

Estimating the terrestrial global carbon budget by global models - Part 1:

Bookkeeping modeling to estimate LULUCF emissions and removals

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Global carbon budget



LULUCF fluxes attributable to land-use activities are estimated by bookkeeping models

Remember from webinar:

- Global models distinguish LULUCF flux by drivers, not by area
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- Global models distinguish LULUCF flux by drivers, not by area
 - Indirect effects are deliberately excluded
- Bookkeeping models are **semi-empirical models** that track changes in the carbon content after a land-use change event or due to land management
 - 3 models in Global Carbon Budget:
 - BLUE (spatially explicit at 0.25 deg; LMU München/J. Pongratz&C. Schwingshackl)
 - H&N/H&C2023 (country level; Woodwell Climate Research Center/R. Houghton)
 - OSCAR (country level; IIASA/T. Gasser)



Bookkeeping models are uncertain...

... as are all (observation, inventory, model) estimates of land CO2 fluxes

 Uncertainties stem from the (equilibrium) carbon densities assumed for specific land-use types, response curves tracking evolution of carbon stocks after a land-use event, how cleared material is allocated (slash, product pools), or which land-use activity data is used

Land-use activity data

- Cumulative LULUCF flux ca. 20% higher with FRA data than LUH2 (Gasser et al., 2020)
- LULUCF flux based on HILDA+ only 65% of LUH2-based estimate (Ganzenmüller et al., 2022)
- Improvements to LUH2-GCB → Mike O'Sullivan's talk



Bookkeeping models are uncertain...

To quantify uncertainties...

- ... three largely independent bookkeeping models are used in the GCB
- ... an additional uncertainty estimate around the bookkeeping average is derived from DGVMs
- ... fluxes are compared, e.g., to NGHGIs or satellite-derived fluxes



Bookkeeping models can split the net LULUCF term into dozens of removals and emissions terms

General agreement of component fluxes with NGHGI on global scale:



Additional information on, e.g., impacts of shifting cultivation:



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GCB and NGHGI LULUCF flux estimates are operationally translated to each other (e.g., in GCB)

- to link country reporting to IPCC Assessments and scenarios (TCRE, remaining carbon budget, net-zero years)
- Based on Grassi et al methodology using DGVM's natural sink (see talk by Mike O'Sullivan and by Giacomo Grassi/Thomas Gasser later)

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- Translation works well in particular on global level; it reveals important issues in one or the other method on national level



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- Quantifying directly NGHGI definition → see poster by Clemens Schwingshackl



Summary of global models' LULUCF flux

- Global models provide net LULUCF flux estimate of *direct* activities, based on drivers, not areas (managed land proxy)
- Aim is identification of the levers for reducing emissions and increasing natural sinks and consistency with IPCC Assessments
- Bookkeeping approach and NGHGI can be and are operationally translated
- Estimates are uncertain, but continuously better understood and improved
- Large pontential of communities joining up for a national-level comparison between global models, NGHGIs and Earth observations