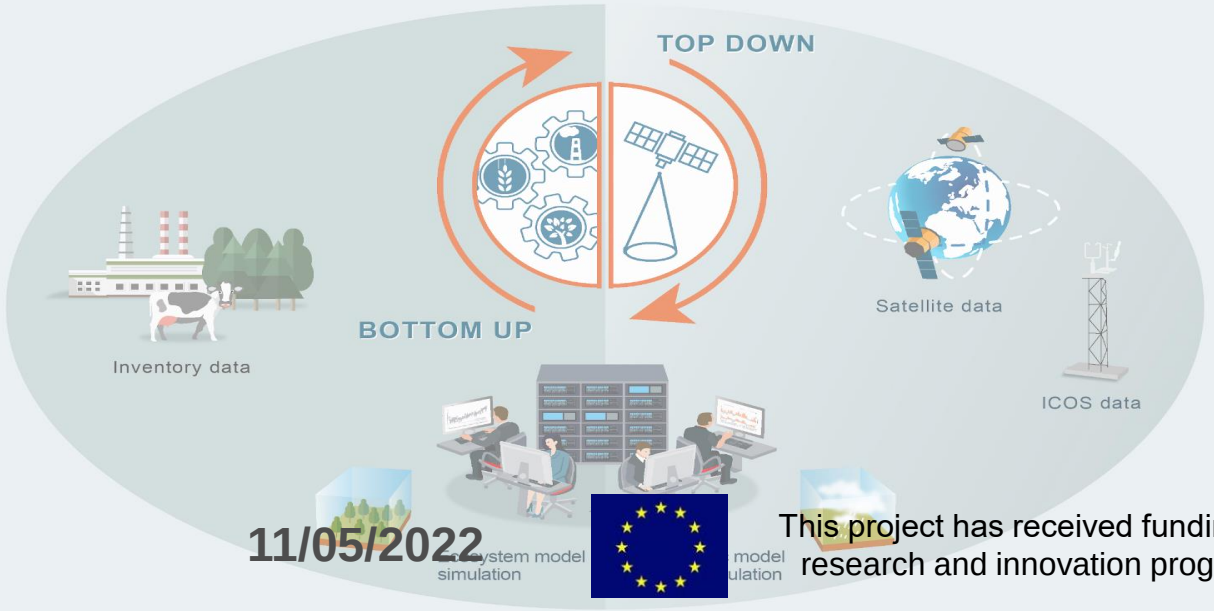
Mapping land use fluxes from global models to national inventories

Giacomo Grassi, Julia Pongratz, Clemens Schwingshackl, Stephen Sitch, Pep Canadell, Pierre Friedlingstein, Thomas Gasser, Richard Houghton et al.



11/05/2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776810

European Commission

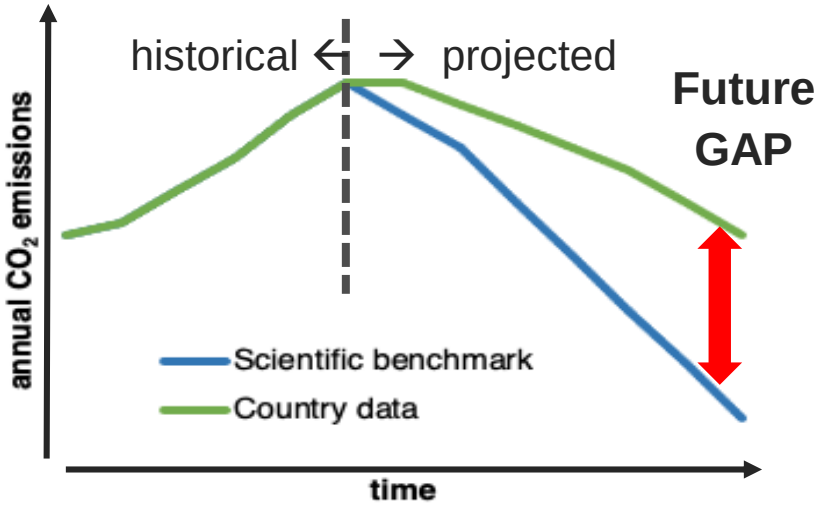
After COP26, focus shifted from *let's pledge emission reductions* to ***let's implement and track the pledges***

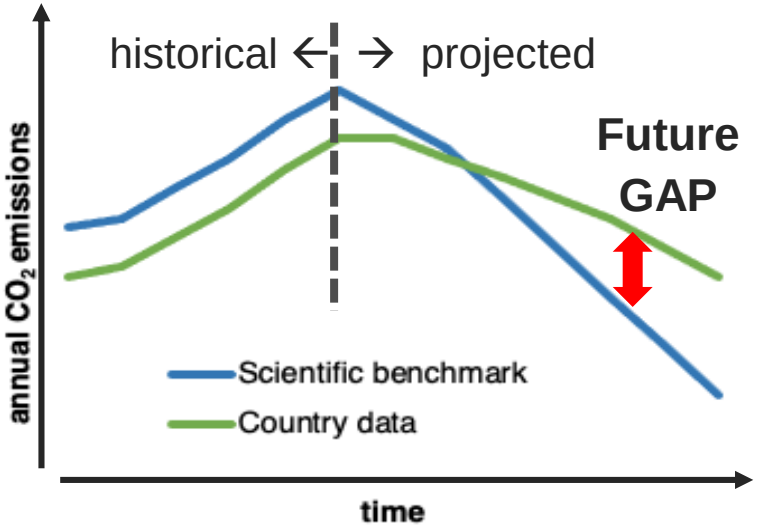
→ country progress will be increasingly scrutinized

→ increasing attention to land-use CO_2 fluxes (LULUCF)

"If you don't measure, you don't manage"

The Global Stocktake:

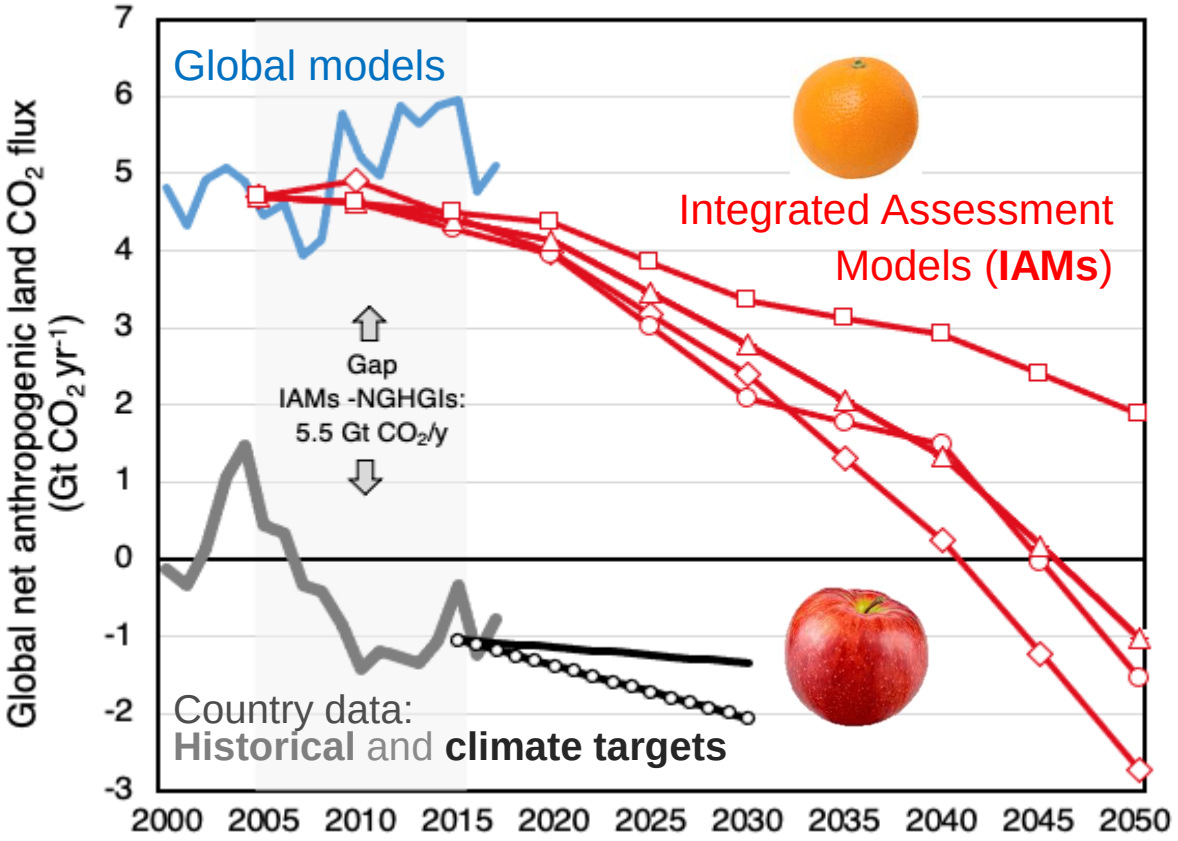




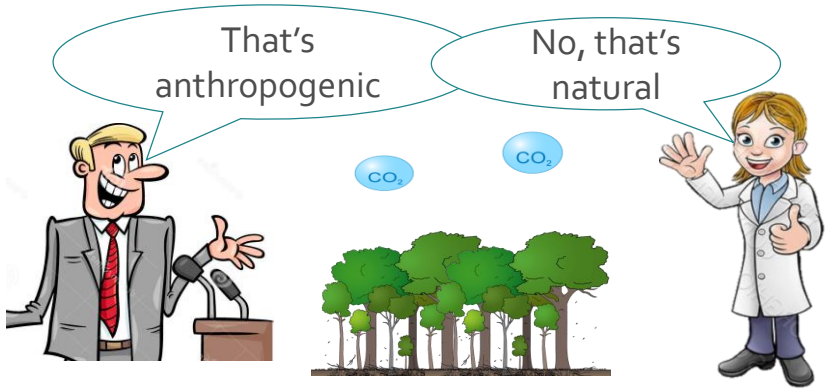
Comparability is needed

European Commission

The problem: large gap on land-use CO_2 flux between models and countries



This large gap confuses policy makers: can global models be used to assess historical and pledged climate progress?



Grassi et al. 2021, Nat Climate Change

European Commission

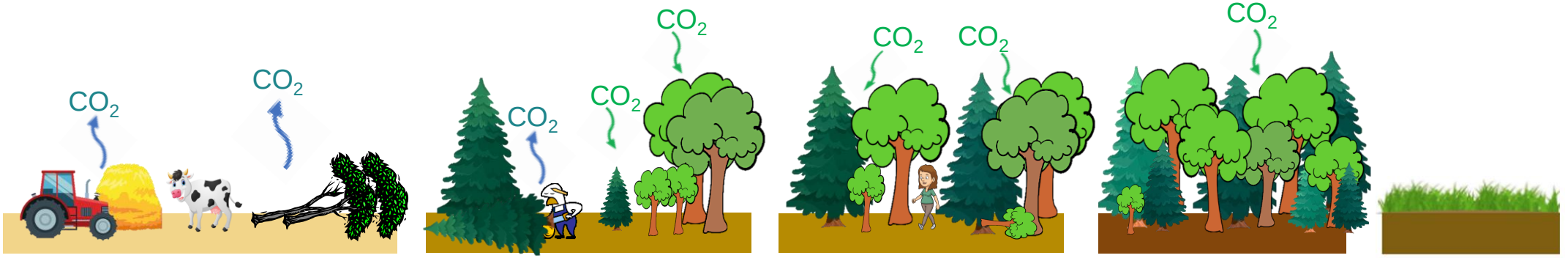
Most of the gap due to different definitions of anthropogenic forest sink

Global models: **Bookkeeping models (BMs)** **DGVMs**

Anthropogenic **Natural**

Direct anthropogenic effects
(e.g. land use changes, shifting cultivation, harvest, regrowth)

Indirect anthropogenic effects
(response of land to human-induced environmental change: increasing CO_2, N deposition, etc.)



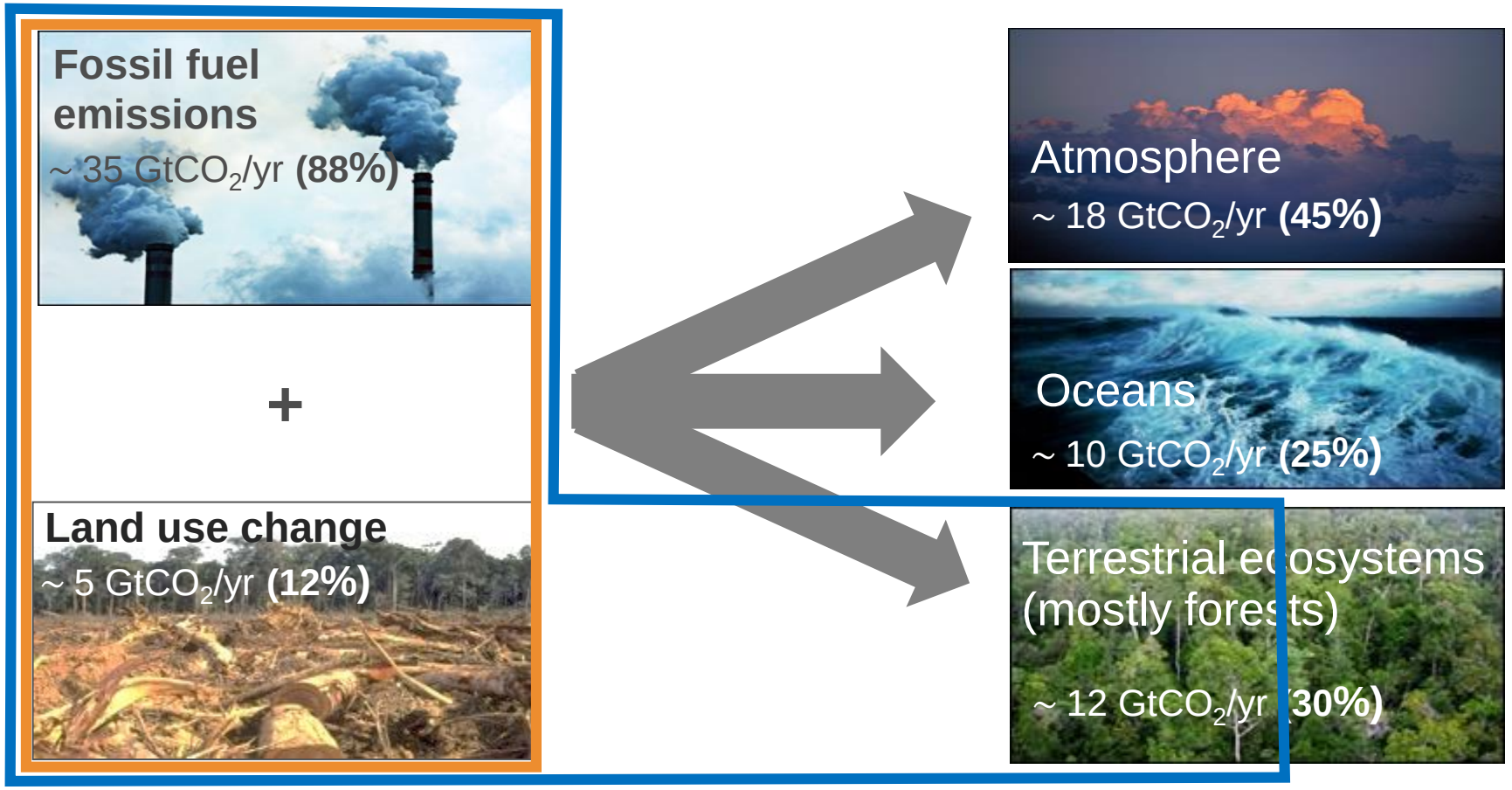
Managed non-forest | Intensively managed forest | Less-intesively managed land | Unmanaged forest | Unmanaged non-forest

Countries: **Anthropogenic (in NGHGIs)** **Natural**

Two approaches developed for different scopes – both valid in their context, but **not directly comparable**

The Global Carbon Budget

anthropogenic in global models



anthropogenic in national inventories

(based on the Global Carbon Project)

Issue acknowledged at the highest levels

Science:

Global Carbon Budget 2021: "*A reconciliation between our land use estimate and those from countries is shown, supporting the assessment of collective climate progress*"

IPCC Summary for Policy Makers AR6 WGIII: "*There is a large gap of ~5.5 $GtCO_2$ yr^{-1} globally on land fluxes between global models and national GHG inventories. The gap reflects differences in how anthropogenic forest sinks and areas of managed land are defined*."

WGIII, Ch 7 "*In the absence of adjustments to reconcile estimates, countries' collective progress under the Paris Agreement would appear better than it actually is*"

Seen as "issue of equity" by several countries

Policy:

UNFCCC's synthesis report for the Global Stocktake: "*adjustments should be made where any comparison between LULUCF data reported by countries and the global emission estimates of the IPCC is attempted*."

European Commission

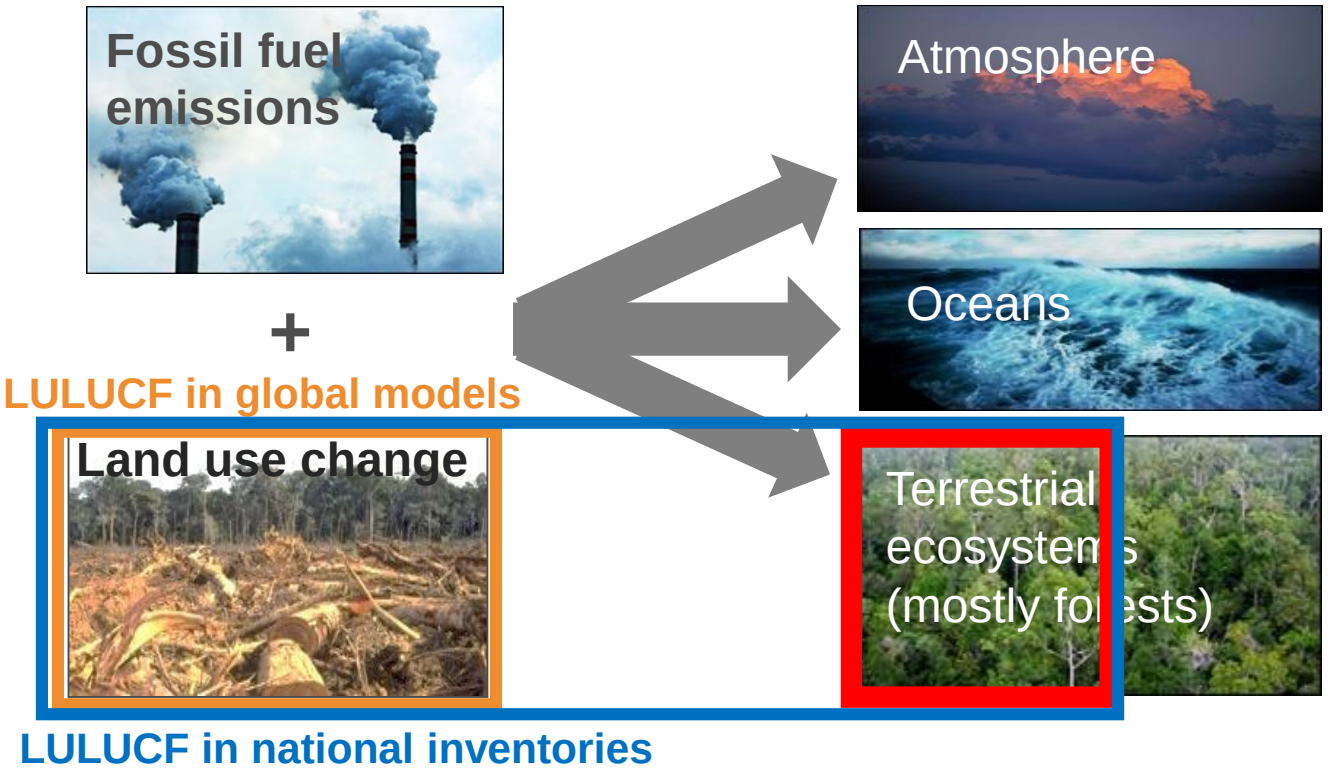
Paper in preparation:

Mapping land use fluxes for 2001-2020 from global models to national inventories

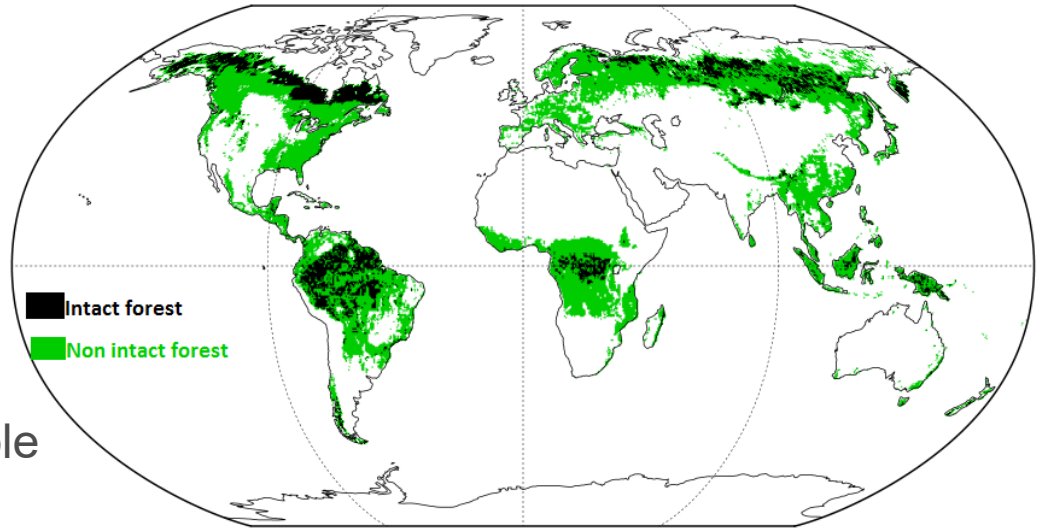
Aim: illustrate & discuss in more details the reconciliation between Bookkeeping Models (BMs) and National GHG inventories (NGHGIs) shown in the Global Carbon Budget 2021 (Friedlingstein et al. 2022) for 2001-2020. This includes a greater level of disaggregation in terms of land categories, regions and countries.

Hypothesis: when land use fluxes by global models are made conceptually more comparable to NGHGIs, most of the previous large differences are reconciled at global, regional and country level.

Approach to reconcile global models and national inventories



We add **the 'natural' CO_2 sink on countries' managed forest area** (due to environmental change, estimated by DGVMs) to the original **anthropogenic land use flux from BMs,** disaggregated to make it comparable to NGHGIs



Countries' managed forest area estimated as "non-intact", unless country maps were available

The National GHG inventories database for LULUCF

https://doi.org/10.5194/essd-2022-104
Preprint. Discussion started: 4 April 2022

Open Access Earth System Science Data Discussions

Carbon fluxes from land 2000-2020: bringing clarity on countries' reporting

Giacomo Grassi[1]*, Giulia Conchedda[2], Sandro Federici[3], Raul Abad Viñas[1], Anu Korosuo[1], Joana Melo[4], Simone Rossi[5], Marieke Sandker[6], Zoltan Somogyi[7], Francesco N. Tubiello[2]

In review: https://essd.copernicus.org/preprints/essd-2022-104/

The quality and quantity of the LULUCF data submitted by countries to the UNFCCC significantly improved in recent years, but important gaps still remain.

With these limits in mind, the database presented here represents the most up-to-date and complete compilation of LULUCF data based on country submissions to UNFCCC.

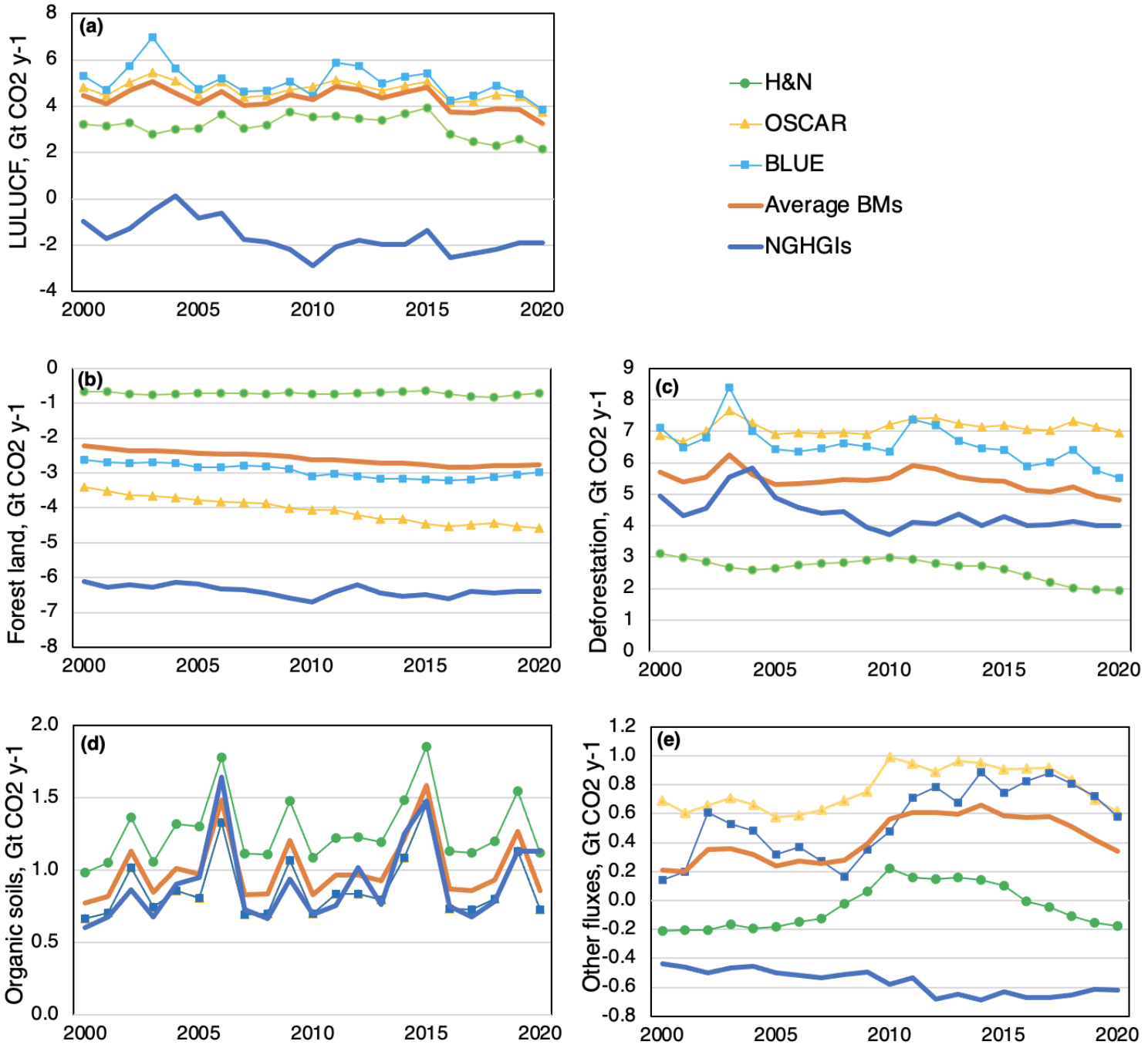
Main results

Differences BMs vs NGHGI (average 2001-2020):

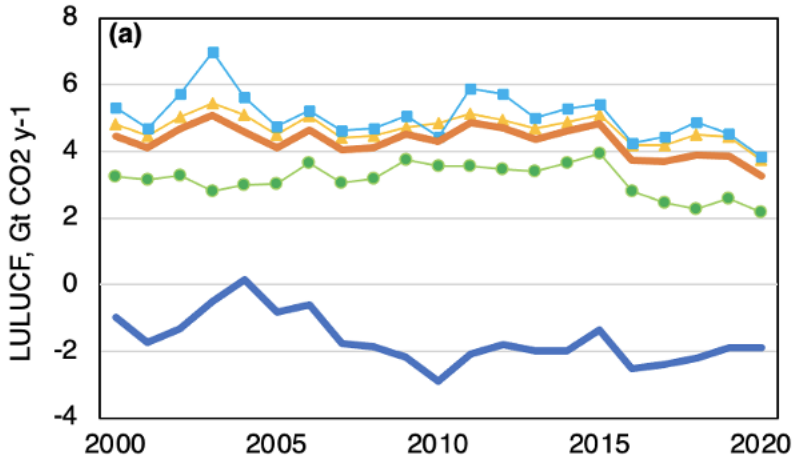
LULUCF: 6.0 $GtCO_2$ yr^{-1}

Forest land: 3.8 $GtCO_2$ yr^{-1}
Deforestation: 1.1 $GtCO_2$ yr^{-1}
Other land uses: 1.0 $GtCO_2$ yr^{-1}
Organic soils: 0.1 $GtCO_2$ yr^{-1}

Trends generally agree

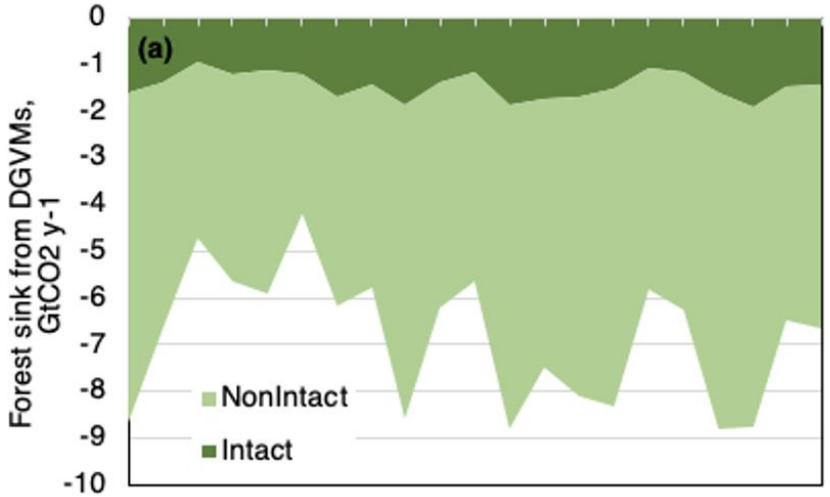


Original BMs results

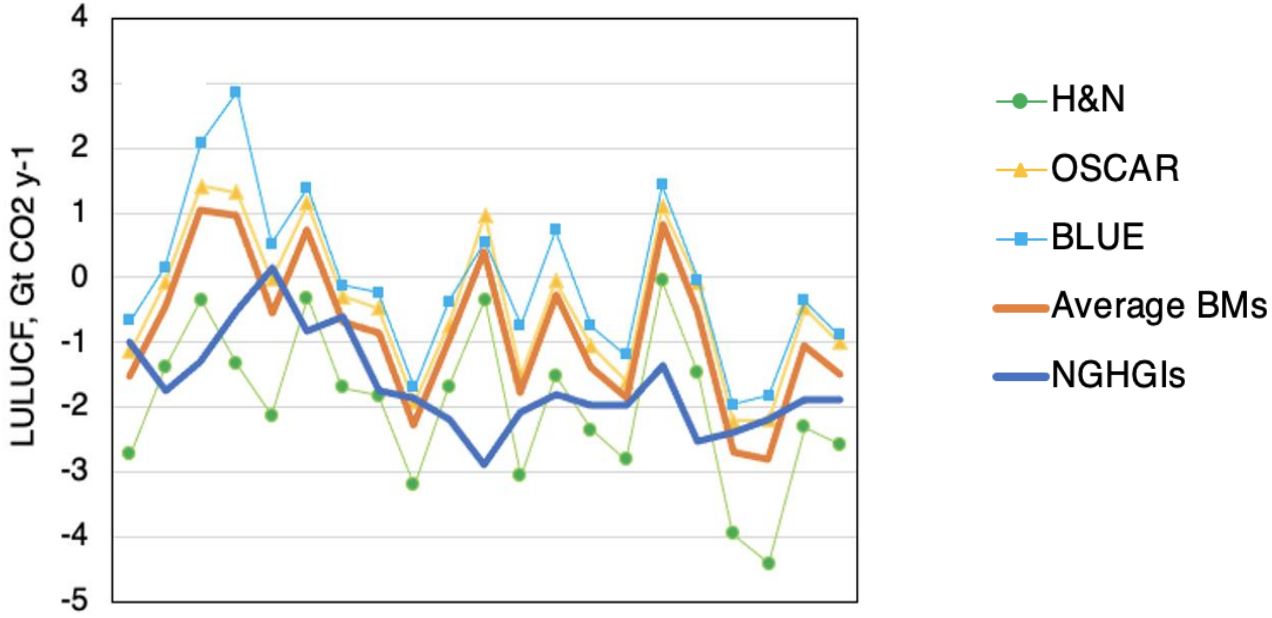


+

CO_2 flux due to environmental change, estimated by DGVMs in non-intact forest



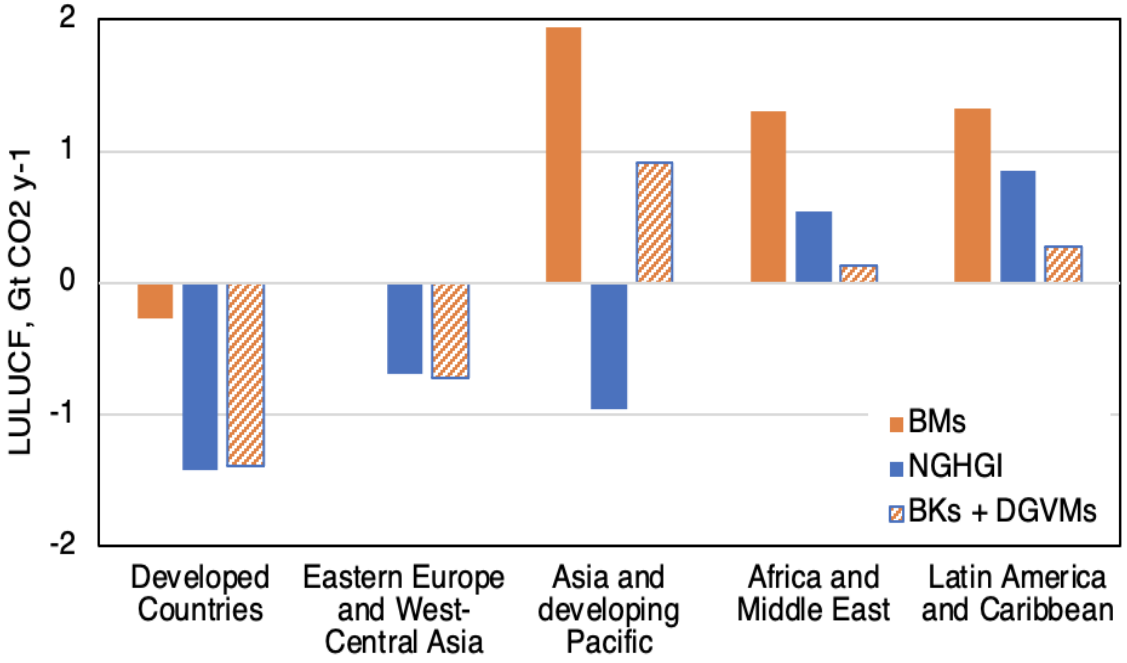
reconciled results

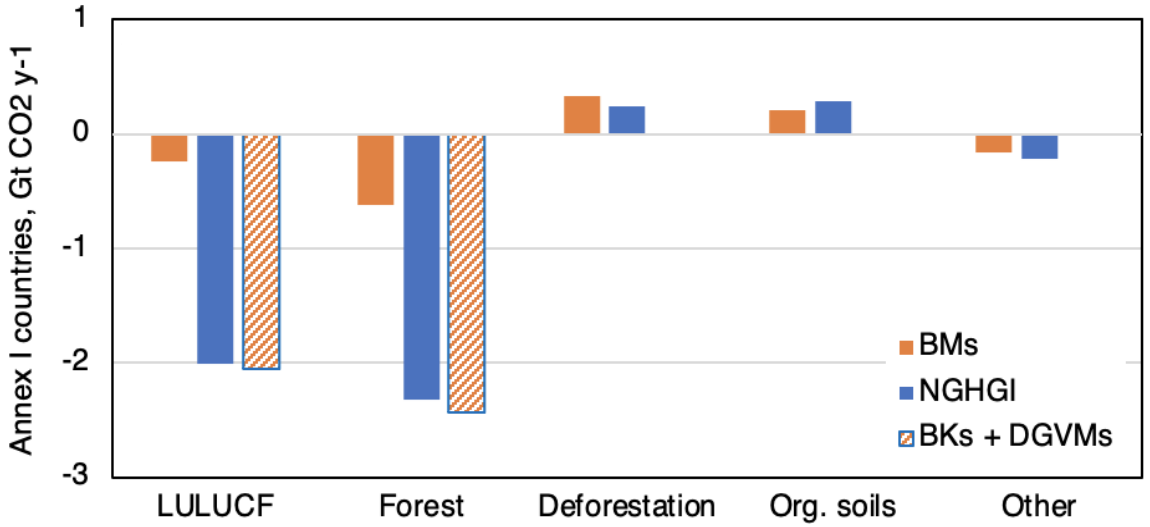


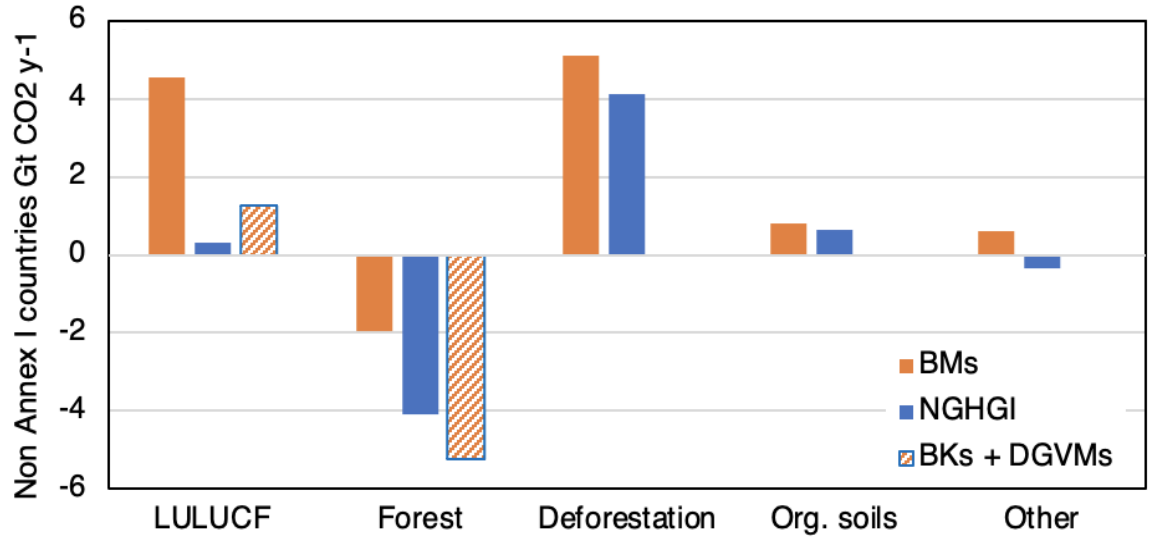
Gap 2001-2020 reduced from 6.0 to 0.9 $GtCO_2$ yr^{-1}

Grassi et al. in prep. Do NOT use nor quote

European Commission







The match between BMs and NGHGIs improves in most (but *not* all) cases after the adjustments.

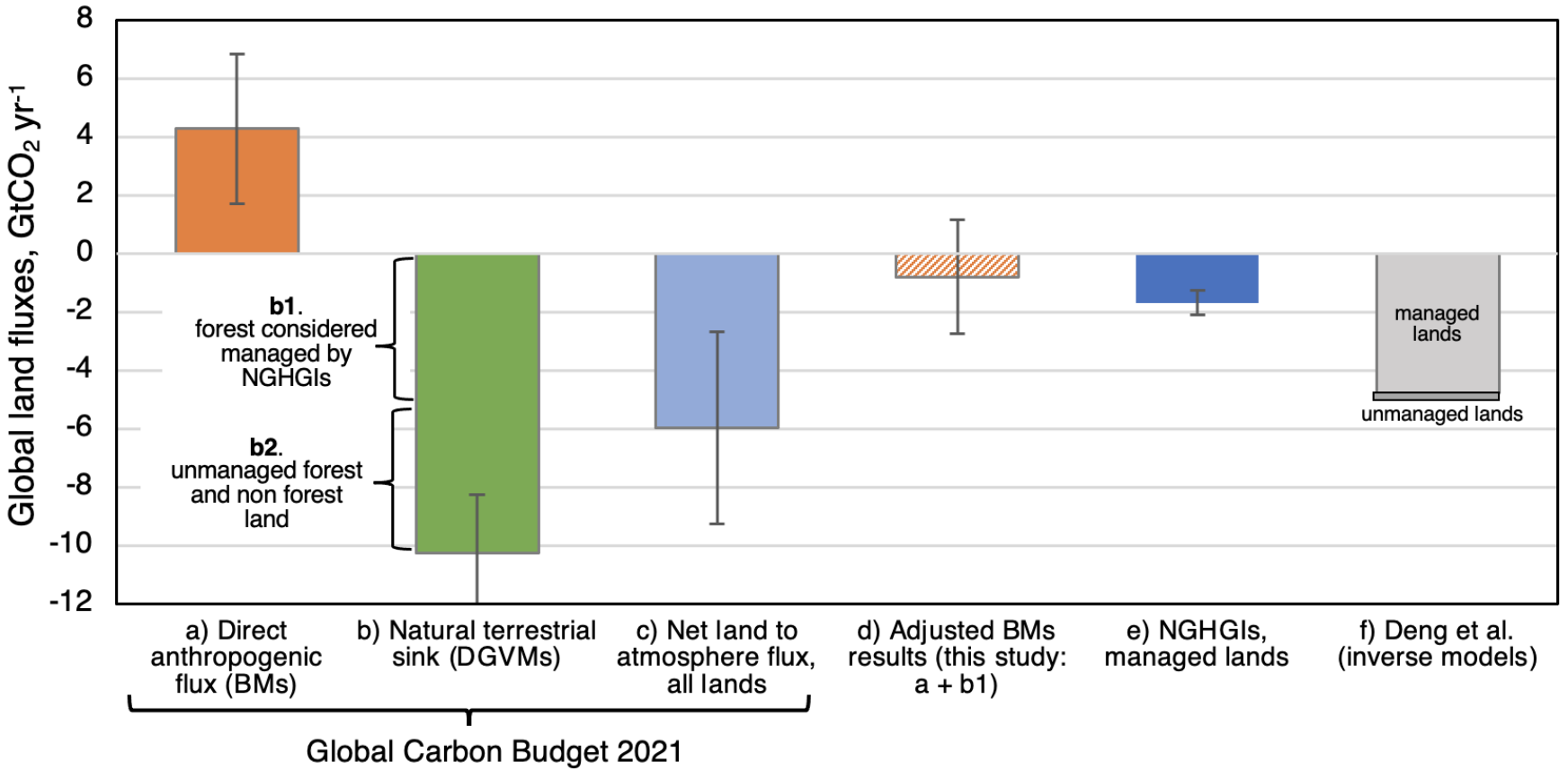
Large discrepancies remain in Asia.

Some discrepacies compensate at global level.

Grassi et al. in prep.
Do NOT use nor quote

On all categories, the match is good for Annex I countries. For Non Annex I countries, differences possibly due to a less complete / accurate NGHGIs

Our results within the global carbon budget

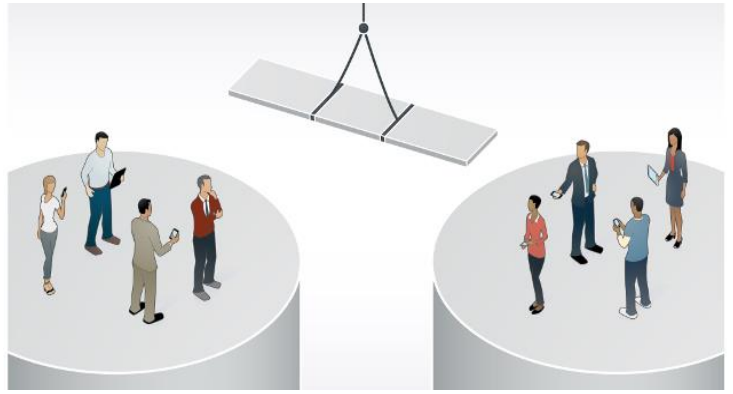


The area of managed land, as defined by NGHGIs, is very likely a net sink of CO_2 globally.

It is possible that this net sink is even greater than in our study, because:

- ¾ of land is managed
- our adjustment of BMs' results does not include non-forest land and, for forest land, may be underestimated
- many NGHGIs are not complete in terms of land uses (especially for non-forest land) and carbon pools (especially for soil), and do not always fully include the impact of human-induced environmental change.

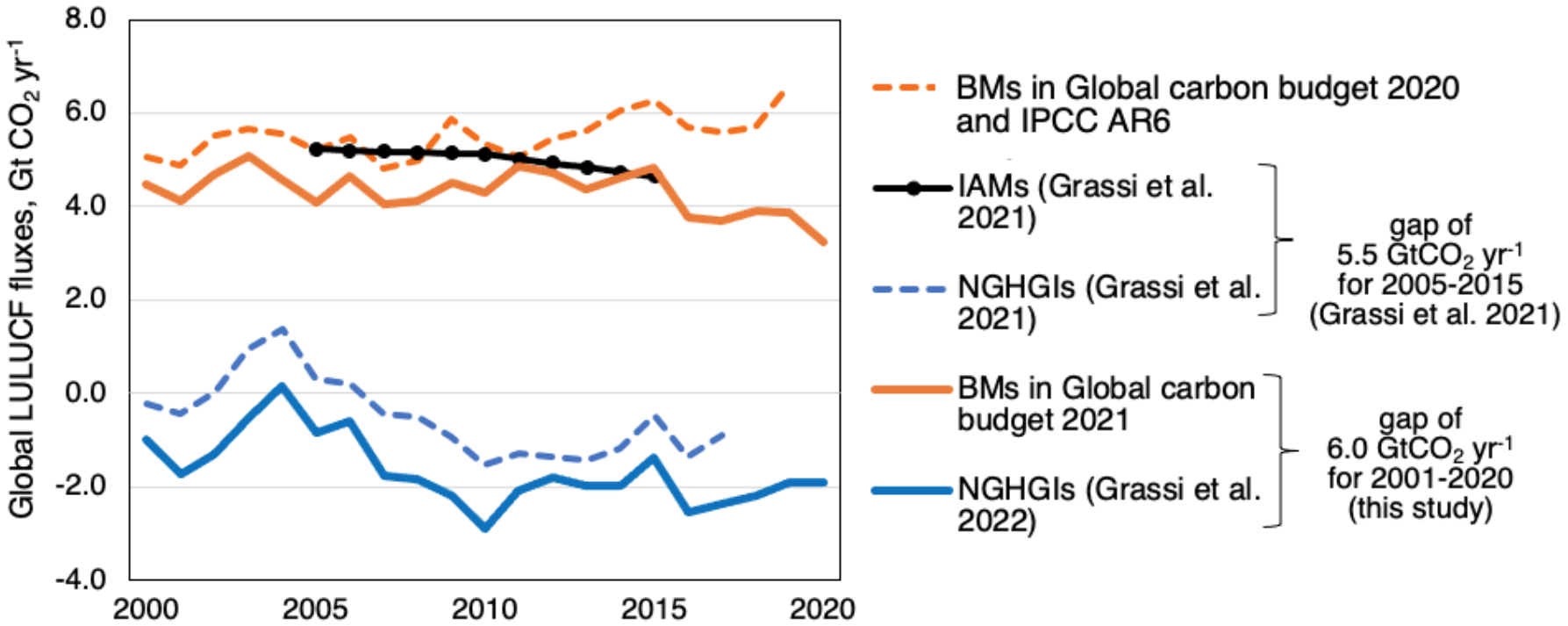
Conclusions



- Large gap on land use fluxes confirmed, mostly on forest land.
- Most of the gap due to how fluxes are labeled (*anthropogenic* vs. *natural*) → our reconciliation is a step to bridge two separate communities and to **increase trust on land-use fluxes**
- Few relevant discrepancies remain, esp. in developing countries → further analyses needed.
- Future improvements:
  - Global models: better representation of forest demography and land management processes, more disaggregated results (e.g. forest NBP at grid level; categories comparable to NGHGIs)
  - NGHGIs: more complete estimates (non-forest land uses, soils), greater use of RS/models, transparency (description of processes included, map of managed lands)
- Irrespective of the attribution of the CO_2 flux in managed land (i.e., if anthropogenic or natural, which has implications for countries' targets), understanding *where* this flux occurs (*which country, land use, pool*) is crucial to **support investment in land use mitigation** and to **assess the countries' collective progress under the Paris Agreement**.

Thank you!

Extras slides


Global LULUCF fluxes, Gt CO_2 yr^{-1}
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
2000
2005
2010
2015
2020
BMs in Global carbon budget 2020 and IPCC AR6
IAMs (Grassi et al. 2021)
NGHGIs (Grassi et al. 2021)
gap of 5.5 $GtCO_2$ yr^{-1} for 2005-2015 (Grassi et al. 2021)
BMs in Global carbon budget 2021
NGHGIs (Grassi et al. 2022)
gap of 6.0 $GtCO_2$ yr^{-1} for 2001-2020 (this study)