

Improving the representation of the fate of harvested wood in global and regional carbon budgets

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Motivation

- Reducing CO₂ emissions from land use (ELUC) and enhancing land-based carbon sinks are critical for staying within the Paris Agreement's carbon budget. Realistic ELUC estimates require an accurate representation of the **fate of harvested wood**, including **how much carbon remains on site as slash versus being removed for harvested wood products, and how long this carbon is stored.**
- The annual **Global Carbon Budget [1]** derives ELUC estimates from **bookkeeping models** that track carbon pools and their responses to land use change and management. These models currently represent the fate of harvested wood in highly simplified ways.

Research questions

- To what extent does the improved representation of the fate of harvested wood **alter global and regional ELUC estimates?**
- How much do the individual modifications of the slash and product pools, of their input and their decay contribute to the **ELUC differences** between our new, improved and the old, default scheme?

Methods

- We implement an improved representation of the fate of harvested wood in the **bookkeeping model BLUE [2]**, informed by literature [3, 4], **FAO and IPCC data**, and the **LUH2 land use forcing**.
- Our approach combines spatially explicit, partially time-varying fractions of harvested carbon allocated to slash and six wood product pools – each capturing specific product groups with distinct lifetimes – with a computationally efficient two-step scheme approximating gamma-function-like decay (Fig. 1).

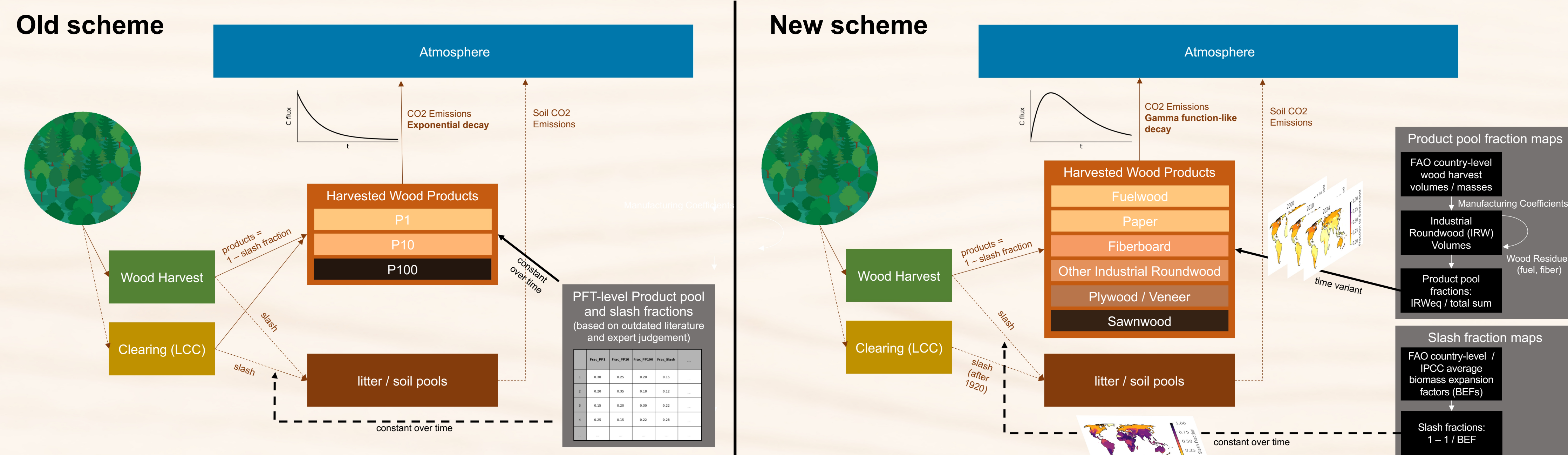


Fig. 1: Comparison of old (left) and new (right) scheme modeling the fate of wood after wood harvest and clearing in BLUE.

Results

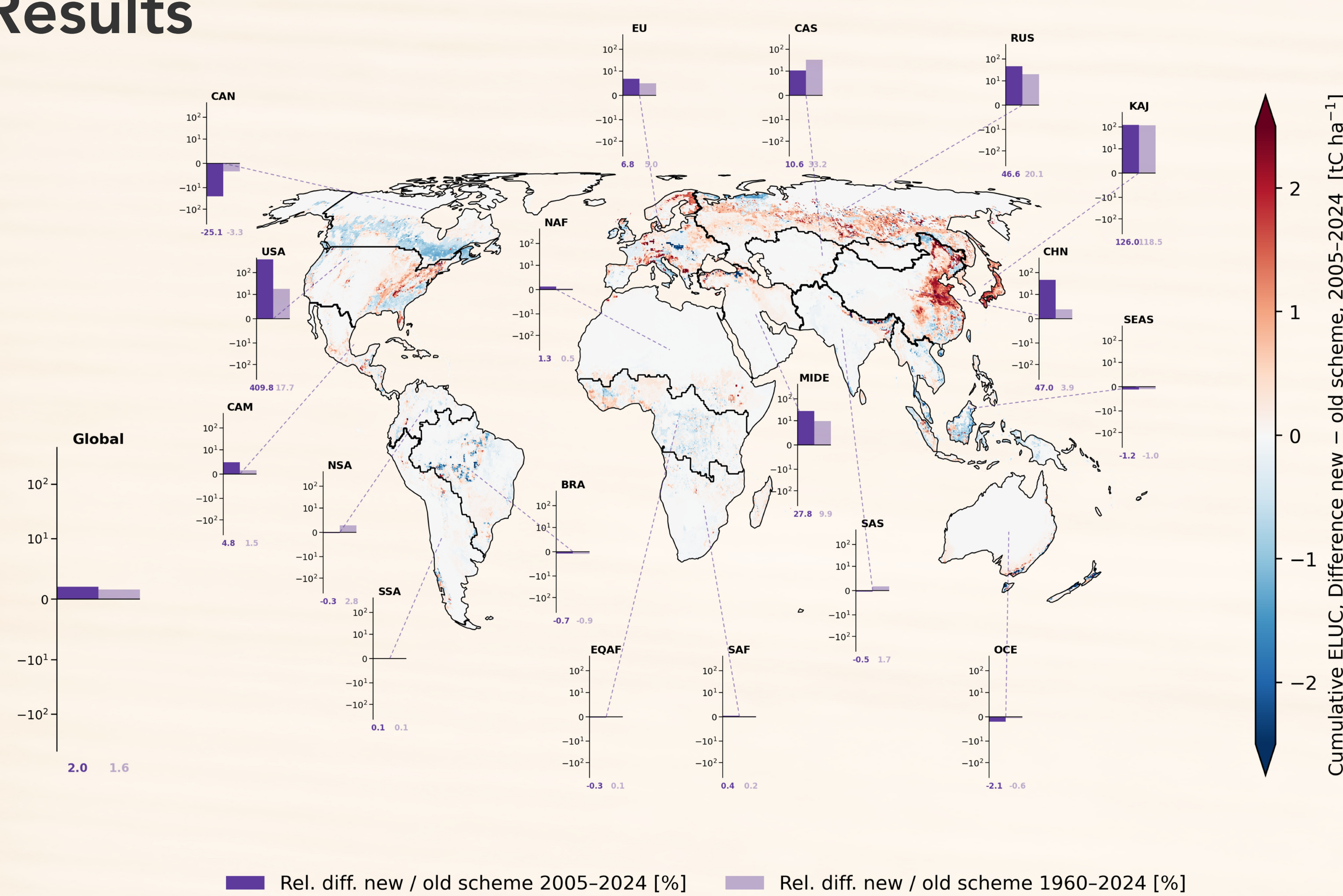


Fig. 2: Global and regional difference of cumulative ELUC between two BLUE simulations using the new and old harvested wood scheme. The map shows the absolute difference of cumulative ELUC over the last 20 years, with black lines delineating the 18 RECCAP regions. Bars show the relative difference over the last 20 years and since 1960, globally and per RECCAP region (note logarithmic scale).

- Compared to the old scheme, **ELUC differs substantially** in regions where harvested carbon is stored for much longer periods, predominantly in the **Global North** (Fig. 2, 3, 4).
- In tropical regions, where **soil turnover times are short and most wood products are short-lived**, differences in ELUC are small – and since the tropics dominate global ELUC, overall differences at the global scale remain low (Fig. 2, 3, 4).
- Longer storage of harvested carbon can also result in **temporary emission increases**, as carbon from past harvest or clearing events remains in the system for longer (Fig. 2, 4).
- Surprisingly, **slash modifications contribute more to ELUC differences** than product pool modifications (Fig. 3).

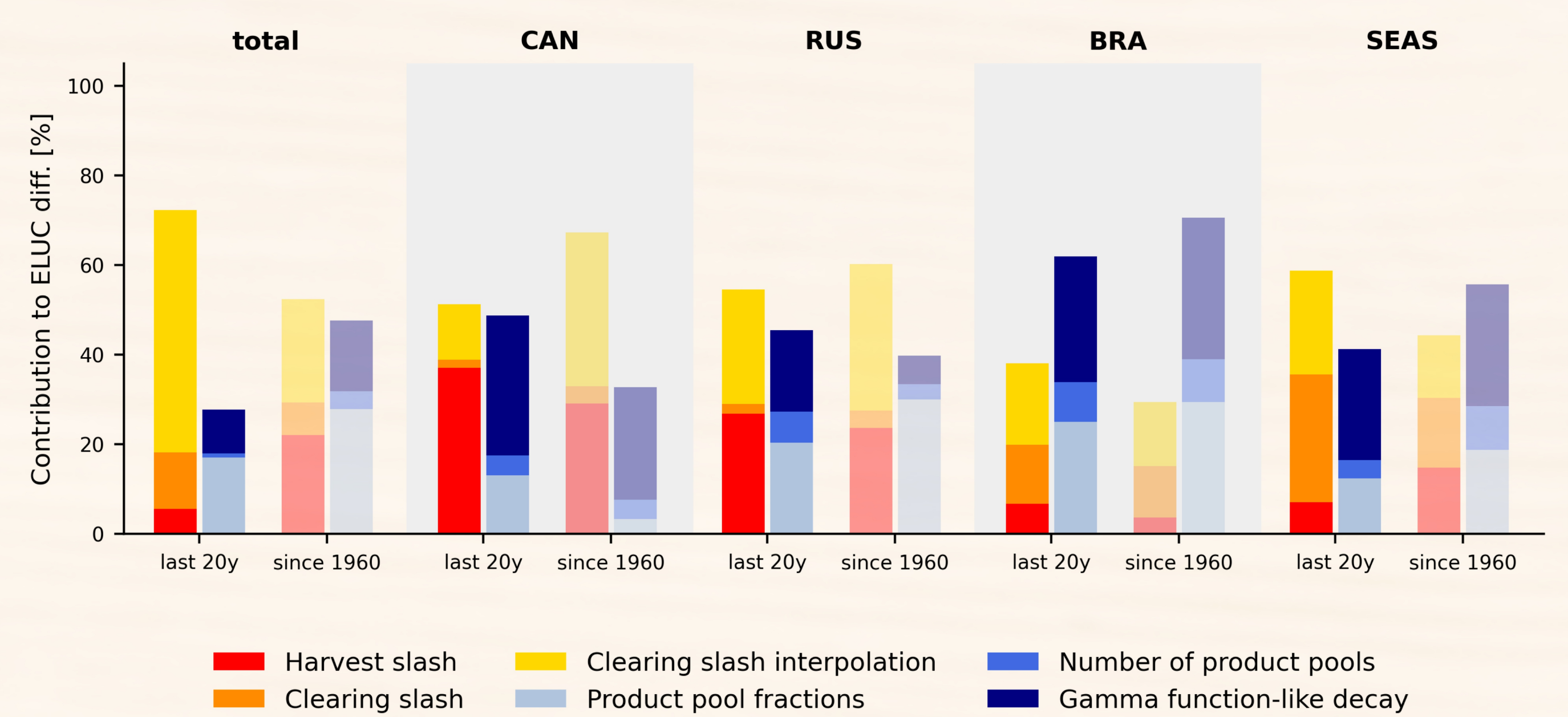


Fig. 3: Global and regional relative contribution of the individual modifications to the difference of ELUC between the new and old harvested wood scheme separated for slash and product pool modifications and for the last 20 years and since 1960.

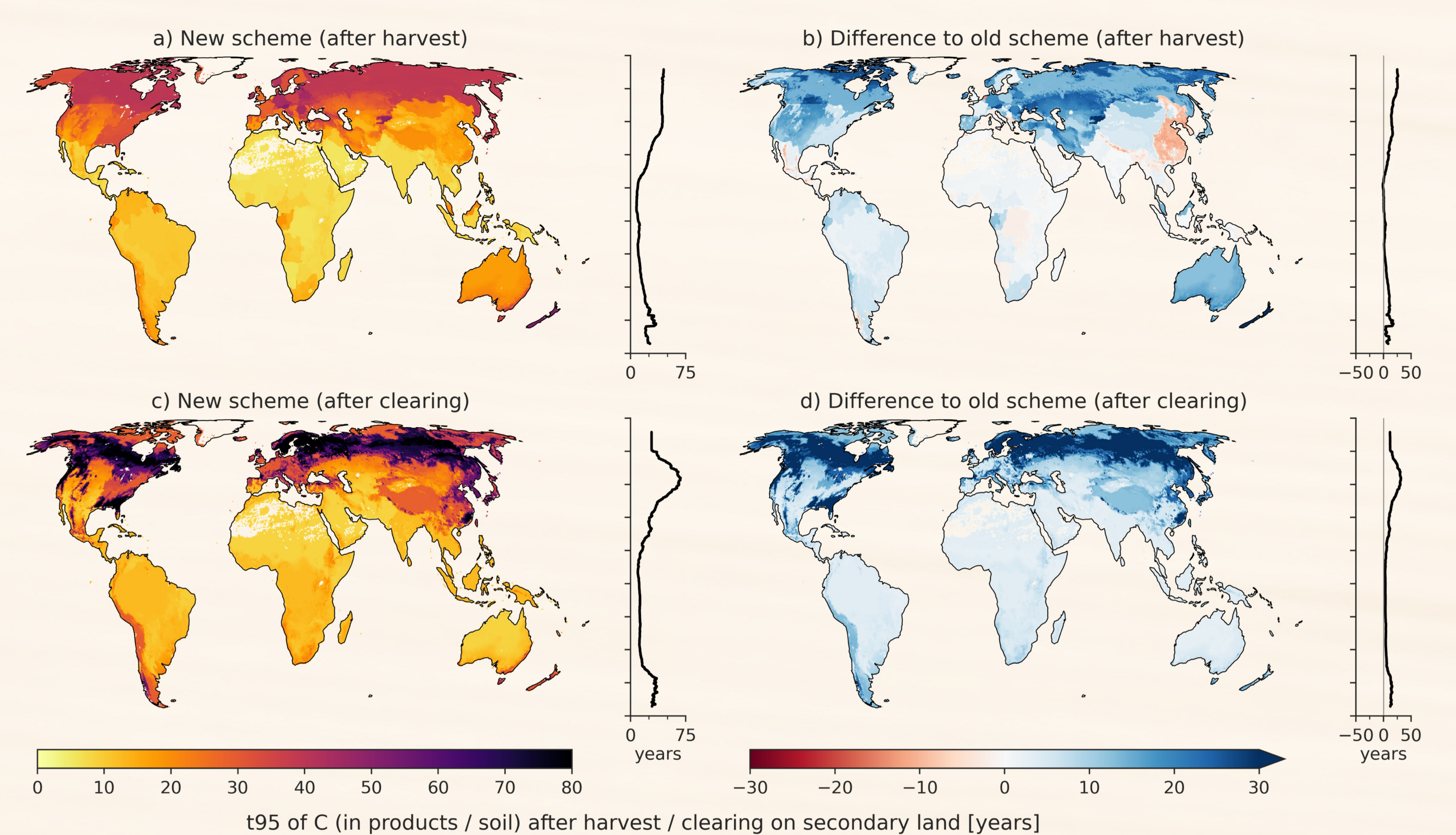


Fig. 4: Timing of emissions after wood harvest (a, b) and clearing (c, d) on secondary land, defined as the time in years until 95% (t95) of the carbon is released to the atmosphere from wood harvest and slash. Global maps and latitudinal means are shown for the new scheme (a, c) and its difference to the old scheme (b, d), averaged since 1960.

What if?!

- If all carbon stored in wood products had historically been assigned to the longest-living product pool in BLUE, **global ELUC over the last 20 years would be 9% (new scheme) to 15% (old scheme) lower**, depending on the slash assumptions.
- Shifting a greater share of tropical harvested wood toward (long-lived) products represents a significant lever for further ELUC reductions.

Conclusions & Outlook

- The simplified harvested wood representation in current bookkeeping models **appears adequate for global ELUC estimates**. However, as regional and national carbon budgets grow in importance, **our improved approach offers a more realistic basis for ELUC estimation.**
- Our approach is also transferable to **land surface and Earth system models**, which exhibit similar limitations in their treatment of harvested wood.
- We do not account for potential climate change mitigation benefits of harvested wood through **substitution in the construction sector.**

