ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

05-08 June 2023
Cross-sectoral ISIMIP and PROCLIAS Workshop

ISIMIP 3a simulation results

Attribution clarifies the complex impacts of climate change on vegetation biomass change

Sector: biomes
Participating models: CLASSIC, DLEM, JULES, MC2, ORCHIDEE, SSiB4-TRIFFID, VISIT
Speaker: Akihiko Ito

Introduction

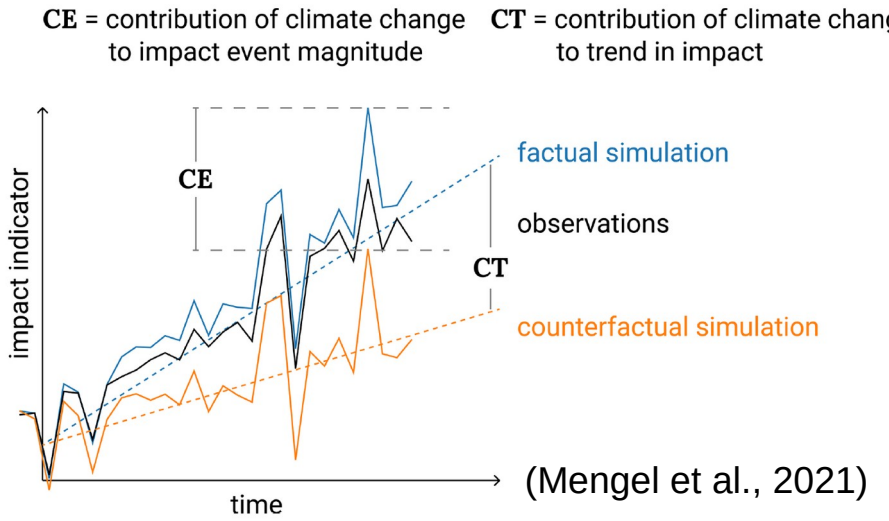
Vegetation biomass is a key variable of the biome sector as an important natural resource providing timber and fiber to human society and habitat to animals, birds, insects, and microorganisms. Vegetation biomass is also one of the large carbon pool.

Historical changes in vegetation biomass were caused by multiple factors such as elevated atmospheric CO_2 concentration, climate change, land-use change (deforestation, afforestation, wood-harvest), and disturbances such as wildfire. Separating these mixed impacts into specific contribution is difficult.

ISIMIP phase 3a allows us to attribute historical changes in sectors by performing factual and counterfactual simulations. This study aims at conducting attribution of historical vegetation biomass change.

Method

Participating models: CLASSIC, DLEM, JULES, MC2, ORCHIDEE, SSiB4-TRIFFID, VISIT



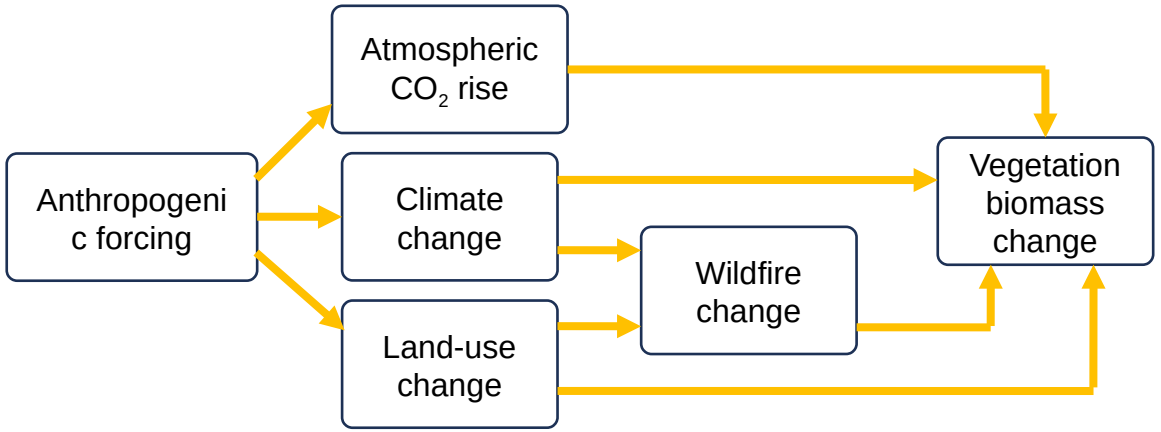
(Mengel et al., 2021)

Step 1 &2:

- Benchmarking: comparison with observation-based global vegetation biomass data (Spawn et al., 2020)
- Inter-model comparison: difference (CT) between factual simulation vs counterfactual simulation by all models

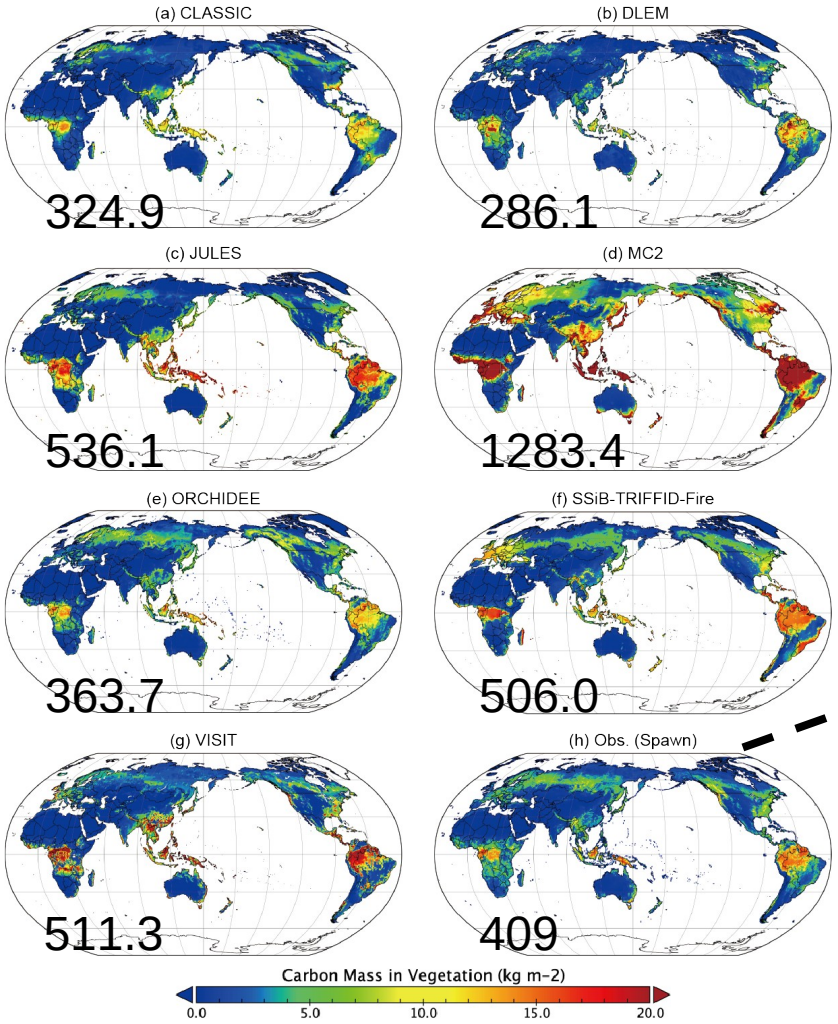
Step 3:

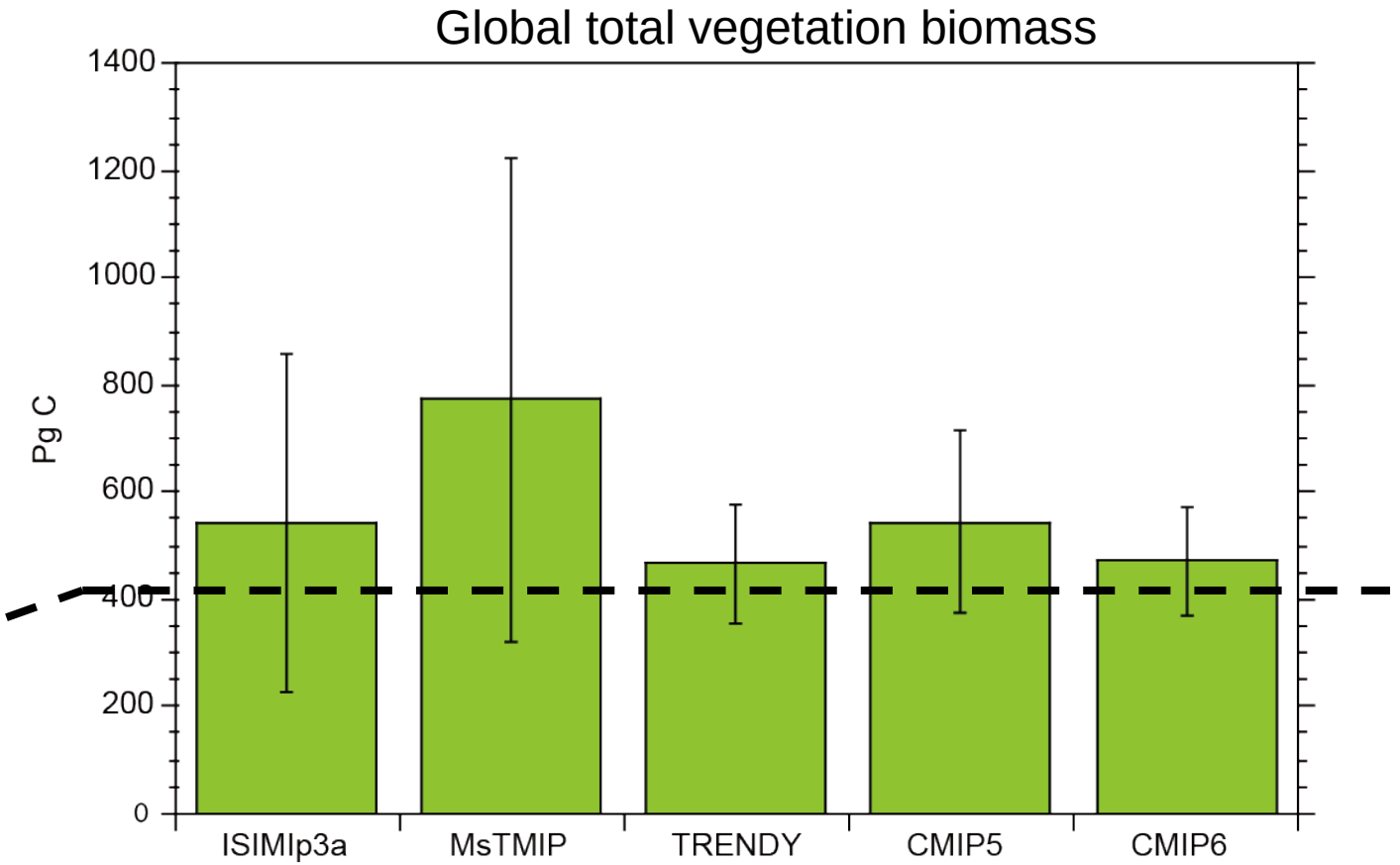
- Attribution: factorial experiments (fixed CO_2, fixed climate, fixed social factors, no fire) by VISIT



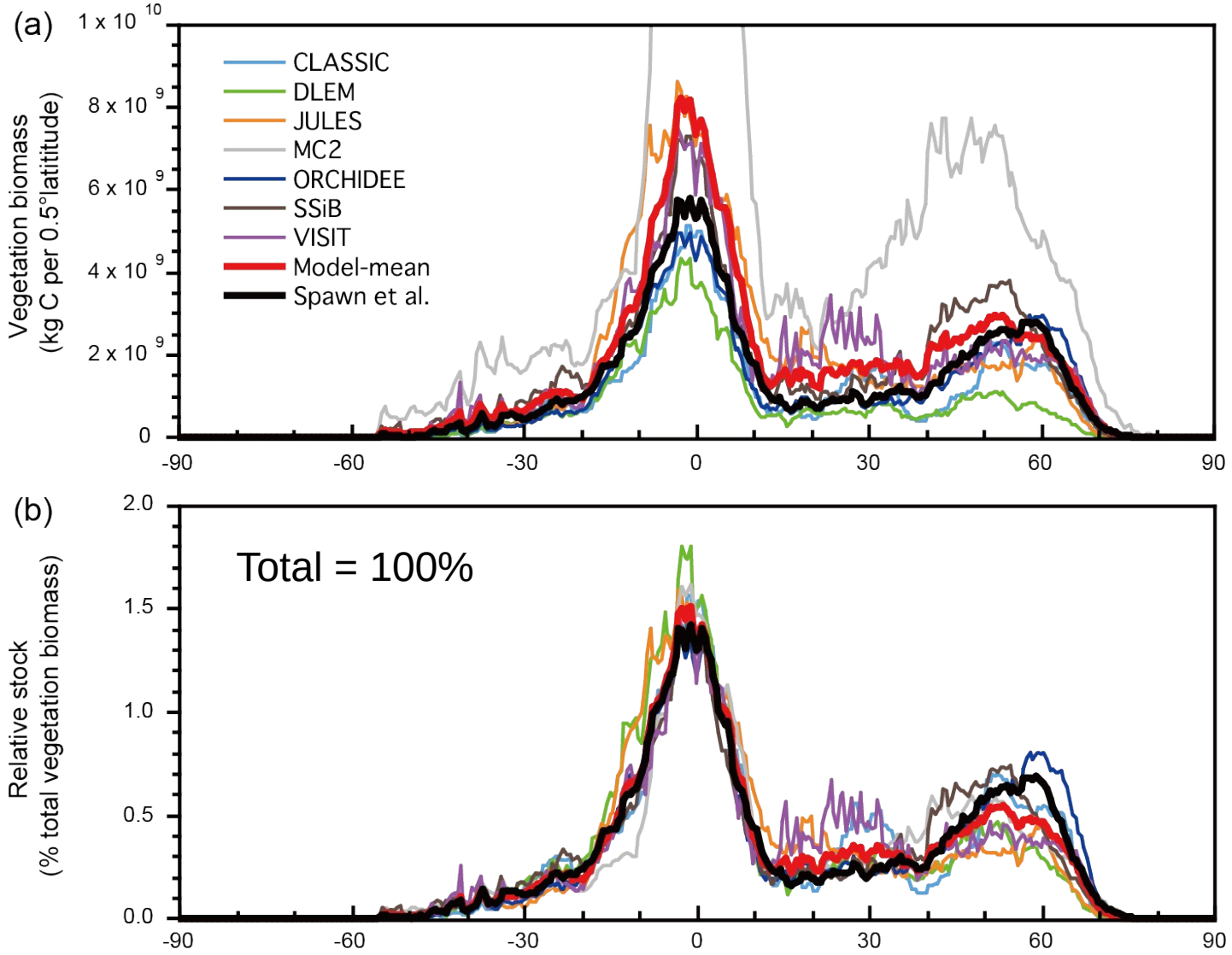
Result: benchmarking

Model-mean ± SD: 544.5 ± 340.7



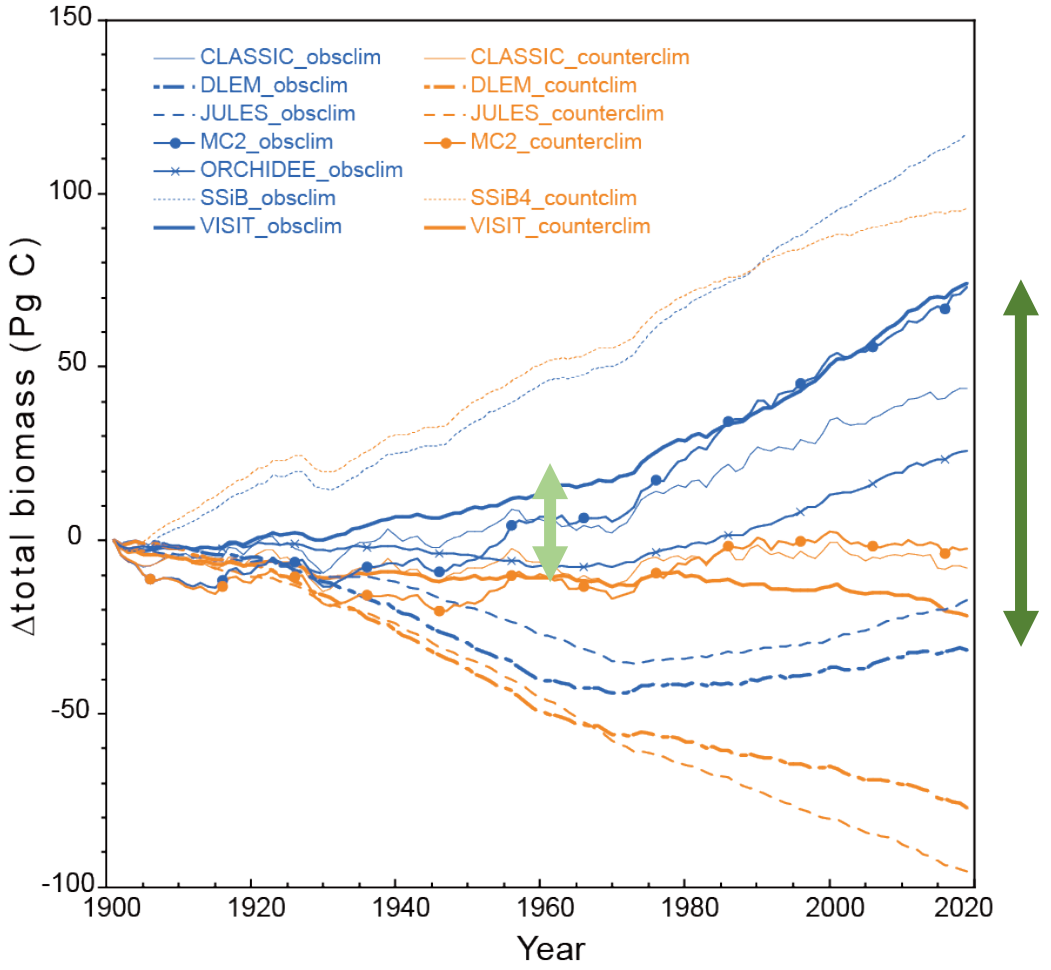


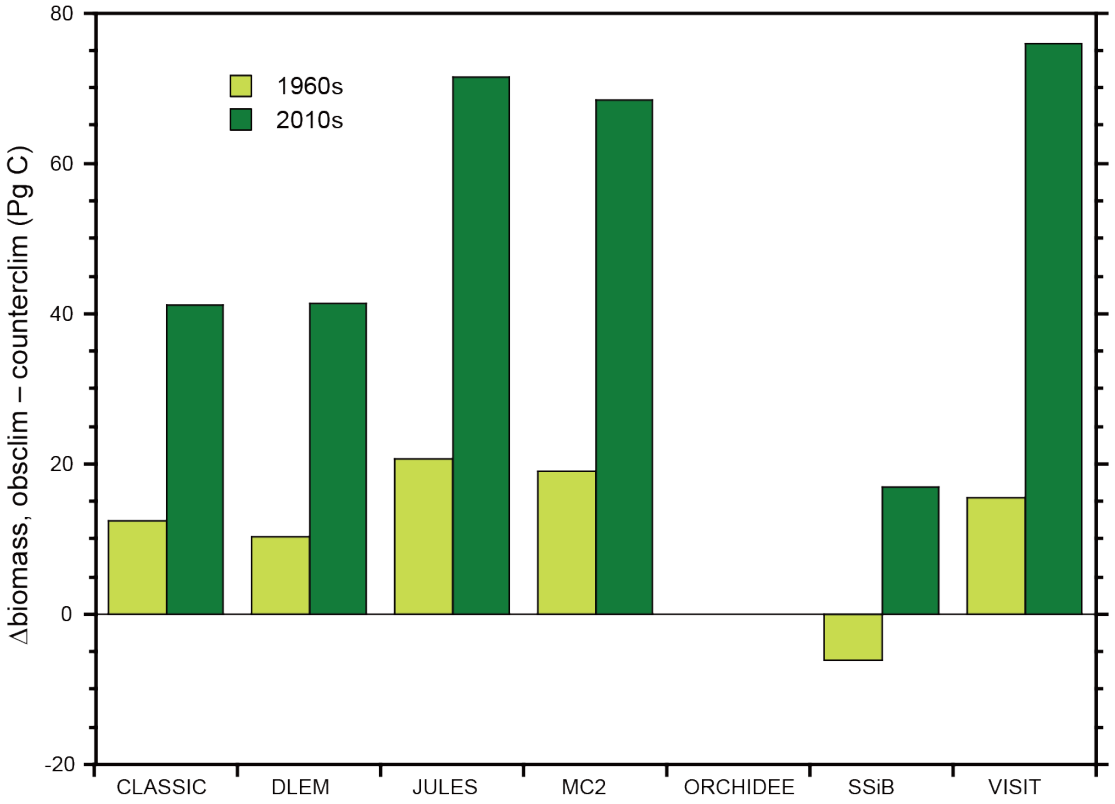
Result: benchmarking



Result: historical change

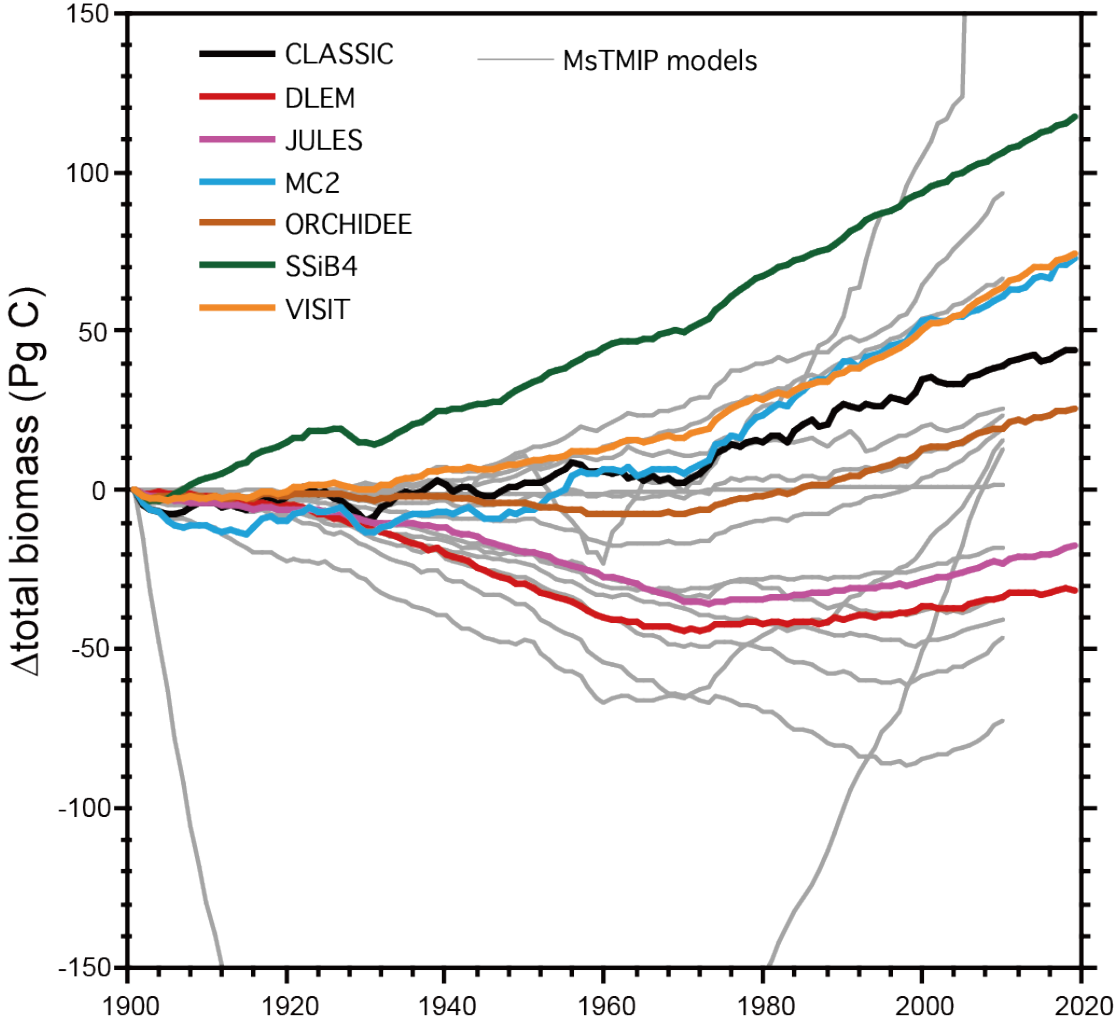
CT: Factual (obsclim) vs. Counterfactual (counterclim)

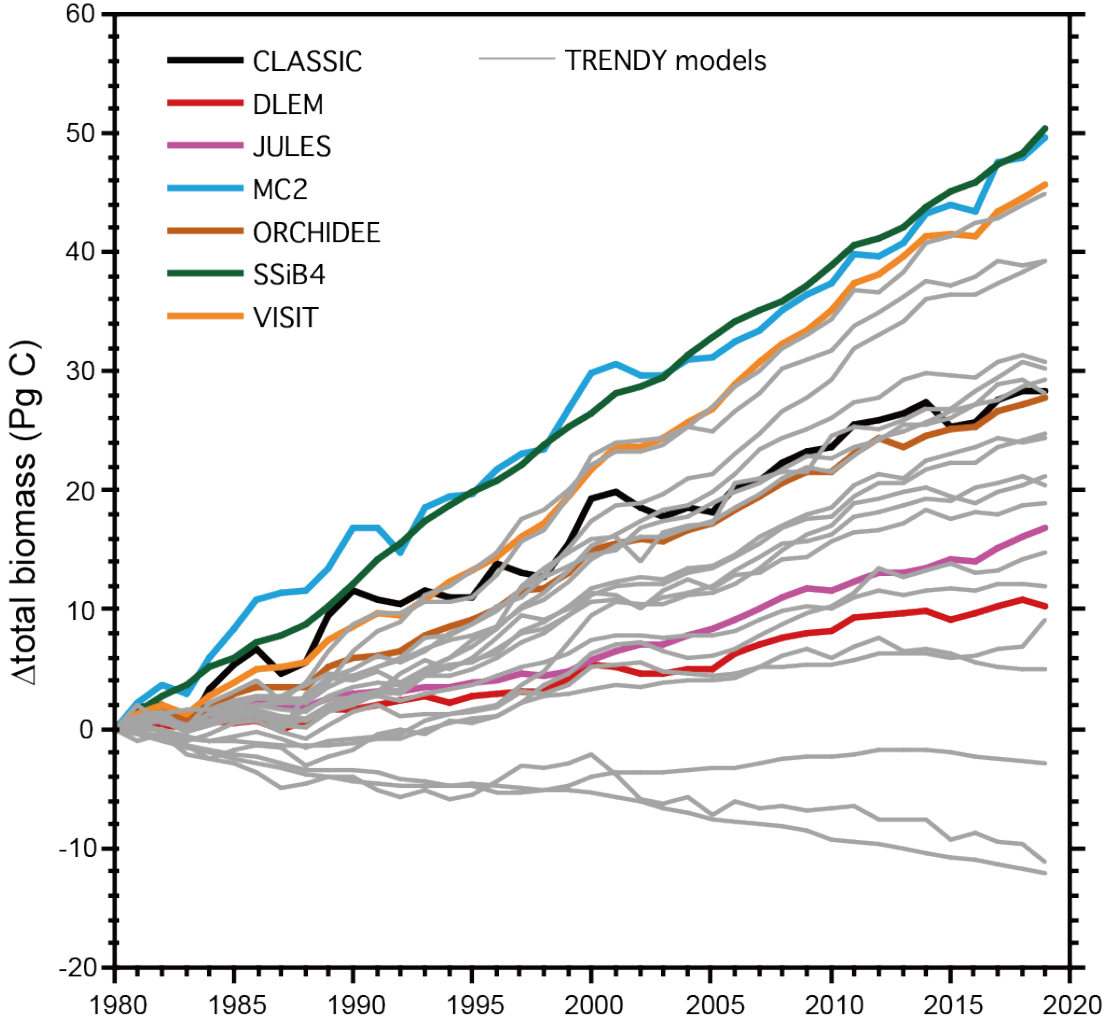




Result: historical change

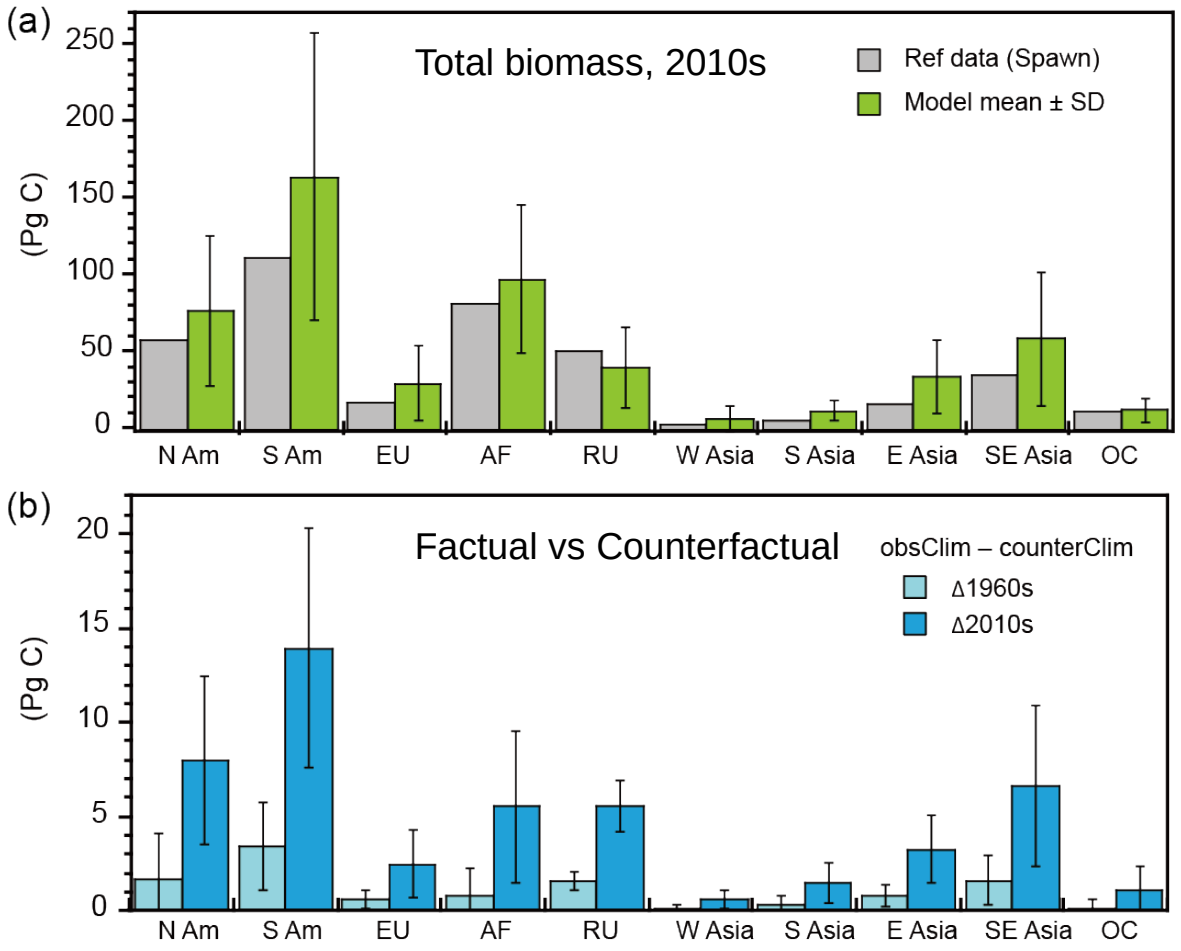
ISIMIP3a: factual (obsclim) simulations
MsTMIP: BG1 or SG3, TRENDY: S3



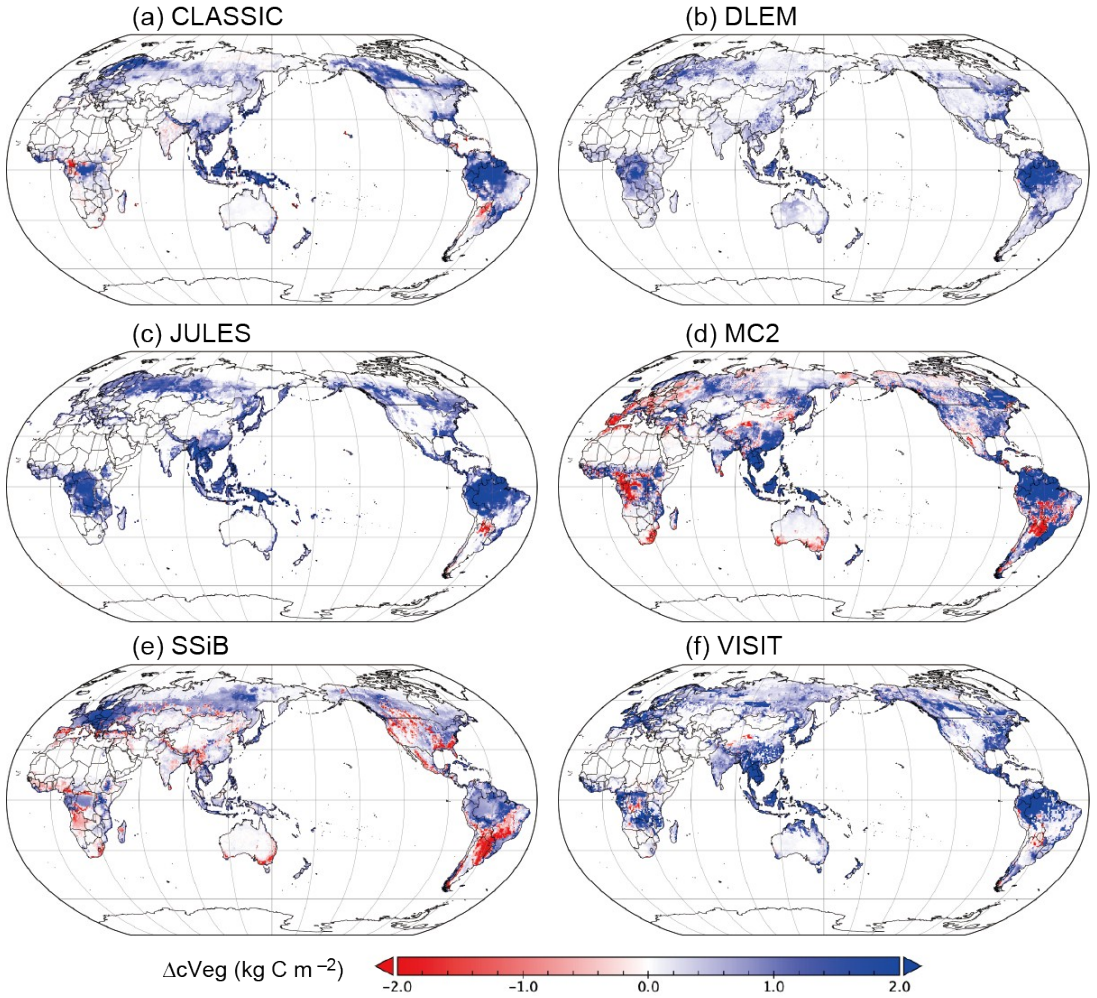


Result: spatial patterns

Regional patterns

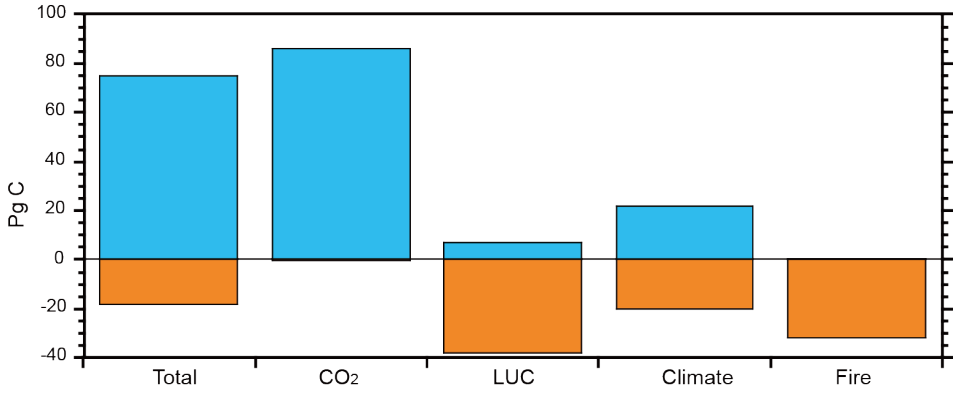


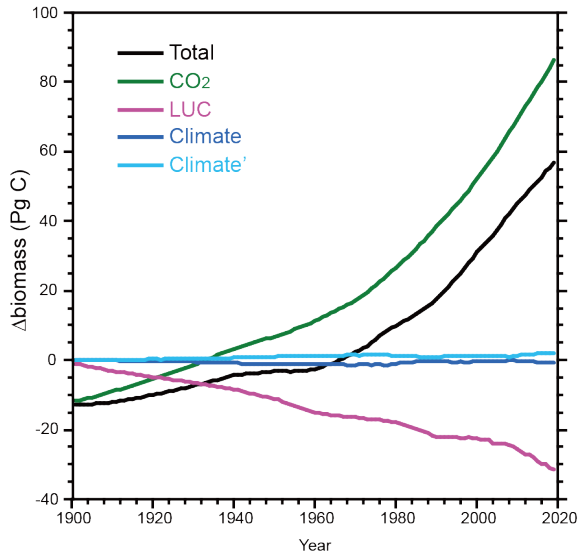
obsclim – counterclim, 2010s

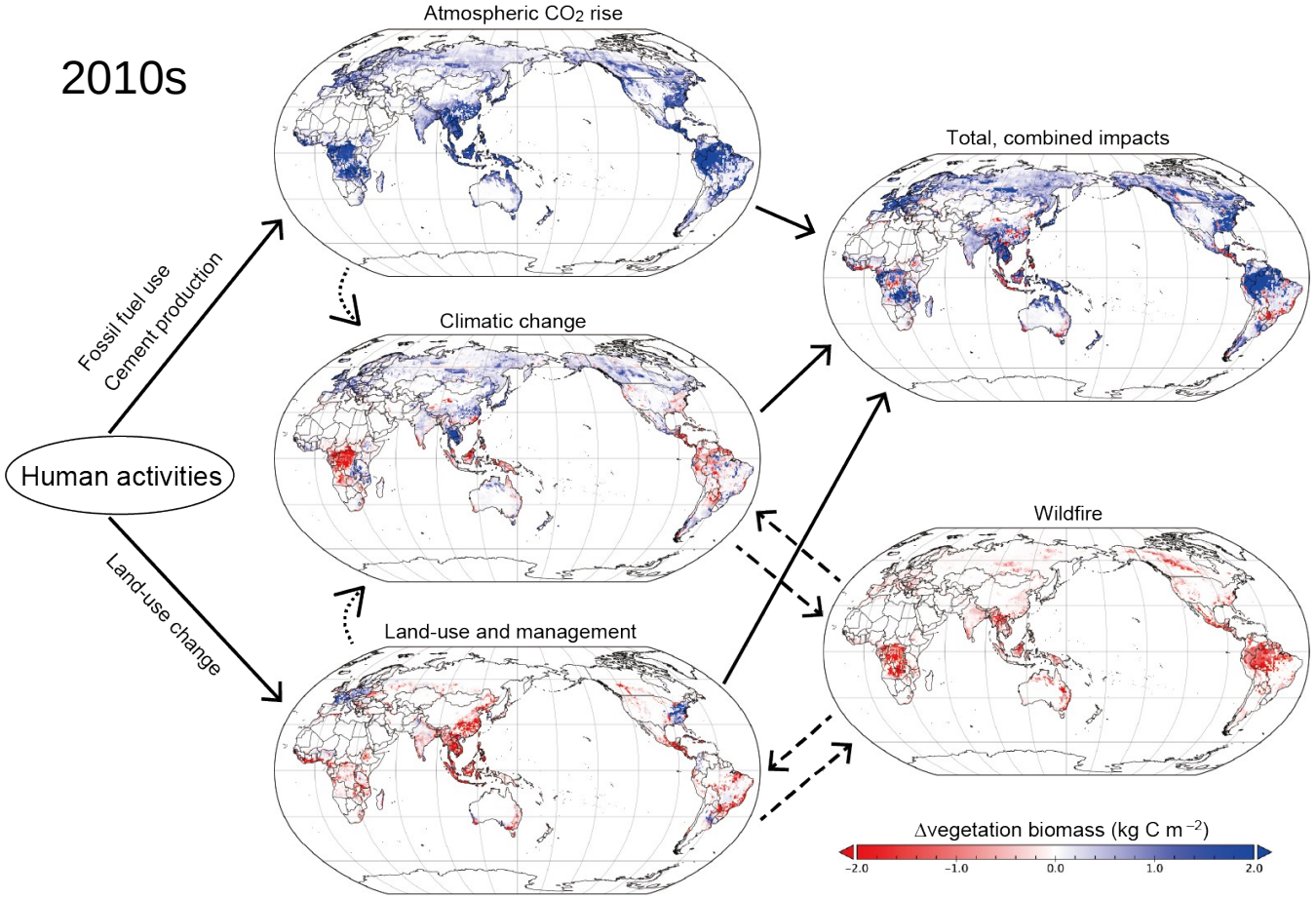


Result: attribution

Historical changes in vegetation biomass was likely to be driven by elevated CO_2 and offset to some extent by land-use change. The impact of climate change looks small at global scale, but looking regionally, we found substantial climatic impacts both positive and negative directions.







Concluding remarks

Benchmarking showed that contemporary ISIMIP3a biome models captured the present global pattern of vegetation biomass, although they differ in total stock.

Historical change in vegetation biomass (0.84 ± 0.41 Pg C yr^{-1}, 1980–2019) is consistent with the net terrestrial carbon sink implied by atmospheric observations and inversions (e.g., GCP C Budget).

Attribution showed, globally, the vegetation biomass change was attributable mainly to elevated CO_2 and land-use and little to climatic change. Regionally, climatic change decreased biomass in tropical forests and increased in temperate to boreal forests.