TRENDY like historical simulations of JULES-RED with Land Use Change

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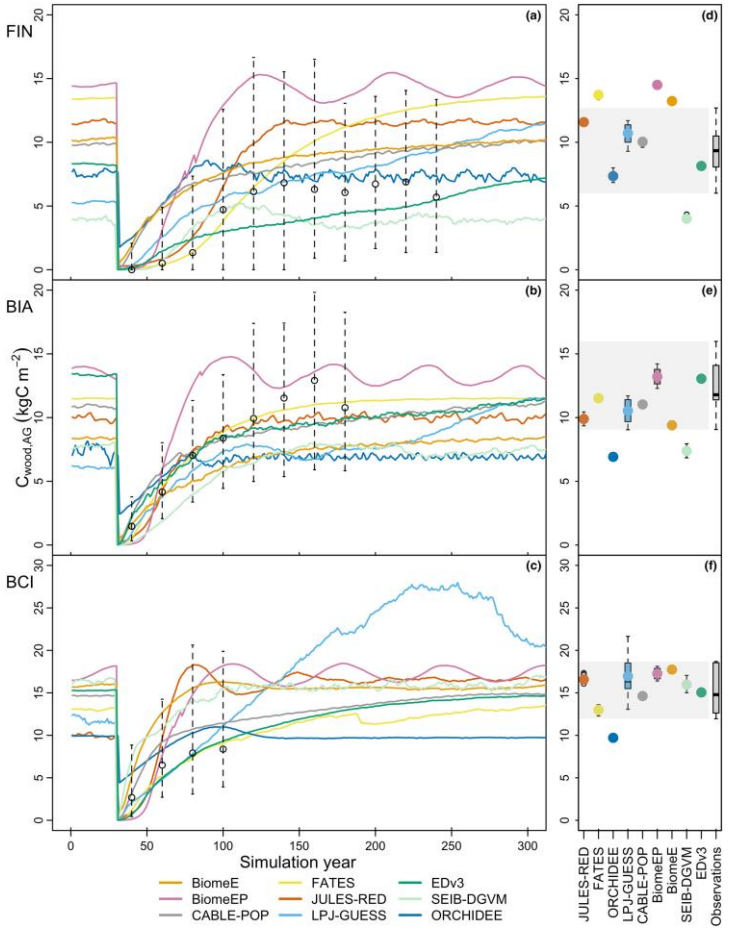
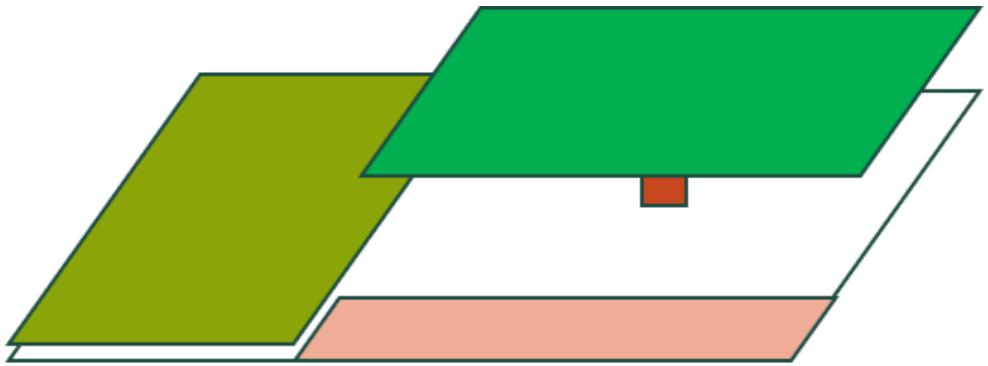
What are demographic vegetation models?

- Classic vegetation dynamics simulates ecology using very simple methods (e.g., a single averaged tree within a gridcell).
- Demographic DGVMs introduce size-structure dynamics(e.g., many plant sizes represented) and represent a compromise between simplicity and realism for large scale.
- They are increasingly being adopted, they are the future of ecological modelling in both LSMs and ESMs.



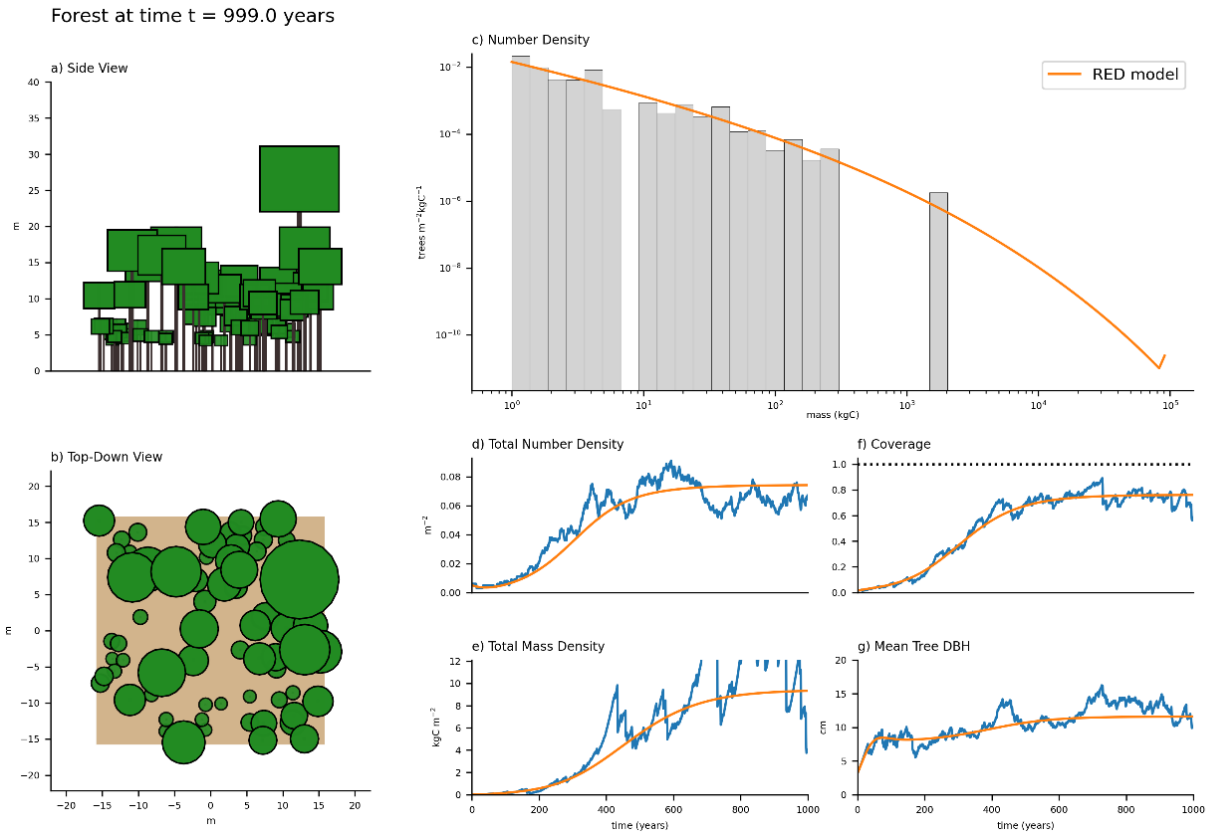
Eckes-Shephard, A.H., et al., 2025

A “Visualisation”



100+ Kilometres

A “JULES-TRIFFID” like model.



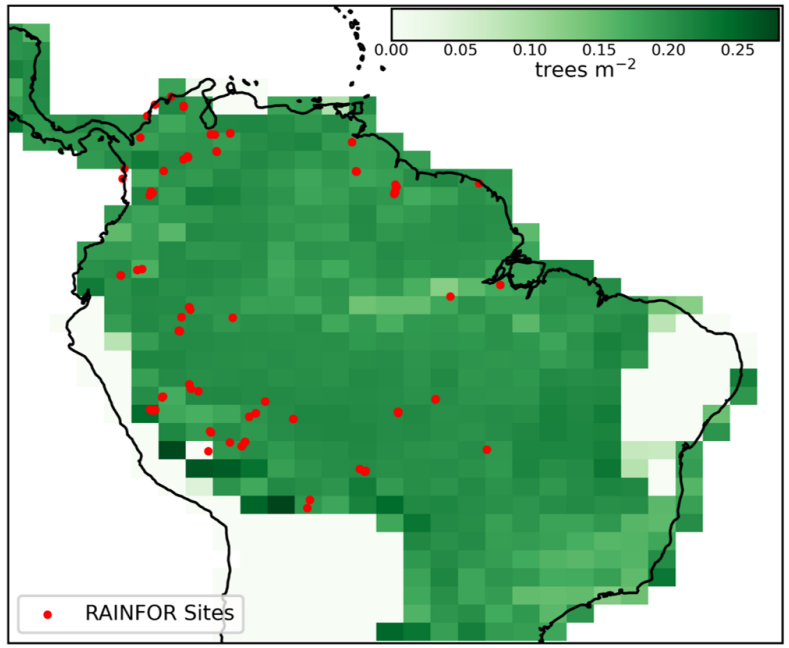
An implementation of RED in Python

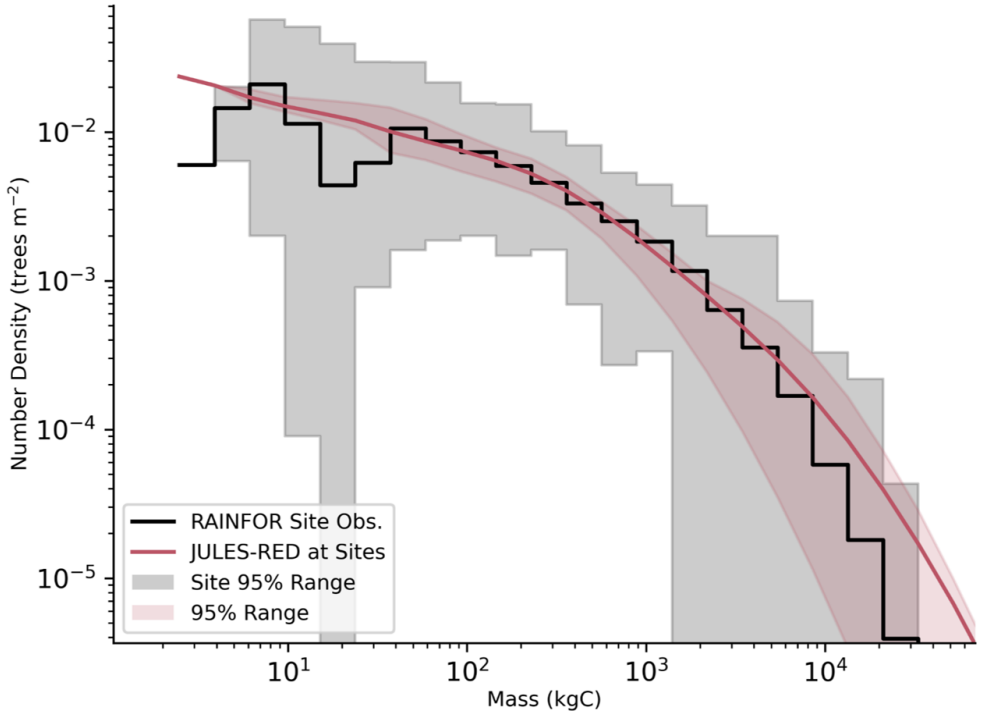
JULES-RED in a TRENDY like set-up

- We have a rose suite that u-dr976 along with a “all* inclusive” version of JULES-RED: r26886_vn7.3_test_add_red_sci_trendy, a global simulation of the historical carbon cycle from the year 1700 to the present day.
- Uses CRU-JRA driving data (1901 - present day at 0.5°) for JULES. With pre-1900 climatology, including spin-up, simulated by cycling through 1901-1920 data (Sitch et al., 2024).
- Historical land use & land use change (LULUC) is represented from the HYDE3.3 data, which has been converted into transitions maps.
- For both TRIFFID and RED, standard TRENDY experiments currently represented: “S2” (Fixed 1700 LU) and “S3” (With LUC forcing).
- Something in the works is “S3_gluc” or “Gross LUC”.

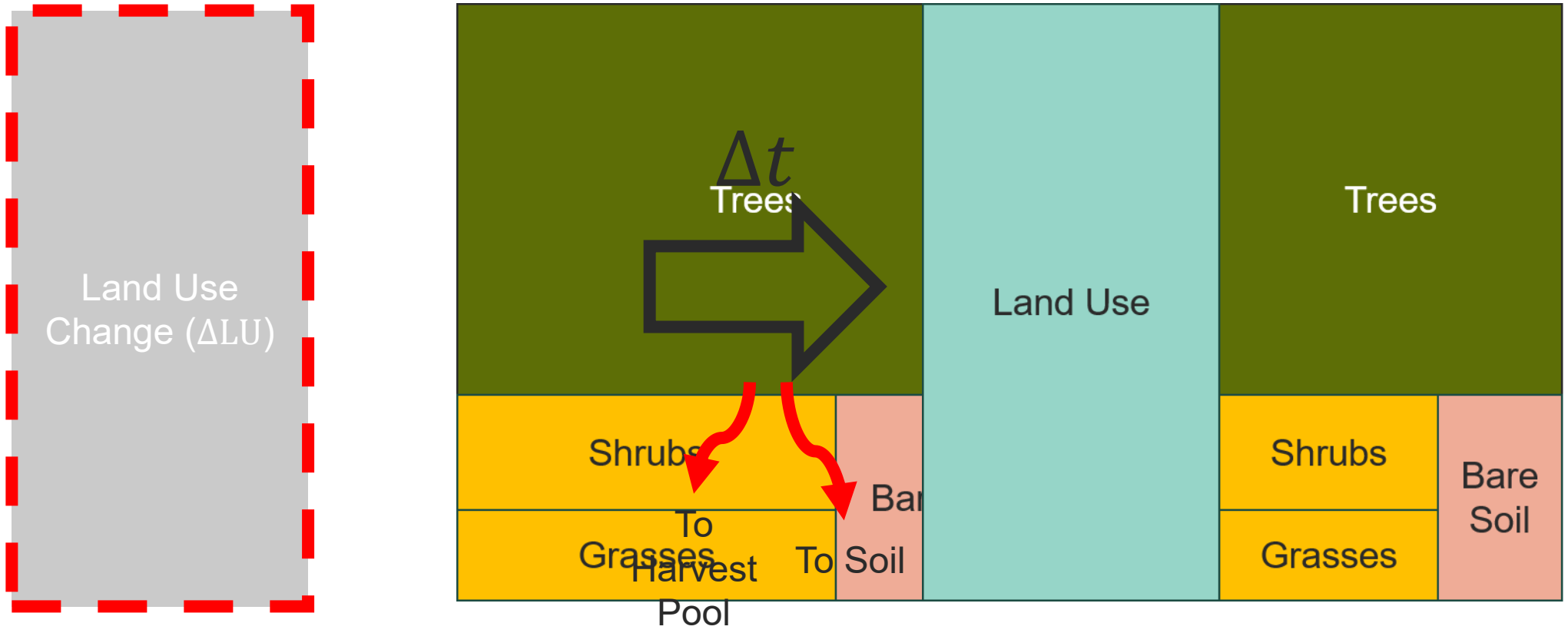
***Not inclusive of the nitrogen & phosphorus cycle, wildfire and other science areas which may already be represented in veg2/TRIFFID, see the GitHub JULES-RED project for more info.**

Some older results – after a 400-year spin-up

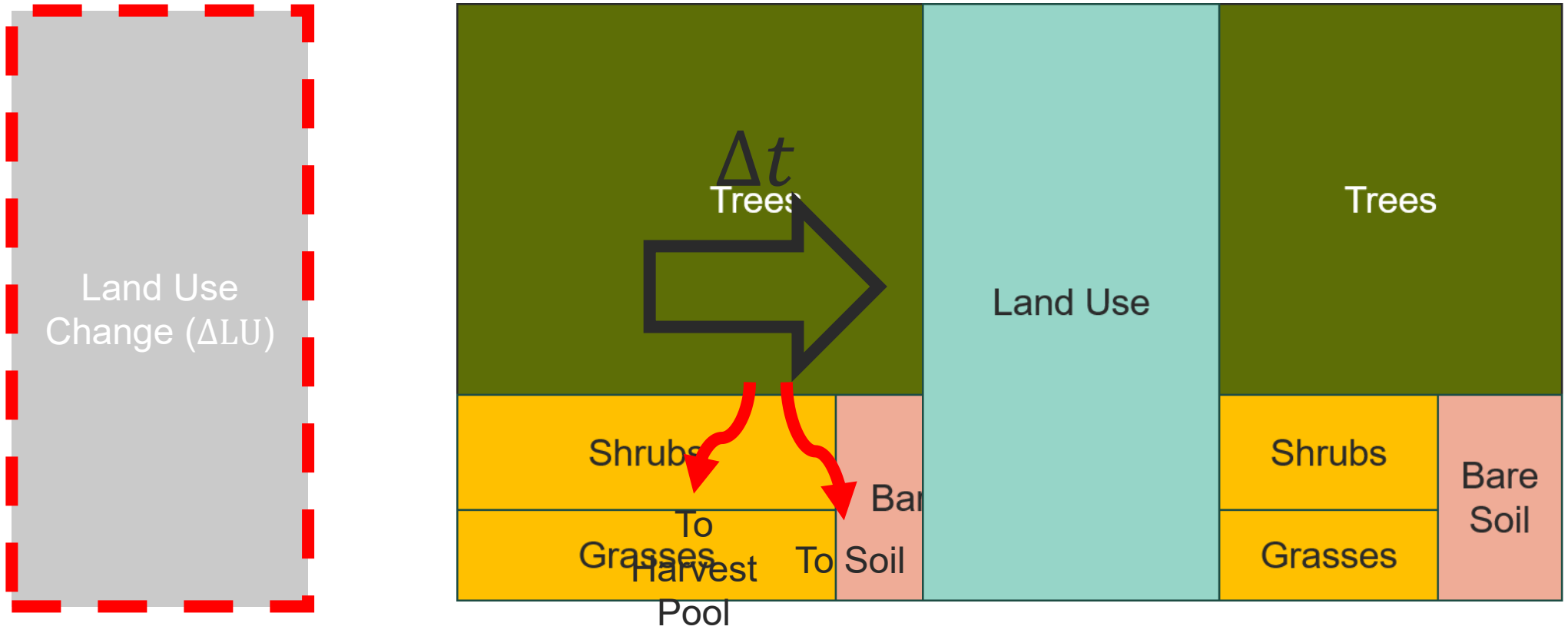




Net Land Use Change (Deforestation)



Net Land Use Change (Deforestation)



Removal Mortality in JULES-RED

- In JULES-RED, we diagnose the necessary change in the mortality rate to remove natural vegetation using the timestep, Δt and a **positive net** change of land-use, $\Delta \nu_{\mathrm{LU}}|_{+}$ for the mortality rate, (uniform across mass class and PFT):

$$\gamma_{\mathrm{LUC}} = \left(\frac{1}{\sum_{i \in \mathrm{PFT}} \nu_i}\right)\left(\Delta \nu_{\mathrm{LU}}\Big|_{+} - \nu_{\mathrm{soil}}\right) \quad (1)$$

- If there is a loss in pasture fraction, but a gain in cropland (or visa-versa). We target pasture or crop fraction for removal (using equation 1), before targeting natural vegetation for any excess $\Delta \nu_{\mathrm{LU}}$.

Current C3/C4 crop and pasture

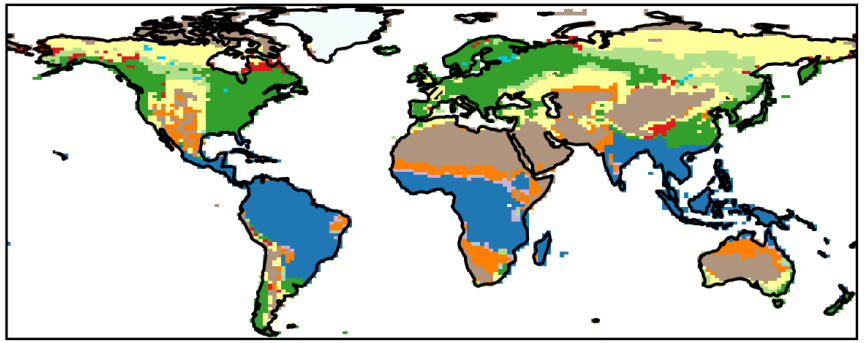
- Like TRIFFID shared PFT parameters with C3/C4 natural grass. But different dynamics.
- Pasture is assumed to not be planted but grows similar to natural grass.
- Crops are sowed based on an initial number density allocated to C3/C4 based on “suitability” (determined by C3/C4 natural fraction weighting) and the maximum size class.
- Crops growing out of the max size class are instead “harvested” and the biomass put into a harvest pool.

Results from simulation – dominant (largest frac) tile type

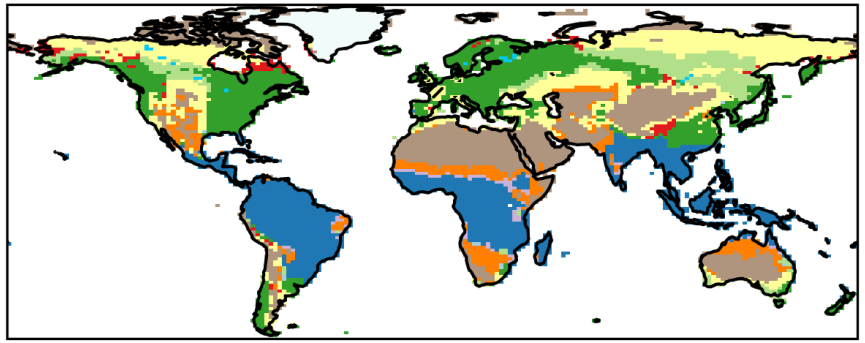
Dominant Land Surface Type - Year: 1700

a) JULES-TRIFFID

a.i) S2 Fixed 1700 Land Use

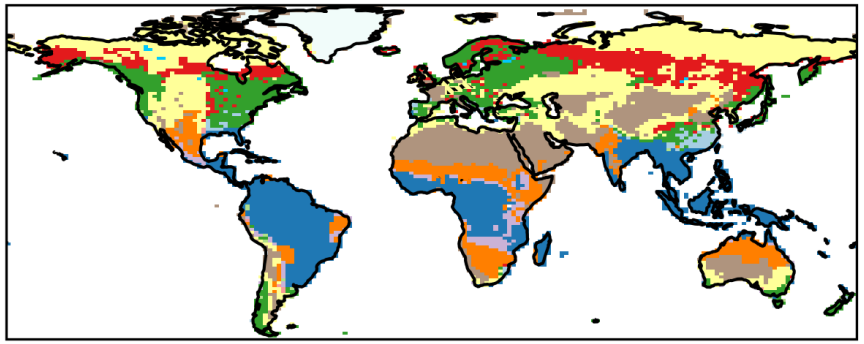


a.ii) S3 Historical Land Use Change

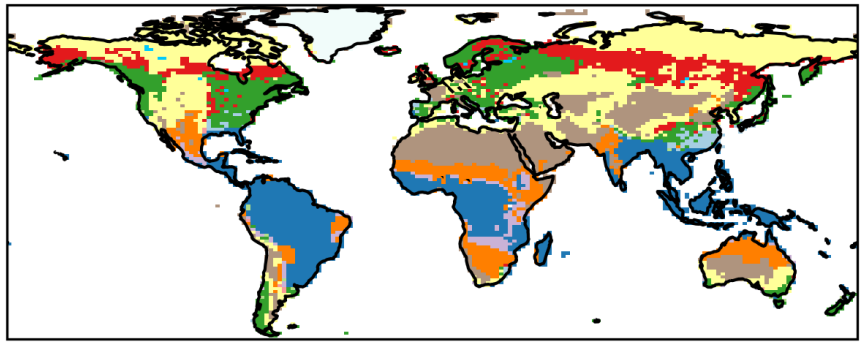


b) JULES-RED

b.i) S2 Fixed 1700 Land Use



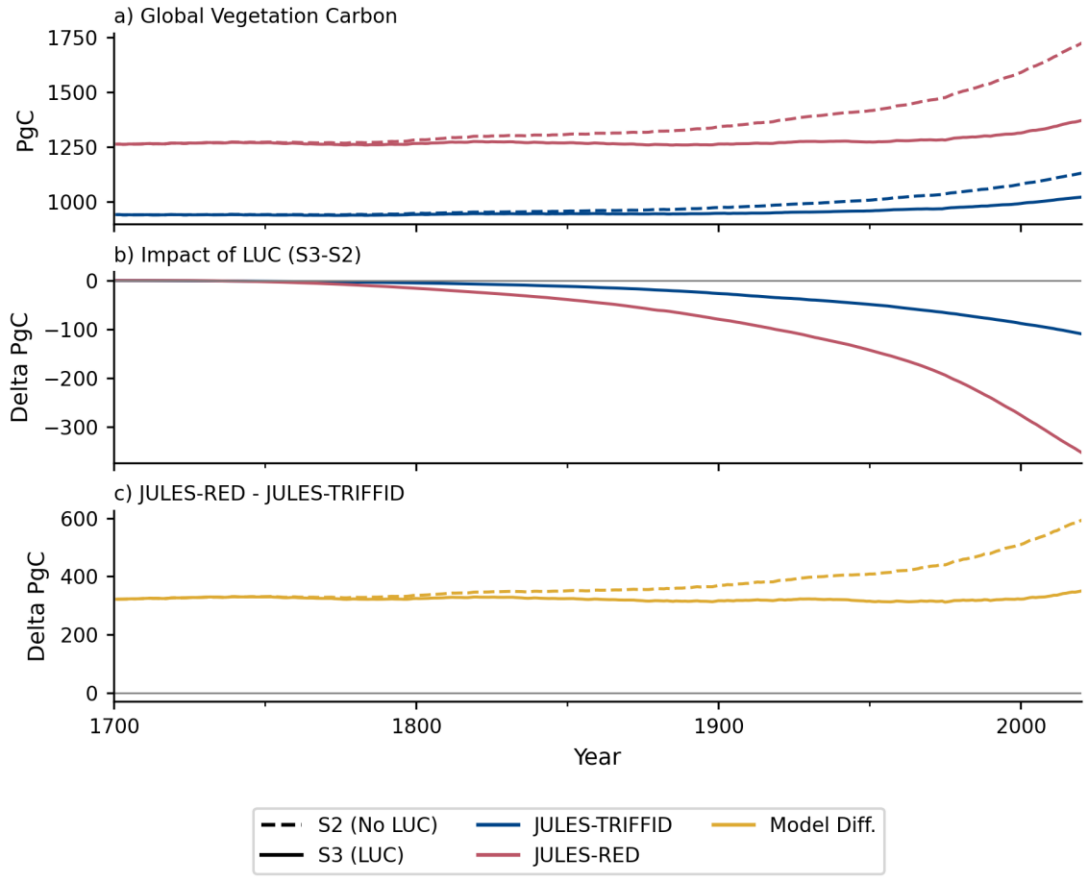
b.ii) S3 Historical Land Use Change



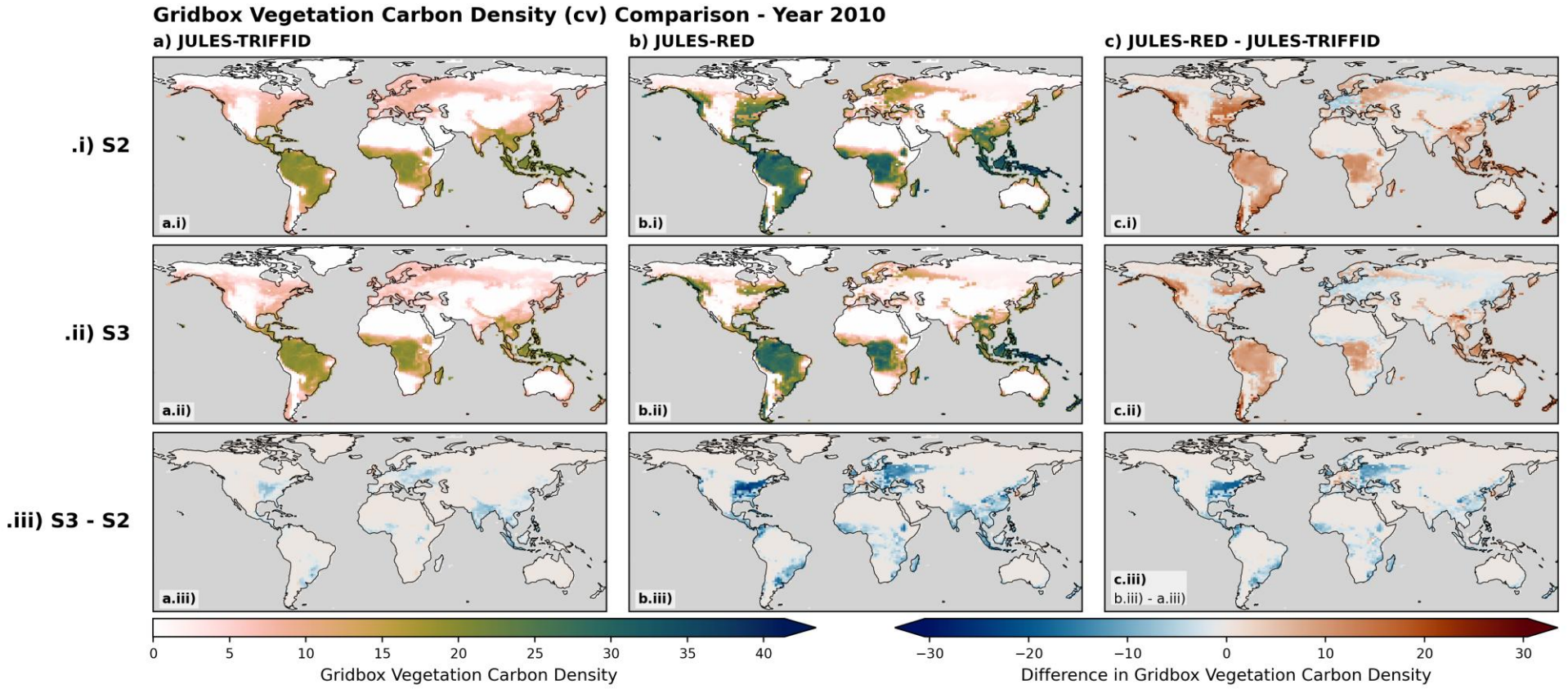
Key

- BDT
- BET-Tr
- BET-Te
- NDT
- NET
- C3G-Nat
- C3G-Crp
- C3G-Pas
- C4G-Nat
- C4G-Crp
- C4G-Pas
- DS
- ES
- Urban
- Lake
- Bare
- Ice

JULES-RED vs JULES TRIFFID Global Carbon Timeseries



Impact of Net LUC on carbon density in 2010

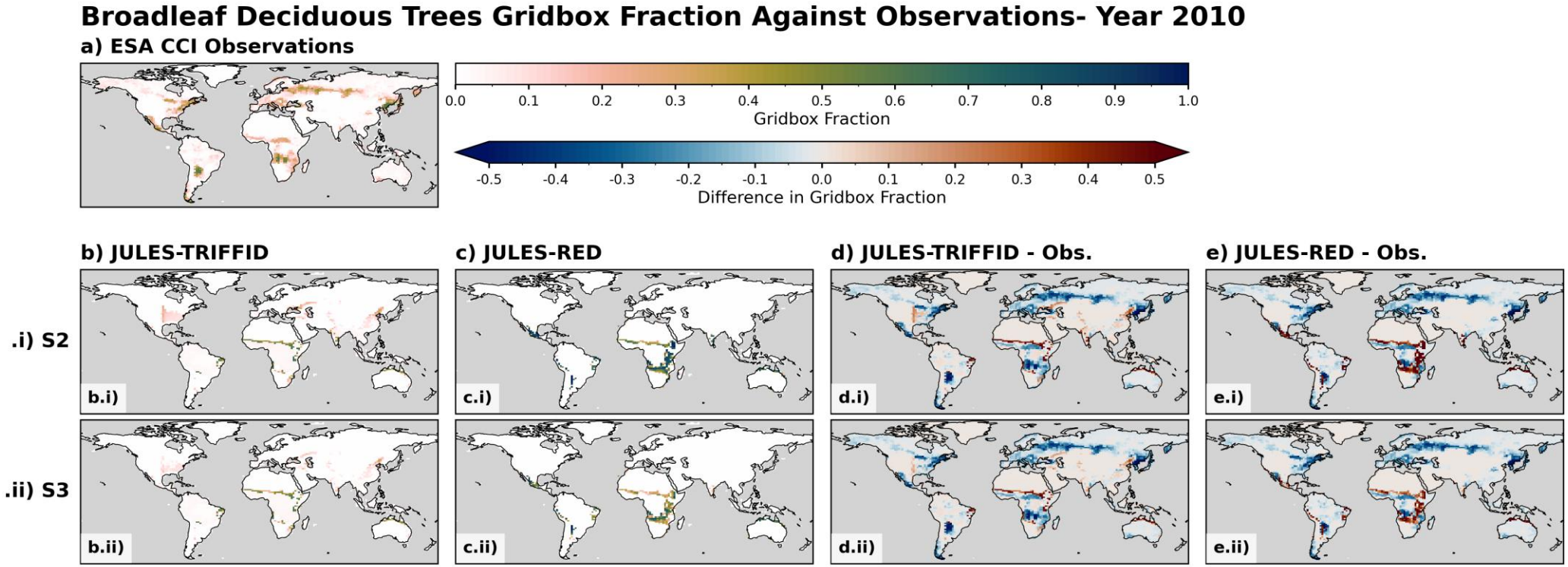


Colourmaps used here were the Batlow and ViK schemes from Crameri 2018 [8] to help with colourblind vision deficiencies [9].

Crameri, F. (2018a), Scientific colour maps. Zenodo. http:// doi.org/10.5281/zenodo.1243862

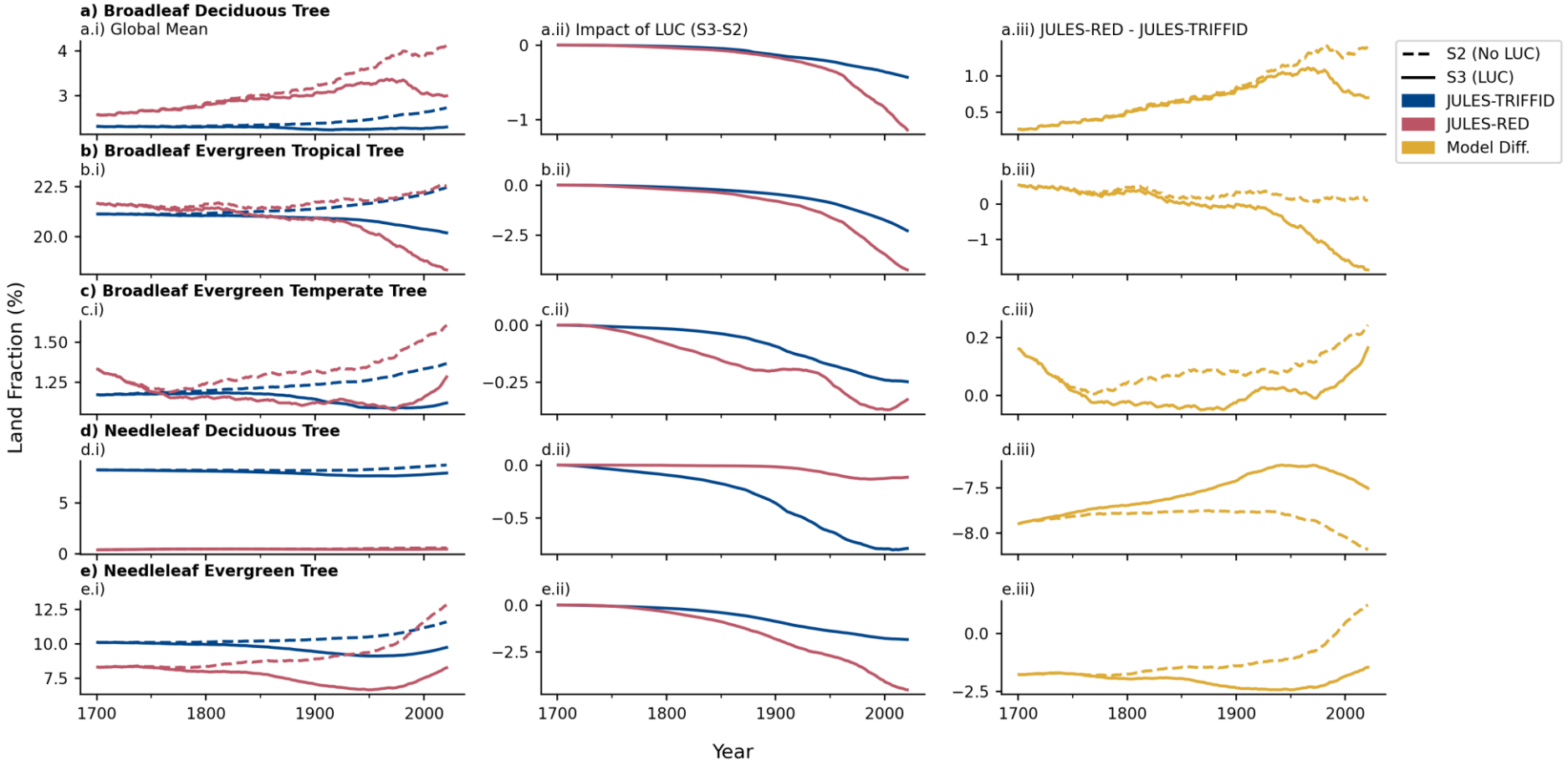
Crameri, F., G.E. Shephard, and P.J. Heron (2020), The misuse of colour in science communication, Nature Communications, 11, 5444. doi: 10.1038/s41467-020-19160-7

Compared against ESA CCI observations

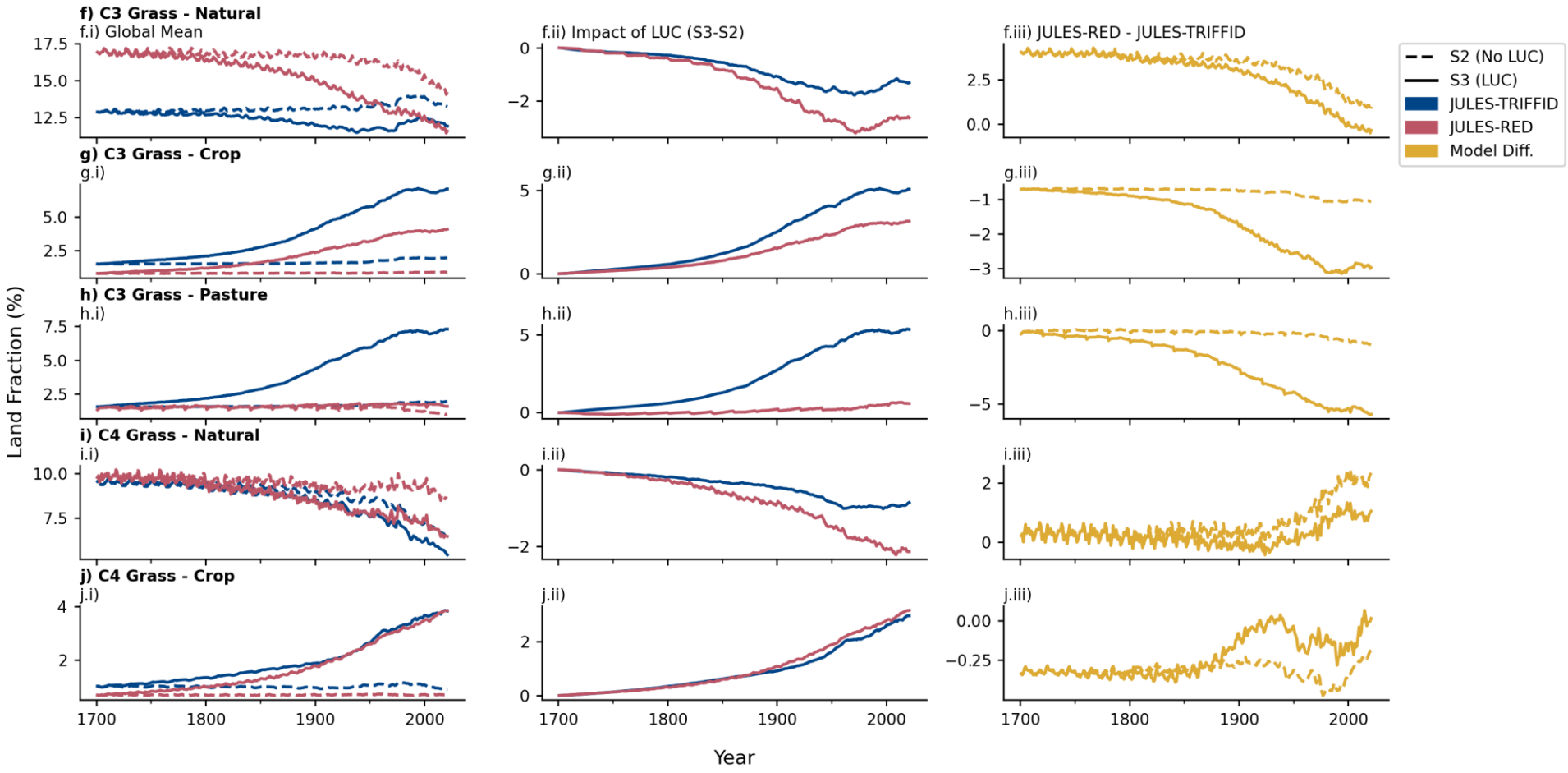


Biomass: JULES-RED simulates higher global biomass than TRIFFID, especially in tropical and sub-tropical regions, but both models overestimate AGB vs ESA CCI and diverge strongly in East North America. LUC (S3) reduces biomass and weakens model–model agreement.

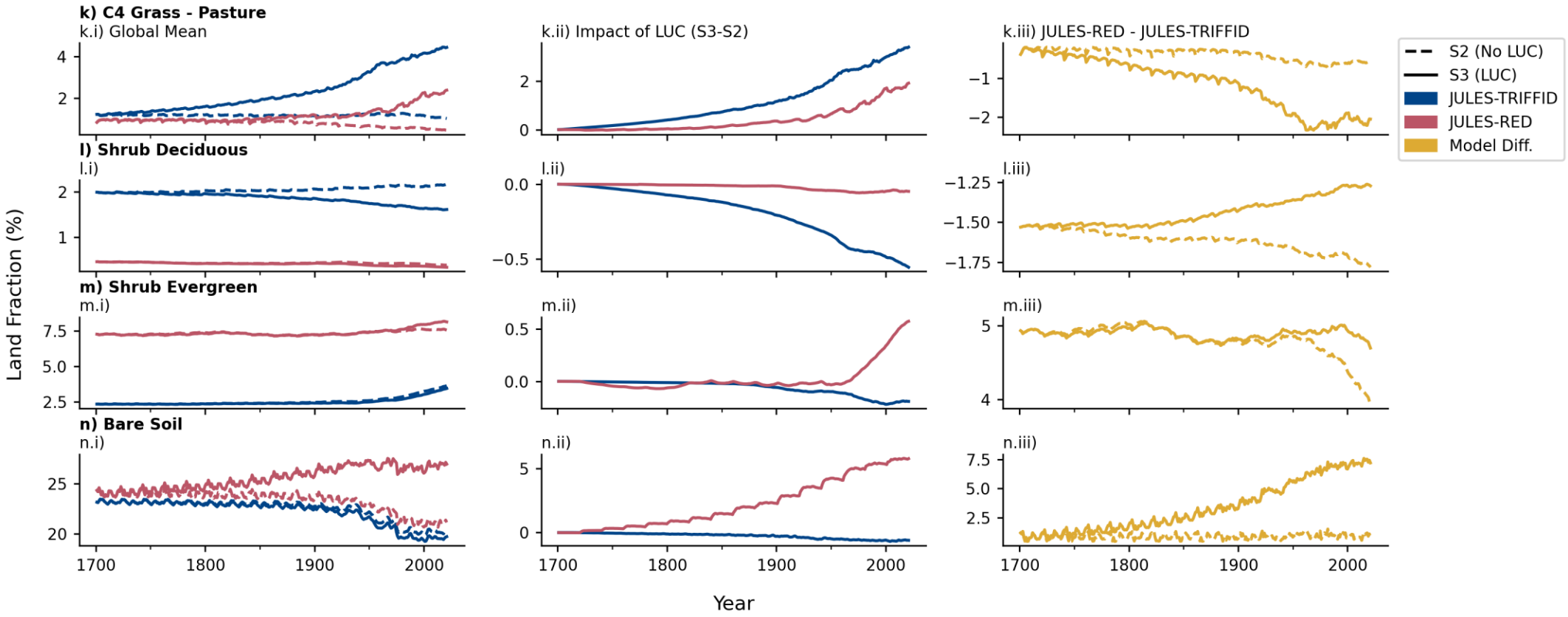
Global Fractions – Part 1



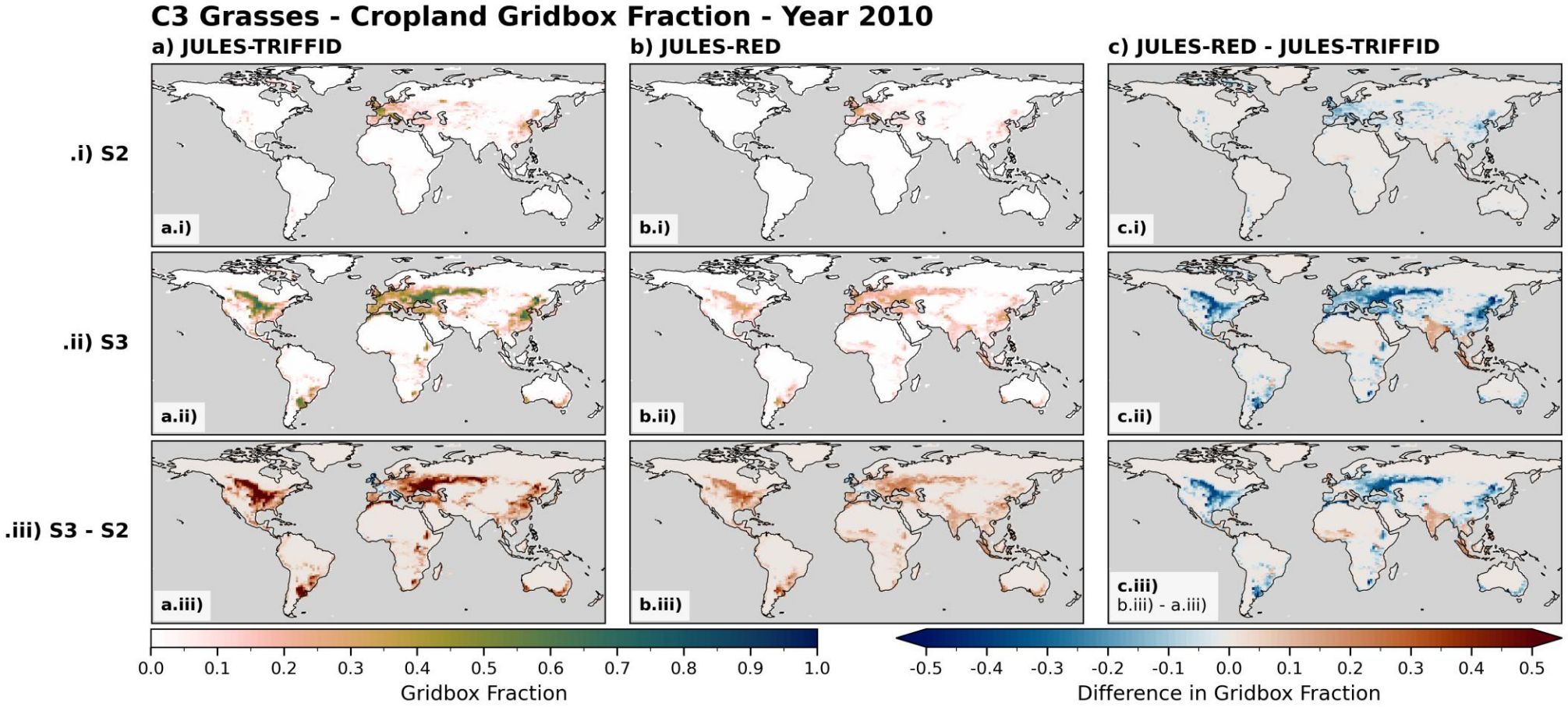
Global Fractions – Part 2



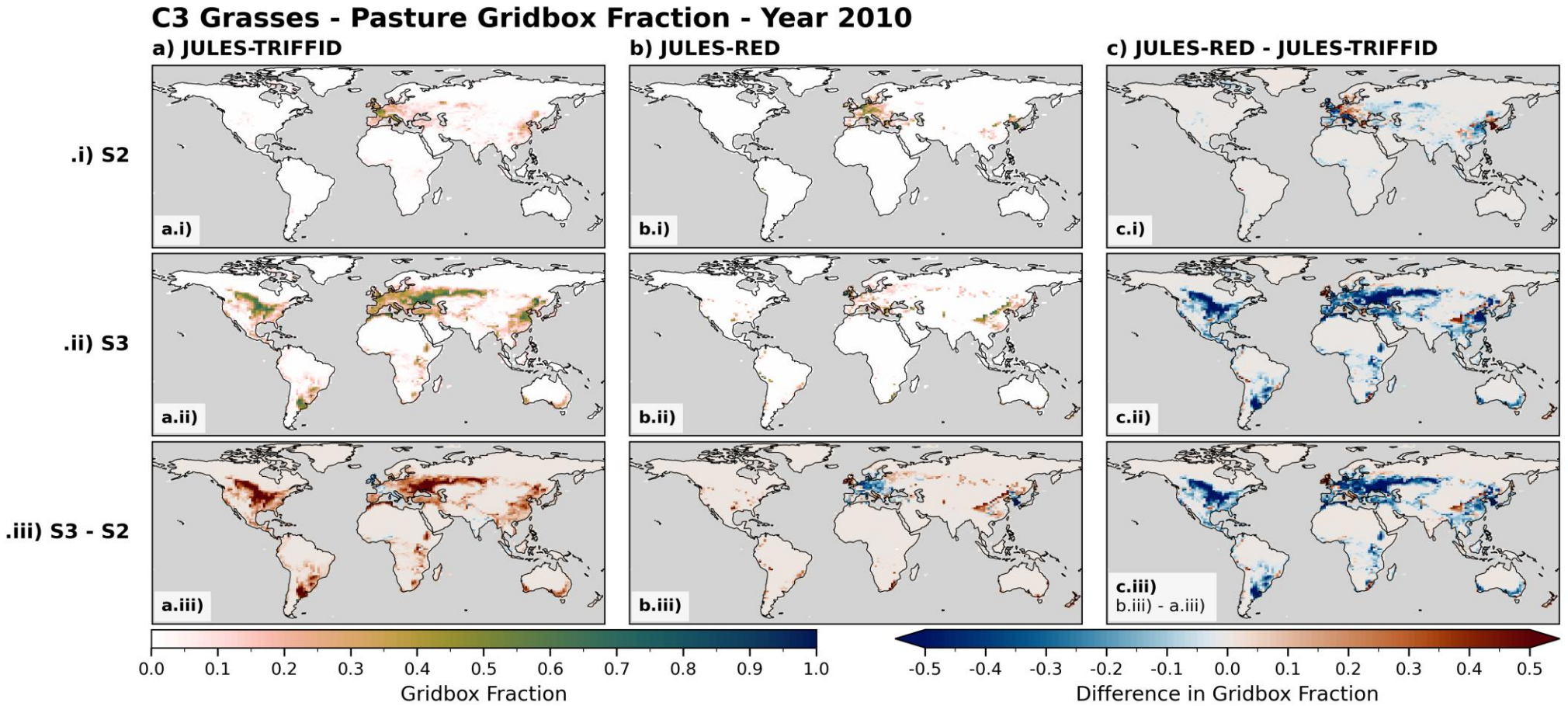
Global Fractions Part 3



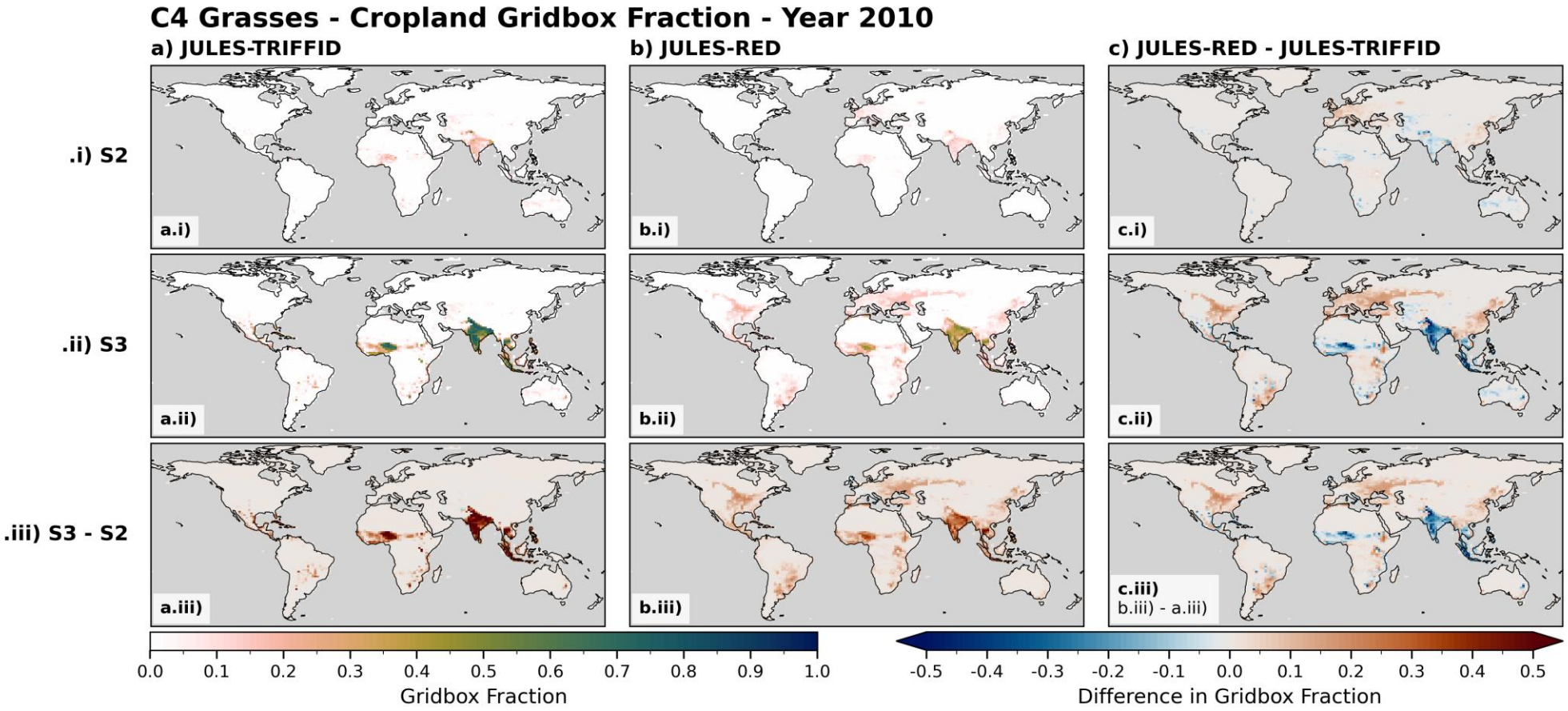
C3 Crops



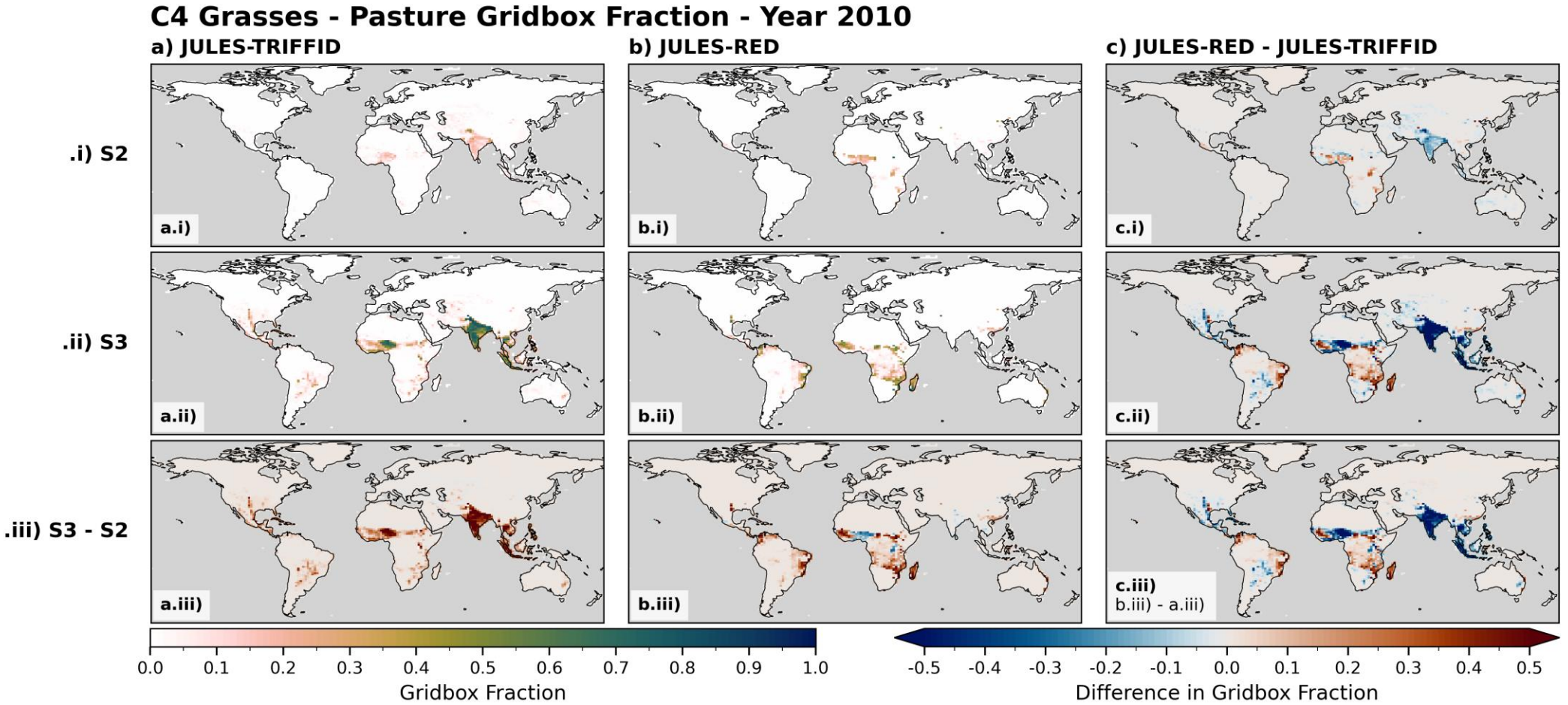
C3 Pasture



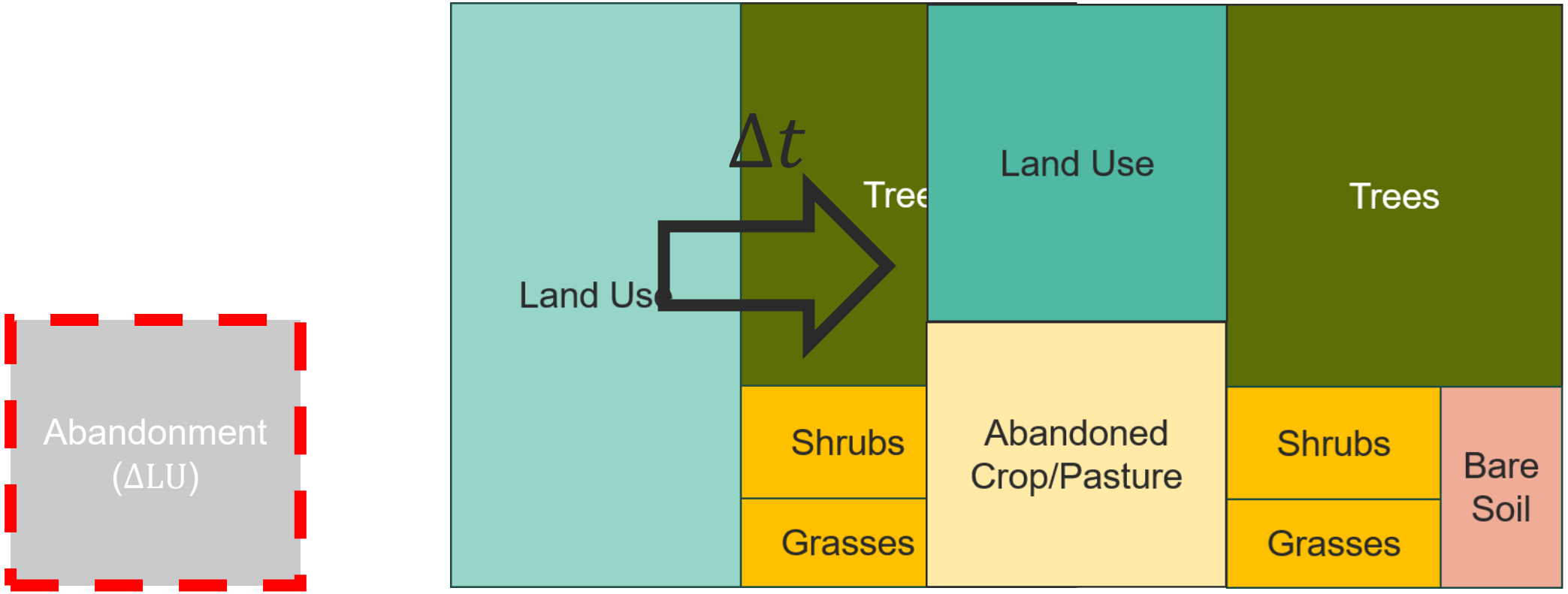
C4 Crop



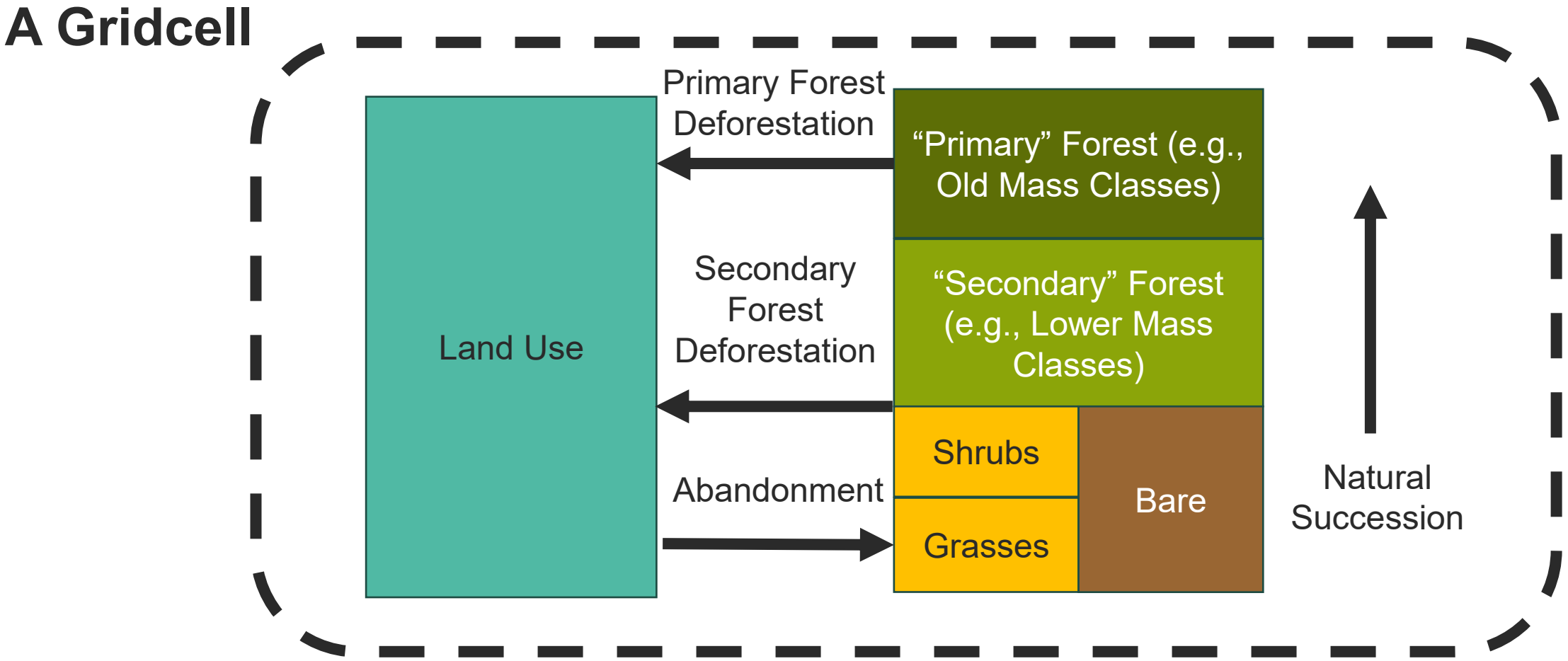
C4 Pasture



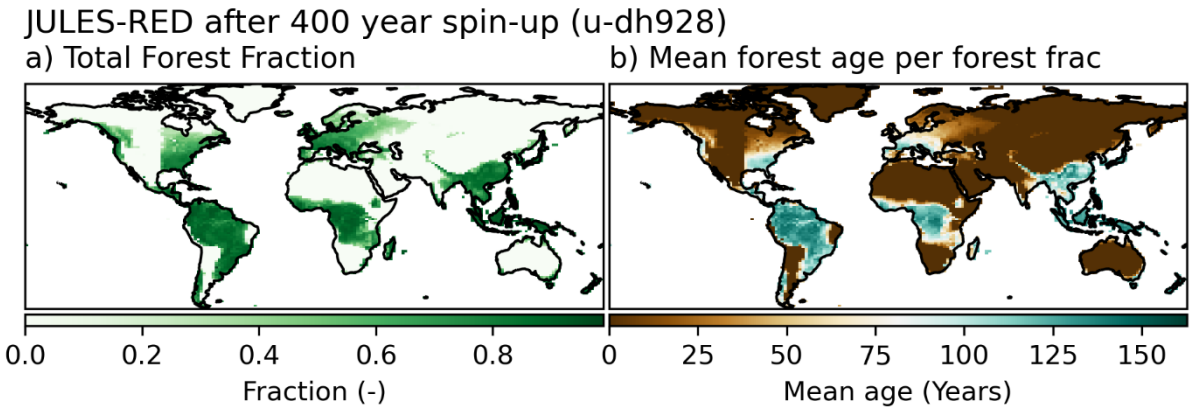
Revenge of the Natural PFTs (Net LUC Abandonment)

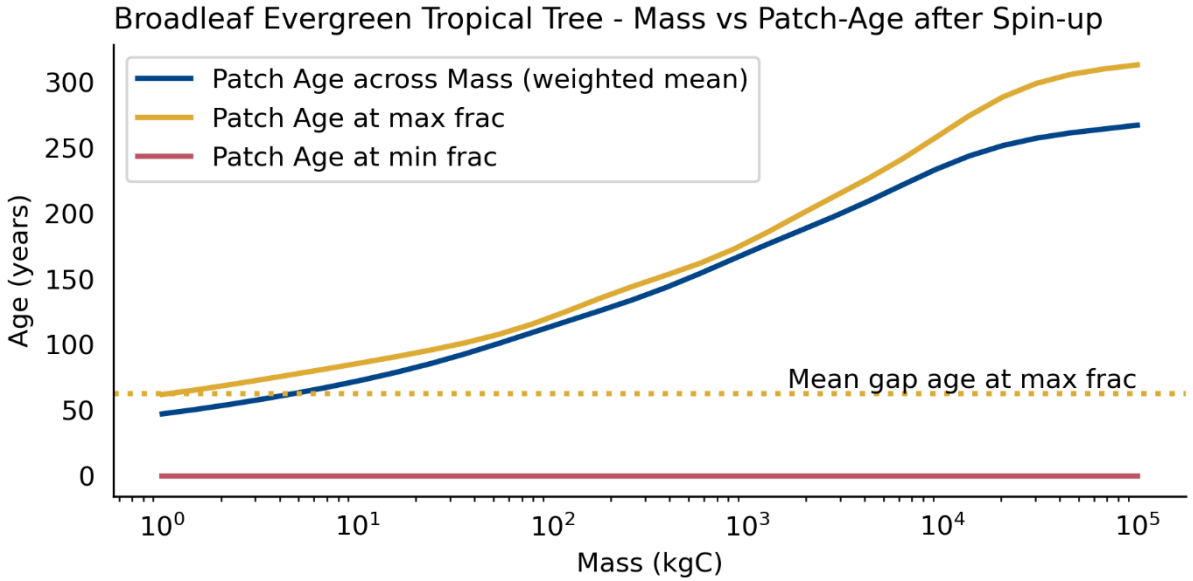


Future Plans – Gross LUC



Can we get patch-age from a one-dimensional Demographic Vegetation Model?





- I have added in a new diagnostic which estimates the “patch-age” based on the average age of a gap.

The CSSP Brazil Early Career Network (ECN)

Manaus
2024

The CSSP Brazil ECN is a group intended for early career researchers from people at Master's level through to Post-Doc or equivalent levels to engage and share their work and thoughts on subjects related to climate science in Brazil. The general goal is to foster a community where we can support or foster each other in our work.

CSSP Brazil Early Career Network

Date	Talk
17th of September 14:00 UK / 10:00 São Paulo	Luis Cattelan (Uni. Leeds): Impacts of Deforestation-Driven Rainfall Reductions on Amazonia Forest Stability
6th of October 14:00 UK / 11:00 São Paulo	UK-Brazil Career Panel for Early Career Researchers: Prof. Liana O. Anderson (INPE), Dr Marcia Zilli (Uni. Oxford), Dr Jess Baker (Uni. Leeds) and Dr Maria Barbossa (UKCEH)
10th of November 14:00 UK / 11:00 São Paulo	Dr. Murilo da Costa Ruv Lemes (INPE): Amazon deforestation induces a non-linear regime shift in atmospheric moisture contribution to La Plata basin subregions
1st of December 14:00 UK / 11:00 São Paulo	Prof. David Schultz (Uni. Manchester): How to Write Scientific Papers That Get Published

Any Questions?

For more information, please visit:

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www.viewpoint-brazil.org/

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