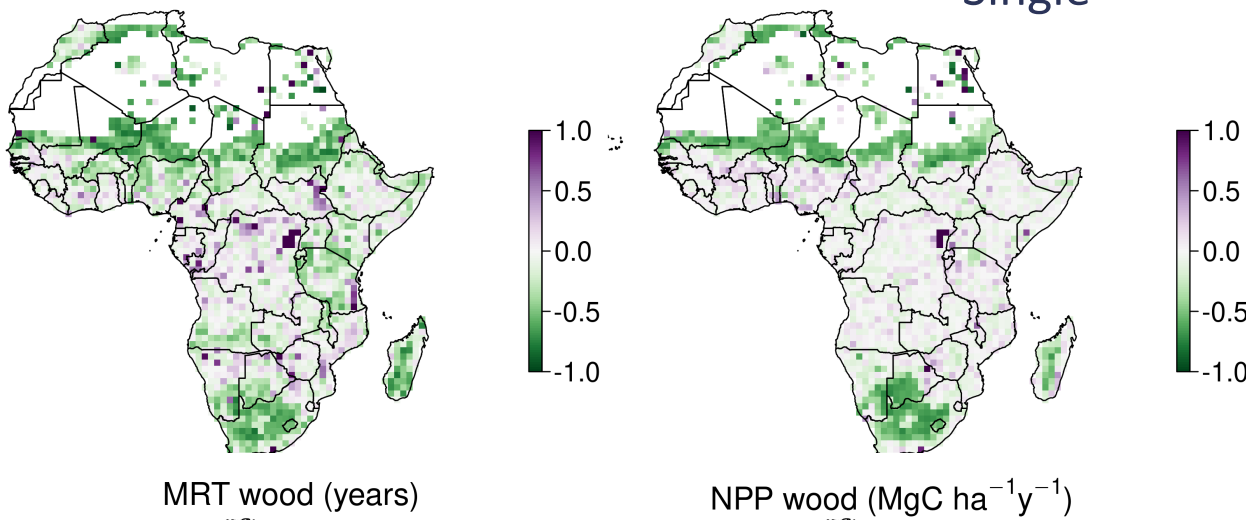
Relative difference = (Repeat – Single) / Single



RESULTS: How is increased constraint achieved?



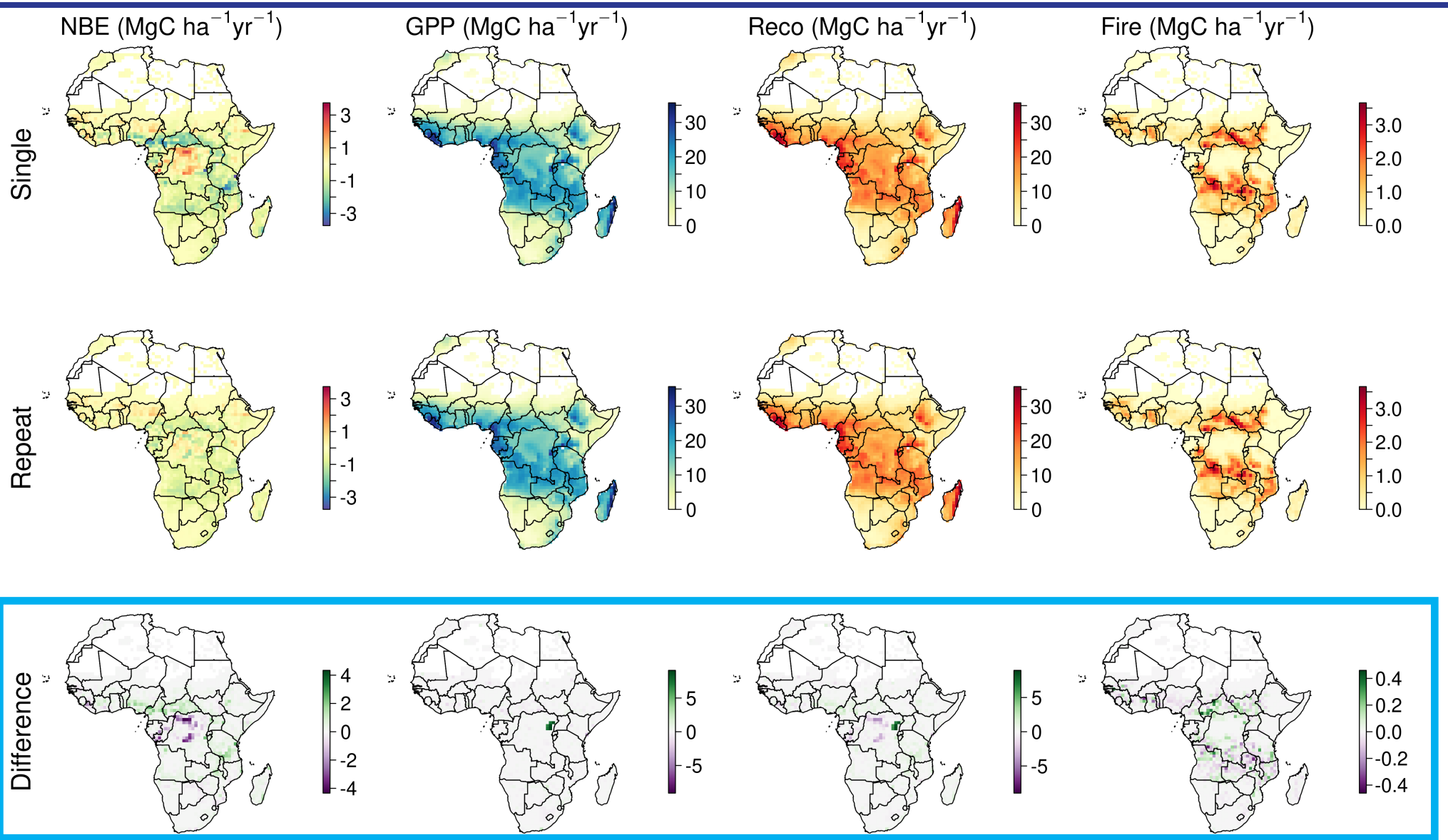
Relative difference = (Repeat – Single) / Single



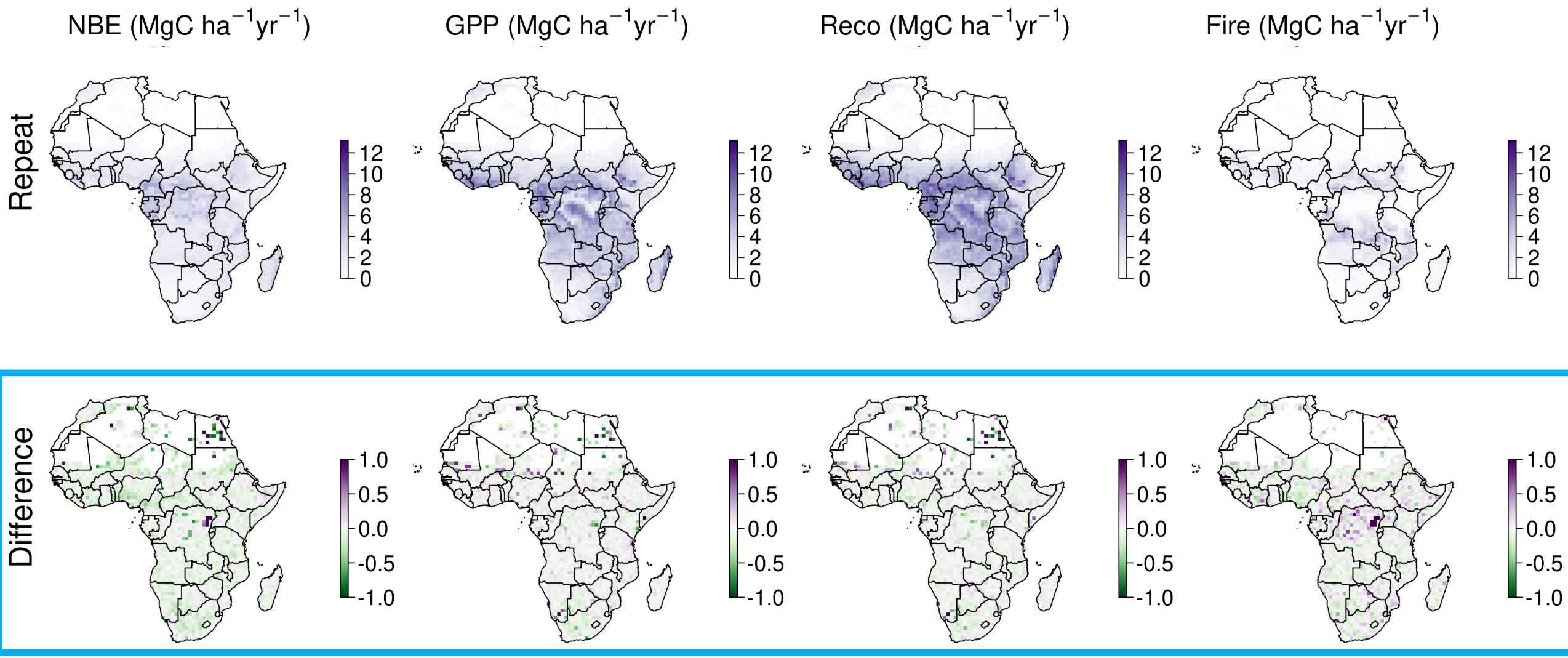
Mean CI change = -0.16

Mean CI change = -0.11

RESULTS: Impact of gross fluxes and uncertainty?



RESULTS: Impact of gross fluxes and uncertainty?



RESULTS: Impact of gross fluxes and uncertainty?