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Fires in JULES & Global Carbon Budget

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JULES ASM - 5/9/24

GLOBAL CARBON BUDGET

esa

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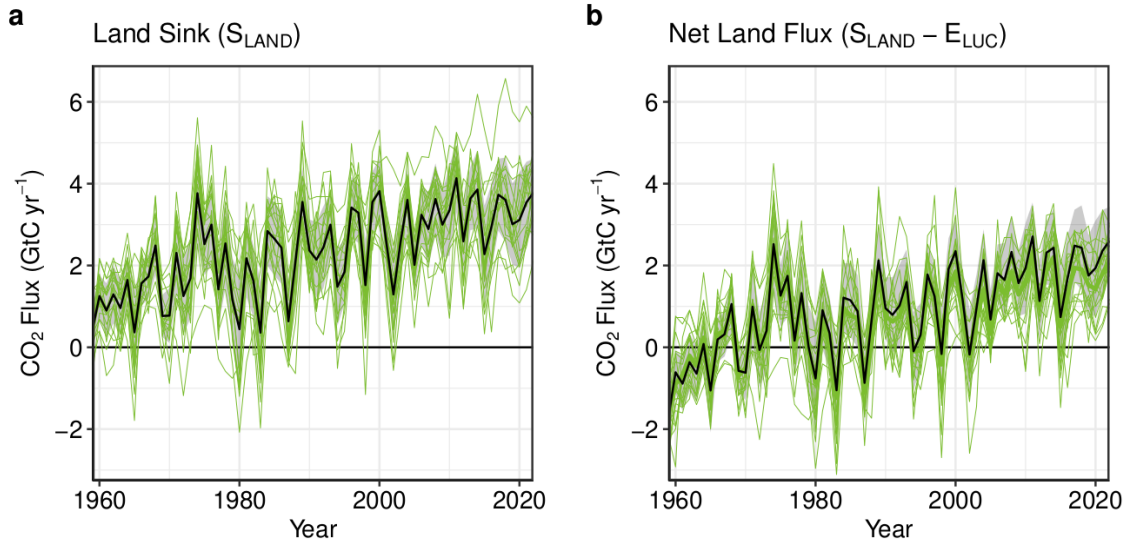
Global Carbon Budget

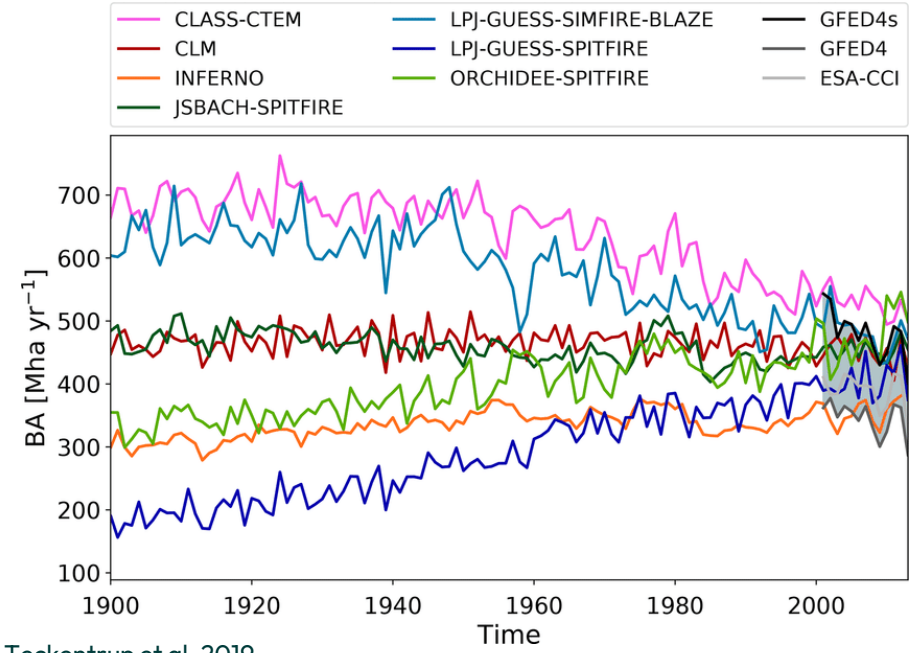


~20 DGVMs estimate the ‘natural’ and ‘net’ land sinks.

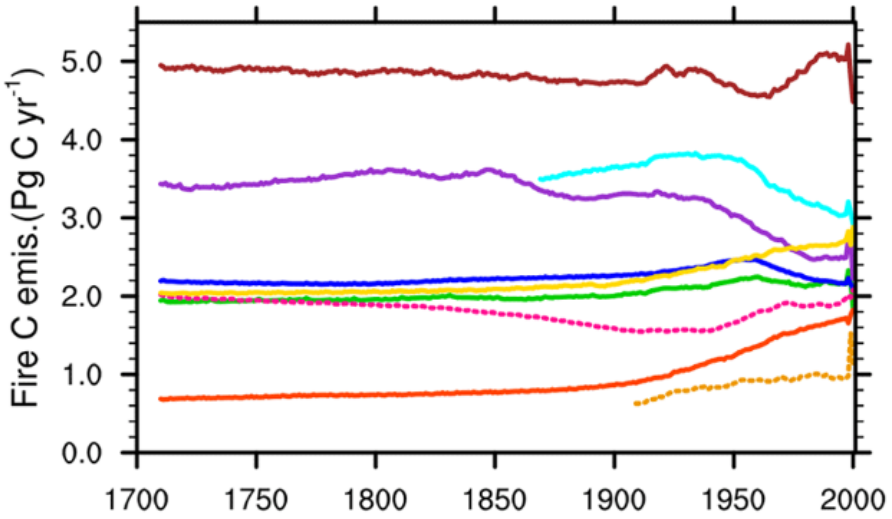
Models capture global scale dynamics

Friedlingstein et al. 2023

DGVM fire disturbance (FireMIP)



Teckentrup et al. 2019

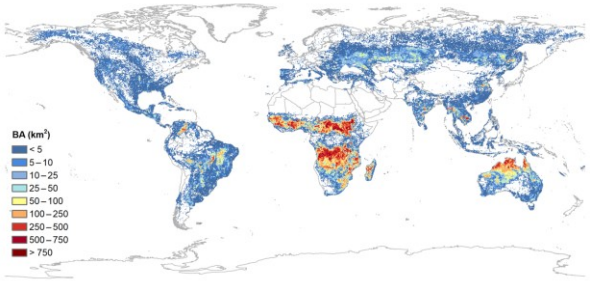


Li et al. 2019

Large range in estimate burned area (**300-600 Mha/yr**) and fire emissions (**1.5-5 PgC/yr**).

Satellite products

GFED



Burned area

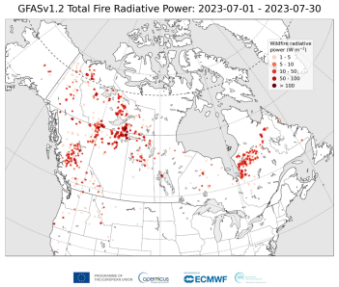
X

Emission factor

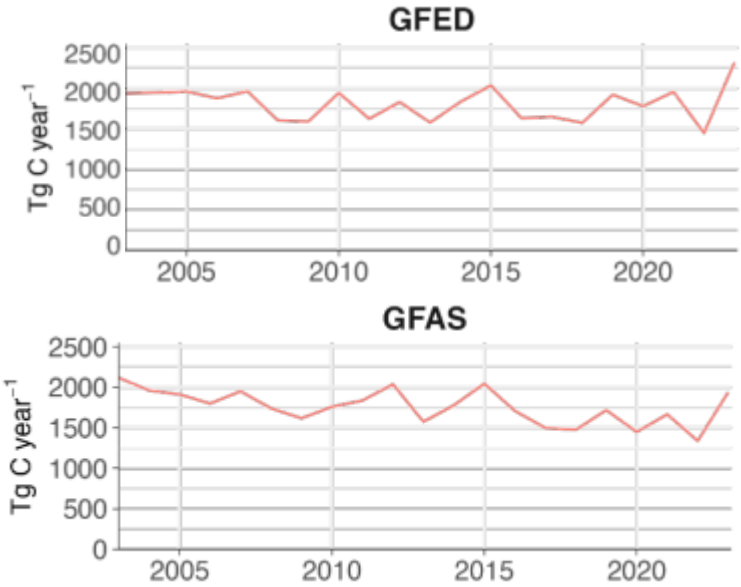
X

Carbon stock

GFAS



Fire Radiative Power



- Both agree on **~2 PgC/yr** emissions
- However, these products do not simulate full C cycle… so we don't know what the full impacts of fire on ecosystems are.
  - This is key for Global Carbon Budget, NGHGI reporting, etc…

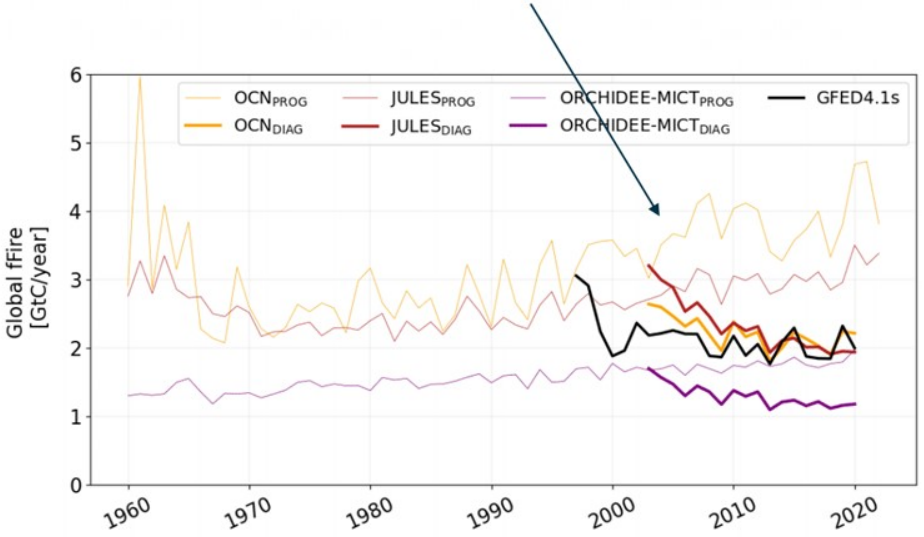
Prescribing fire in JULES

- Project funded by the European Space Agency
- **FireCCI51** burned area. 2002-2020, 250m -> 0.25°
- Idea: Compare JULES-INFERNO with JULES-CCI
  - No code changes - just turn INFERNO off and prescribe burned area.

- Spin-up carbon cycle to 1960 conditions (ERA5-Land), run with INFERNO on ("prognostic"), run to 2020.
- Second simulation where we branch from the "prognostic" simulation in 2002 and prescribe the burned area (**g_burn_pft**). Varies each month.

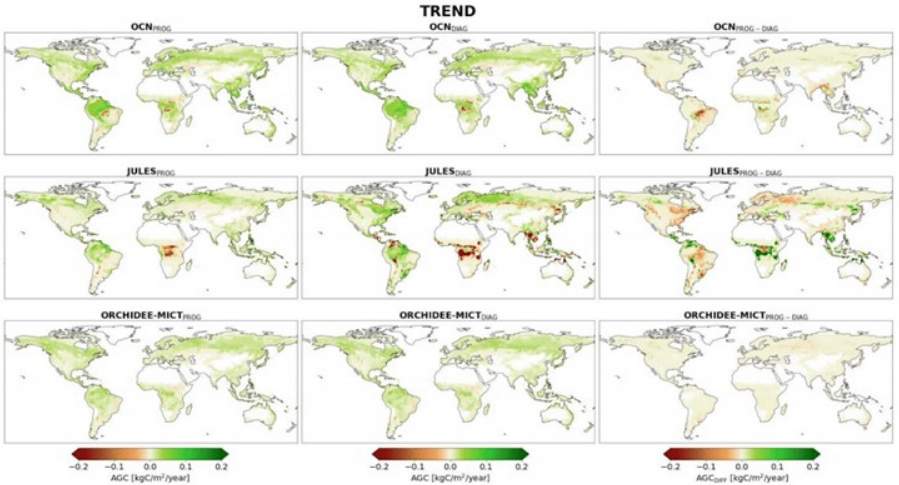
Improving fire emissions from DGVMs with EO

Many DGVMs simulate burned area and their trends quite poorly.



Source: Ana Bastos (pers. comm.)

Improved agreement in fire emissions in magnitude, spatial distribution, IAV and trends, but also other variables, e.g. biomass

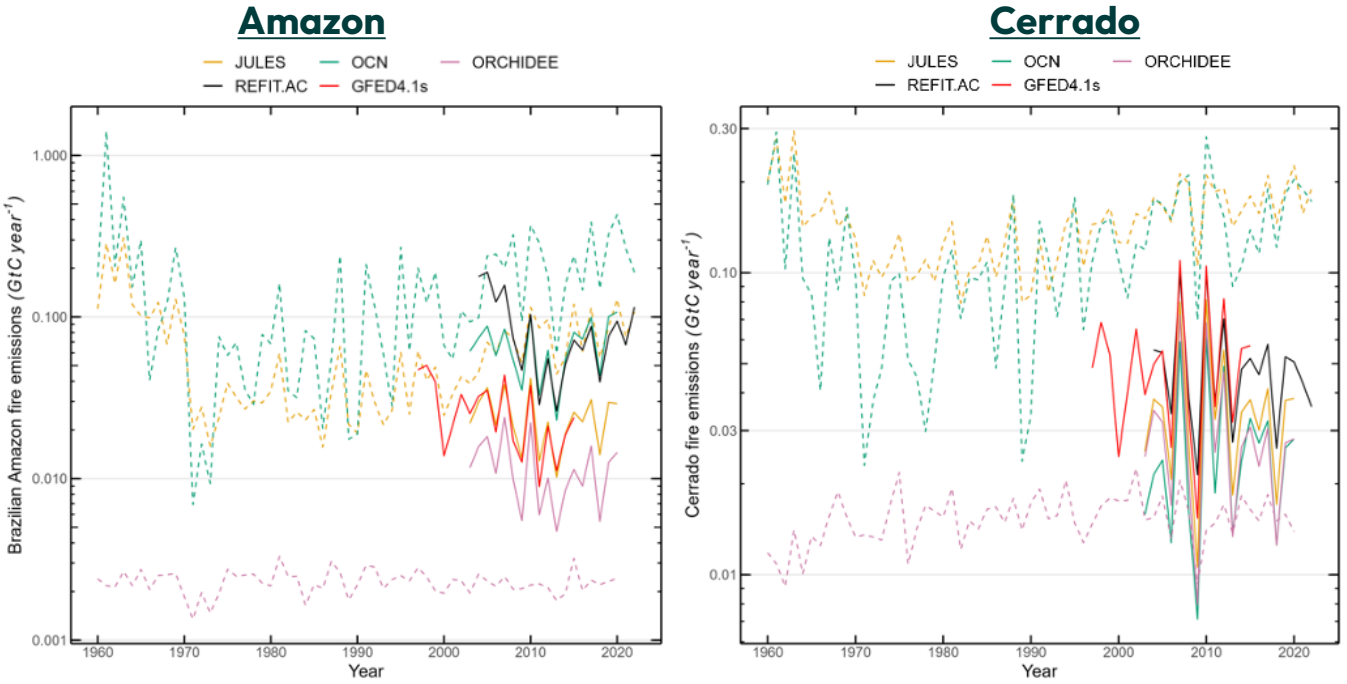


We prescribe burned area from Fire CCI in DGVM simulations to assess the impact on C budgets & other variables

fire cci

Ermitão et al. in prep

Brazil fire C emissions



- Improvement in both Amazon and Cerrado. Larger spread among DGVMs in Amazon (variation in biomass density)

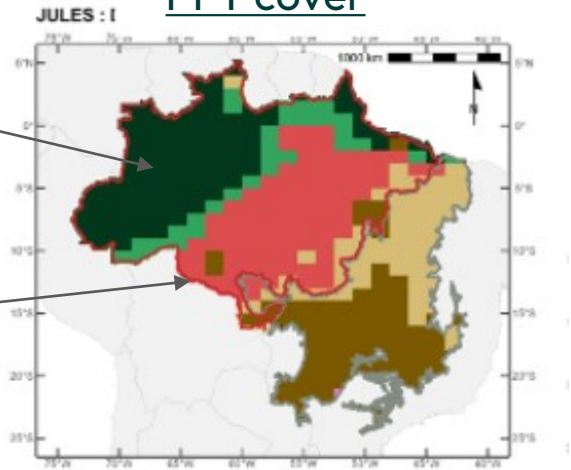
Current issues

- Fire CCI data only starts in 2001 -> We branch out of a JULES run which has INFERNO on.
- We realised after performing the simulations that INFERNO is highly sensitive to climate forcing used (now using ERA5) -> JULES PFT distribution not great -> issues with biomass, etc.

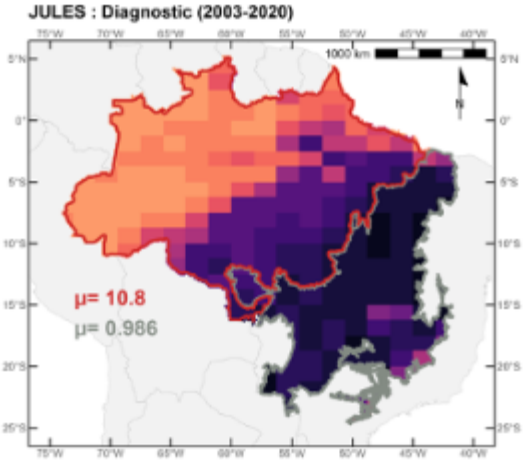
PFT cover

TREES

SHRUBS

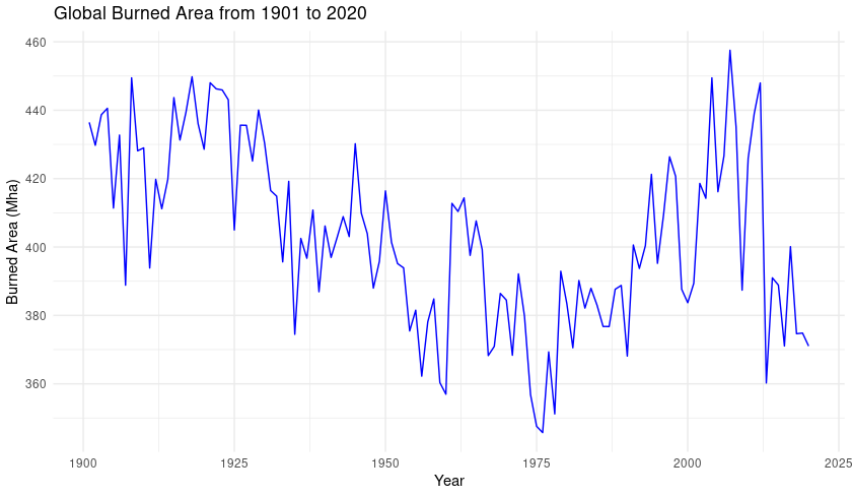


Biomass Carbon



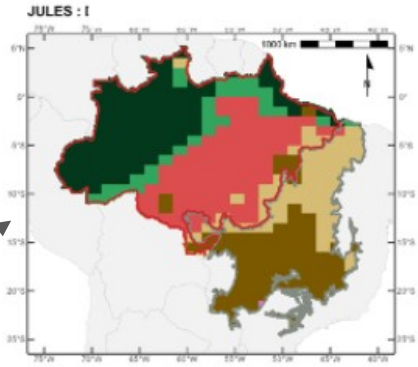
New for GCB2024

- Wei Li (Tsinghua University): ML based global burned area dataset starting in 1900.
  - Burned area = f(climate, land cover)

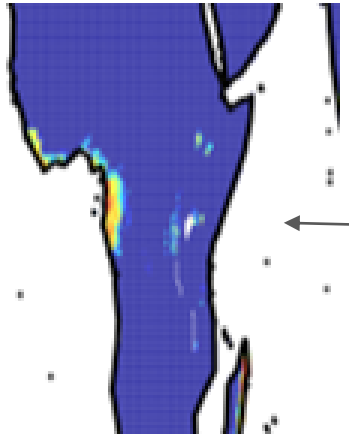


- Spin JULES using GCB protocol: "pre-industrial" conditions
  - ~1900 climate **& prescribed fires**,
  - 1700 crops/pastures
- **Aim: Improved fire in spin up -> correct land cover & biomass**

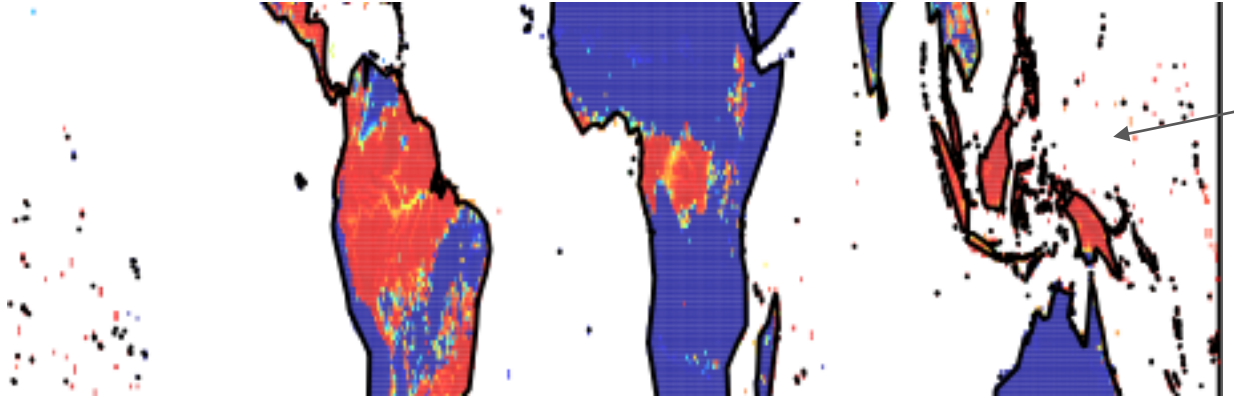
Impact on broadleaf cover



ERA5 spin up



GCB spin up (**CRUJRA**)



New “Prescribed fire” spin up

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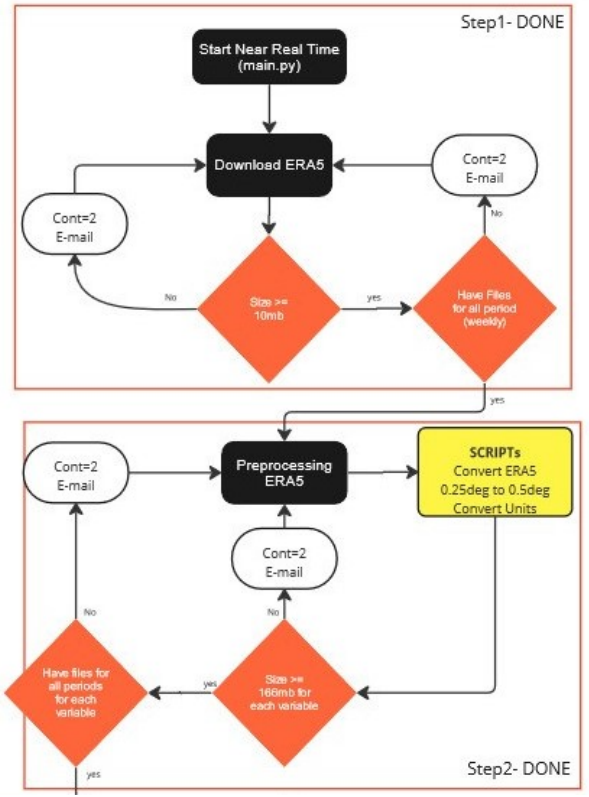
Next steps: Near real time (NRT) Fires

- GCB provides annual updates with a latency of 1 year. I.e. GCB2024 will provide data up to end of 2023.
- E.g. Canadian wildfires in summer 2023 - We can only report on these in December 2024 (when GCB2024 is released)
- GCB is policy facing - i.e. we attend COP, contribute to IPCC task force on NGHGIs. Would be great to provide faster updates, constrained with more EO data.
- Also, public comms and wider impact if we can comment on carbon impacts of extreme events as they occur.

Current NRT setup

- We currently have a JULES NRT pipeline - lag of 1-2 months. ERA5-Land Climate.
  - Jefferson Goncalves De Souza (Exeter Uni) leading this work.
- This setup uses INFERNO.



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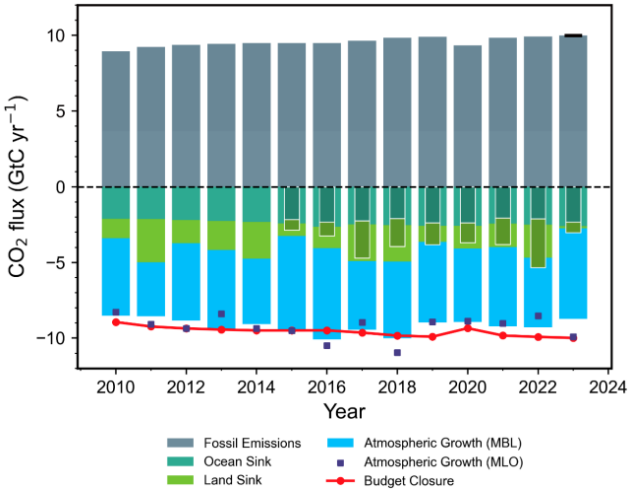
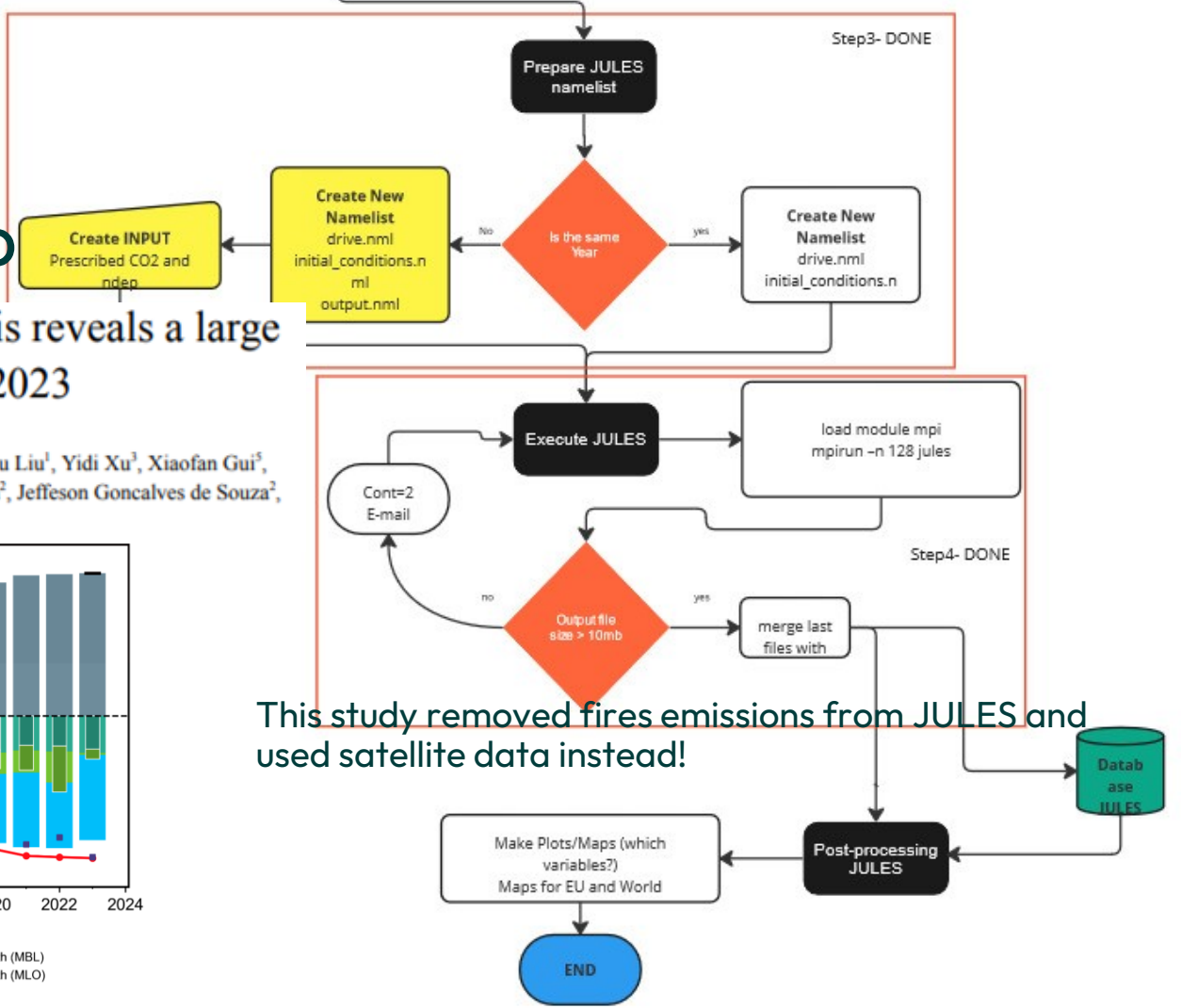
Current NRT setup

Low latency carbon budget analysis reveals a large decline of the land carbon sink in 2023

Piyu Ke[1,2], Philippe Ciais[3,*], Stephen Sitch[2], Wei Li[1], Ana Bastos[4], Zhu Liu[1], Yidi Xu[3], Xiaofan Gui[5], Jiang Bian[5], Daniel S. Goll[3], Yi Xi[3], Wanjing Li[1], Michael O'Sullivan[2], Jeffeson Goncalves de Souza[2], Pierre Friedlingstein[2], Frédéric Chevallier[3]





This study removed fires emissions from JULES and used satellite data instead!

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JULES-NRT-Fires

- Extend the NRT system with EO fires.
- We now have JULES runs up to June 2024 with prescribed fires from MODIS.

Summary

- Issues:
  - DGVM disturbances generally not captured well
  - GCB high latency (> 1 year)
- Fixes:
  - Prescribe fires from satellites
  - “Operationalised” JULES providing NRT C cycle data