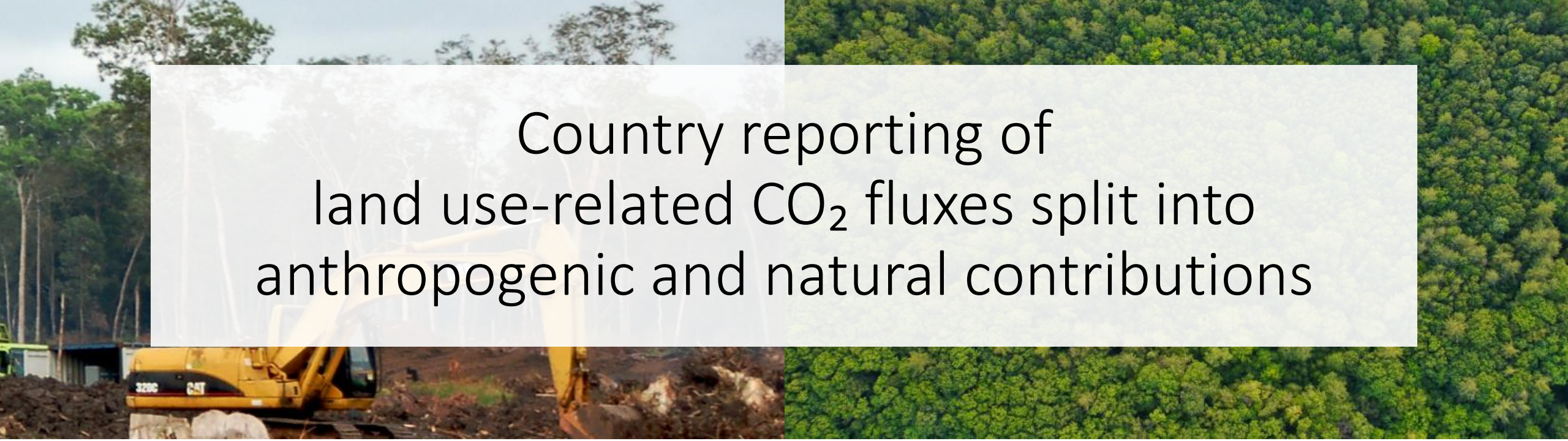


Country reporting of land use-related CO_2 fluxes split into anthropogenic and natural contributions

Clemens Schwingshackl (Ludwig-Maximilians-Universität München)

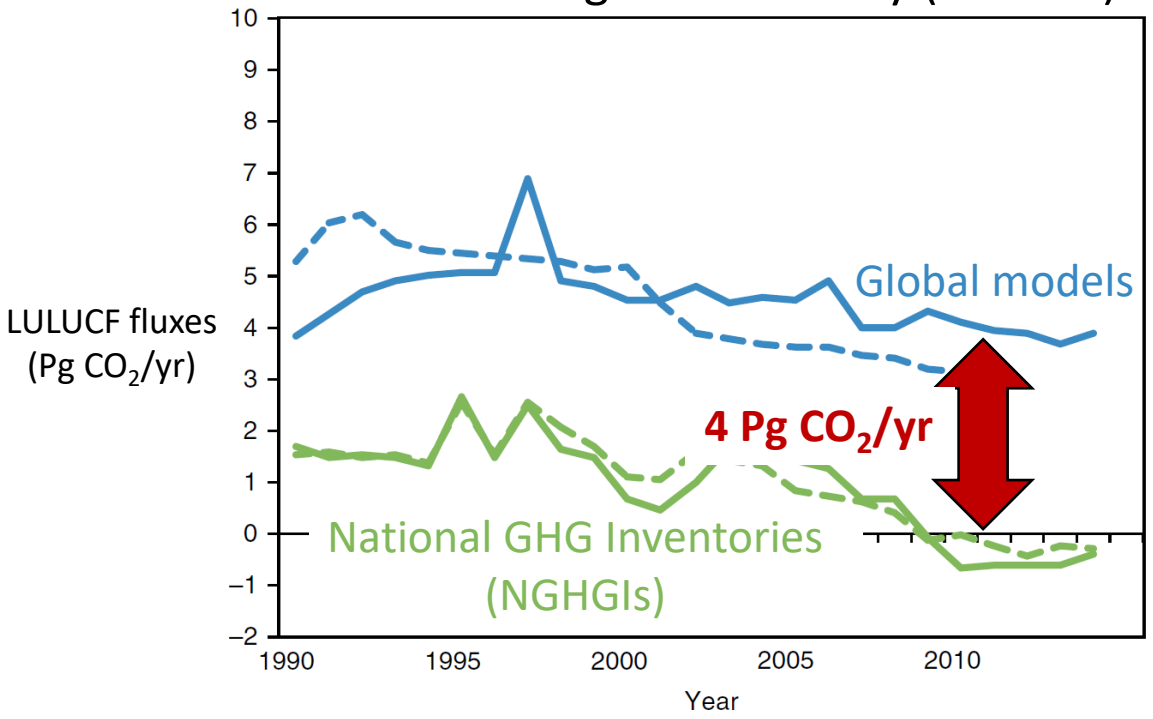
Wolfgang Obermeier, Selma Bultan, Giacomo Grassi, Josep G. Canadell, Pierre Friedlingstein, Thomas Gasser, Richard A. Houghton, Werner A. Kurz, Stephen Sitch, Julia Pongratz

Living Planet Symposium 2022

25.5.2022

Background: Gap in land-use related CO_2 fluxes

Global anthropogenic CO_2 fluxes from land use, land use change and forestry (LULUCF)



Grassi et al. (2018)

Explanation of the gap (Grassi et al., 2018):

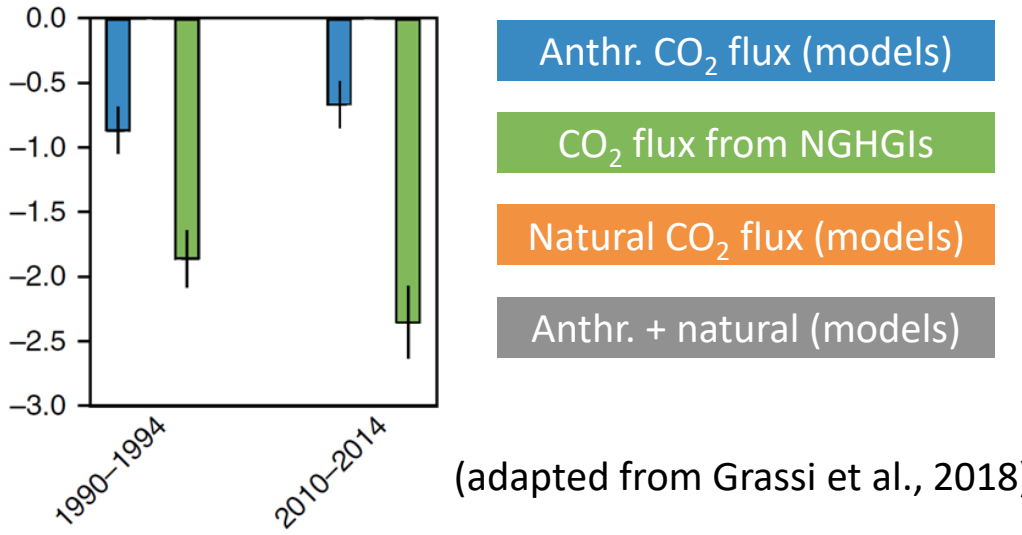
1. National GHG Inventories (NGHGIs) include natural fluxes on managed land
2. Managed land area in NGHGIs is larger than in bookkeeping models

Managed land proxy:
"Anthropogenic" land GHG fluxes are defined as all those occurring on "managed land",

Background: Closing the gap

1. NGHGIs include natural fluxes on managed land:
   - Use bookkeeping models to calculate **anthropogenic** CO_2 fluxes
   - Use Dynamic Global Vegetation Models (DGVMs) to calculate **natural** CO_2 fluxes
2. Managed land area in NGHGIs is larger than in bookkeeping models:
   - Apply a spatial mask to identify managed lands in DGVMs
   - **Only** include natural CO_2 fluxes on managed land (*more precisely: managed forest*)

CO_2 fluxes in forests (Pg CO_2/yr)



(adapted from Grassi et al., 2018)

Gap can be reconciled at global scale

Background: Global Carbon Budget 2021

Earth System Science Data

Article

Articles / Volume 14, issue 4 / ESSD, 14, 1917–2005, 2022

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Earth Syst. Sci. Data, 14, 1917–2005, 2022
https://doi.org/10.5194/essd-14-1917-2022

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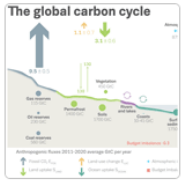
Data description paper

26 Apr 2022

Global Carbon Budget 2021



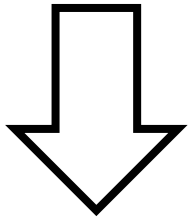
Pierre Friedlingstein[1,2], Matthew W. Jones[3], Michael O'Sullivan[1], Robbie M. Andrew[4], Dorothee C. E. Bakker[5], Judith Hauck[6], Corinne Le Quéré[3], Glen P. Peters[4], Wouter Peters[7,8], Julia Pongratz[9,10], Stephen Sitch[11], Josep G. Canadell[12], Philippe Ciais[13], Rob B. Jackson[14], Simone R. Alin[15], Peter Anthoni[16], Nicholas R. Bates[17], Meike Becker[18,19], Nicolas Bellouin[20], Laurent Bopp[2], Thi Tuyet Trang Chau[13], Frédéric Chevallier[13], Louise P. Chini[21], Margot Cronin[22], Kim I. Currie[23], Bertrand Decharme[24], Laique M. Djeutchouang[25,26], Xinyu Dou[27], Wiley Evans[28], Richard A. Feely[15], Liang Feng[29], Thomas Gasser[30], Dennis Gilfillan[31], Thanos Gkritzalis[32], Giacomo Grassi[33], Luke Gregor[34], Nicolas Gruber[34], Özgür Gürses[6], Ian Harris[35], Richard A. Houghton[36], George C. Hurtt[21], Yosuke Iida[37], Tatiana Ilyina[10], Ingrid T. Luijkx[7], Atul Jain[38], Steve D. Jones[18,19], Etsushi Kato[39], Daniel Kennedy[40], Kees Klein Goldewijk[41], Jürgen Knauer[12,42], Jan Ivar Korsbakken[4], Arne Körtzinger[43], Peter Landschützer[10], Siv K. Lauvset[19,44], Nathalie Lefèvre[45], Sebastian Lienert[46], Junjie Liu[47], Gregg Marland[48,49], Patrick C. McGuire[50], Joe R. Melton[51], David R. Munro[52,53], Julia E. M. S. Nabel[10,54], Shin-Ichiro Nakaoka[55], Yosuke Niwa[55,56], Tsuneo Ono[57], Denis Pierrot[58], Benjamin Poulter[59], Gregor Rehder[60], Laure Resplandy[61], Eddy Robertson[62], Christian Rödenbeck[54], Thais M. Rosan[11], Jörg Schwinger[44,19], Clemens Schwingshackl[9], Roland Séférian[24], Adrienne J. Sutton[15], Colm Sweeney[53], Toste Tanhua[43], Pieter P. Tans[63], Hanqin Tian[64], Bronte Tilbrook[65,66], Francesco Tubiello[67], Guido R. van der Werf[68], Nicolas Vuichard[13], Chisato Wada[55], Rik Wanninkhof[58], Andrew J. Watson[11], David Willis[3], Andrew J. Wiltshire[62], Wenping Yuan[69], Chao Yue[13], Xu Yue[70], Sönke Zaehle[54], and Jiye Zeng[55]

GCB 2021 includes for the first time a comparison of model estimates with National GHG Inventories (NGHGIs) at global scale

… but what about comparisons at smaller scales?

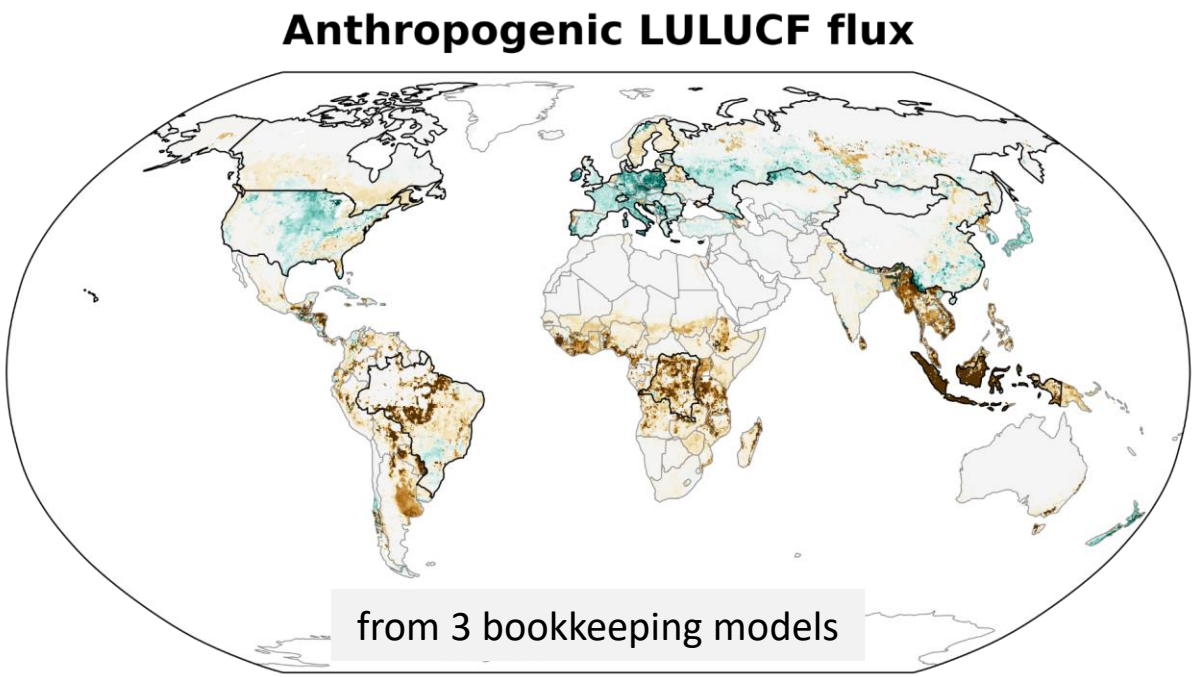
Methodology

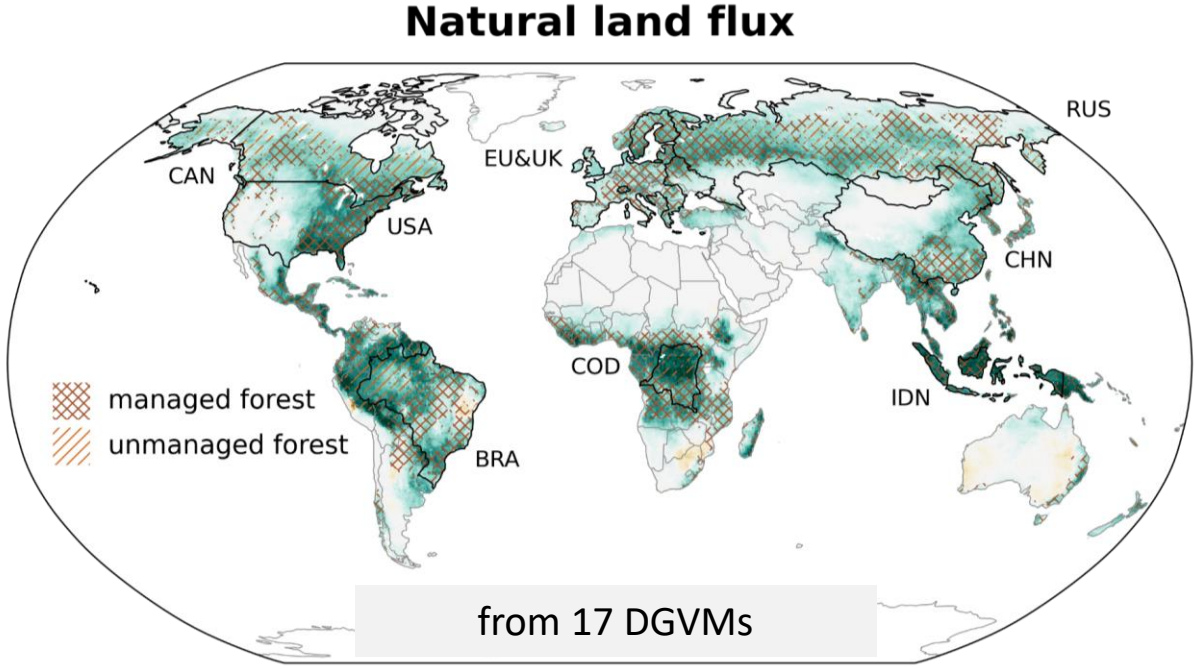
Apply method for closing the gap at country-level

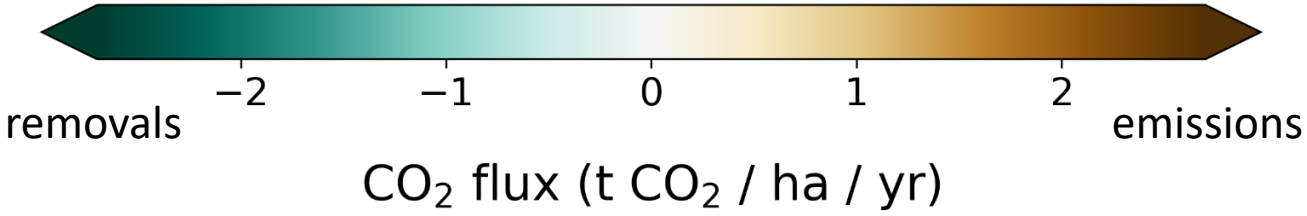


Analyze to which extent different countries include the natural sink in their NGHGI estimates

Results: Anthropogenic and natural CO_2 fluxes

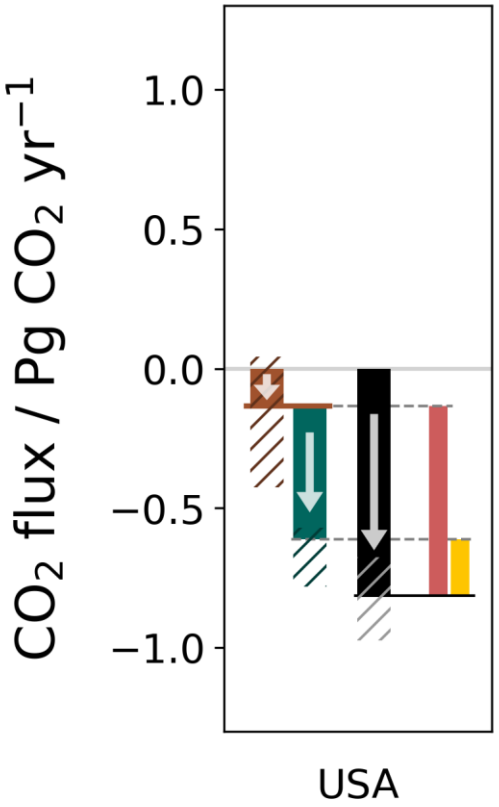






2001-2015

Results: Combining the different fluxes



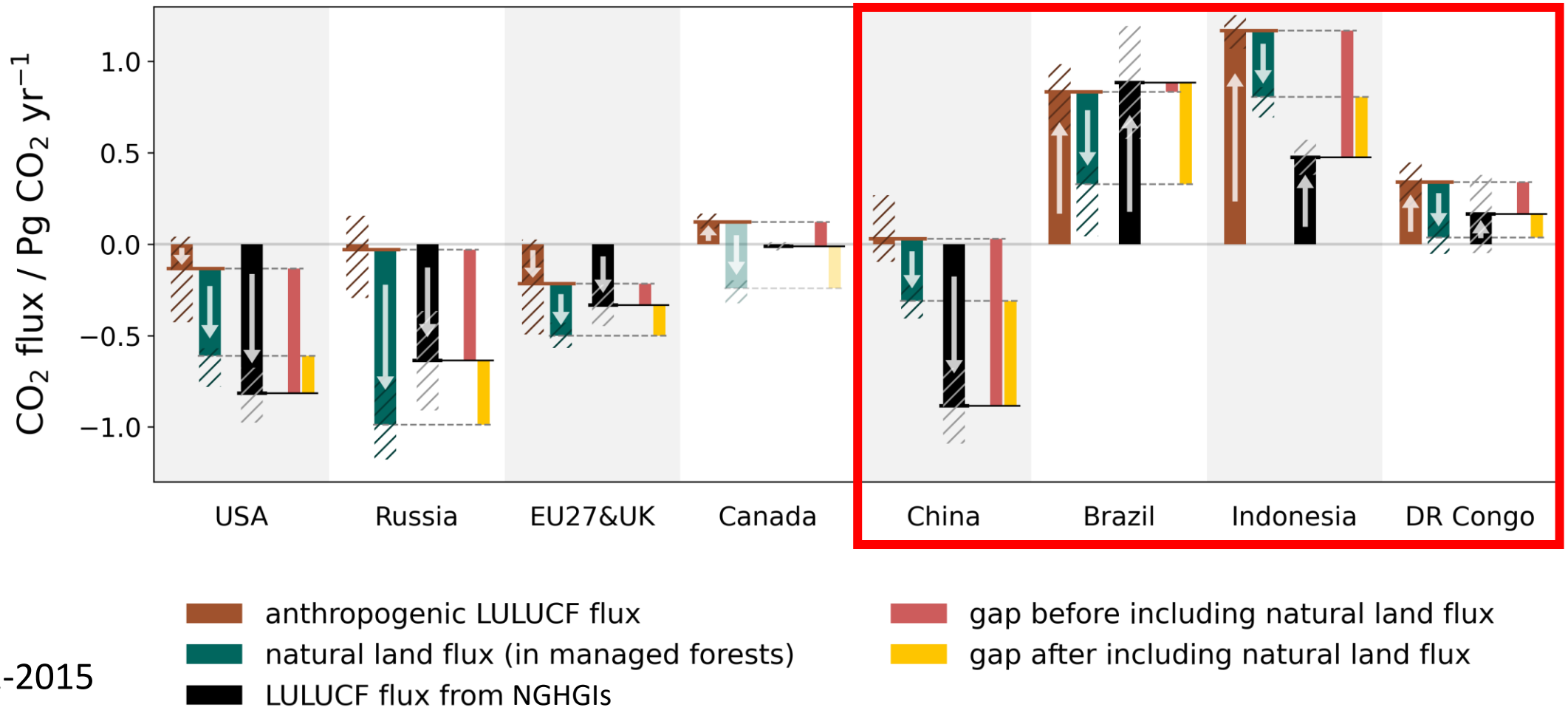
Gap in USA considerably reduced when considering natural CO_2 flux in managed forest

anthropogenic LULUCF flux
natural land flux (in managed forests)
LULUCF flux from NGHGI

gap before including natural land flux
gap after including natural land flux

2001-2015

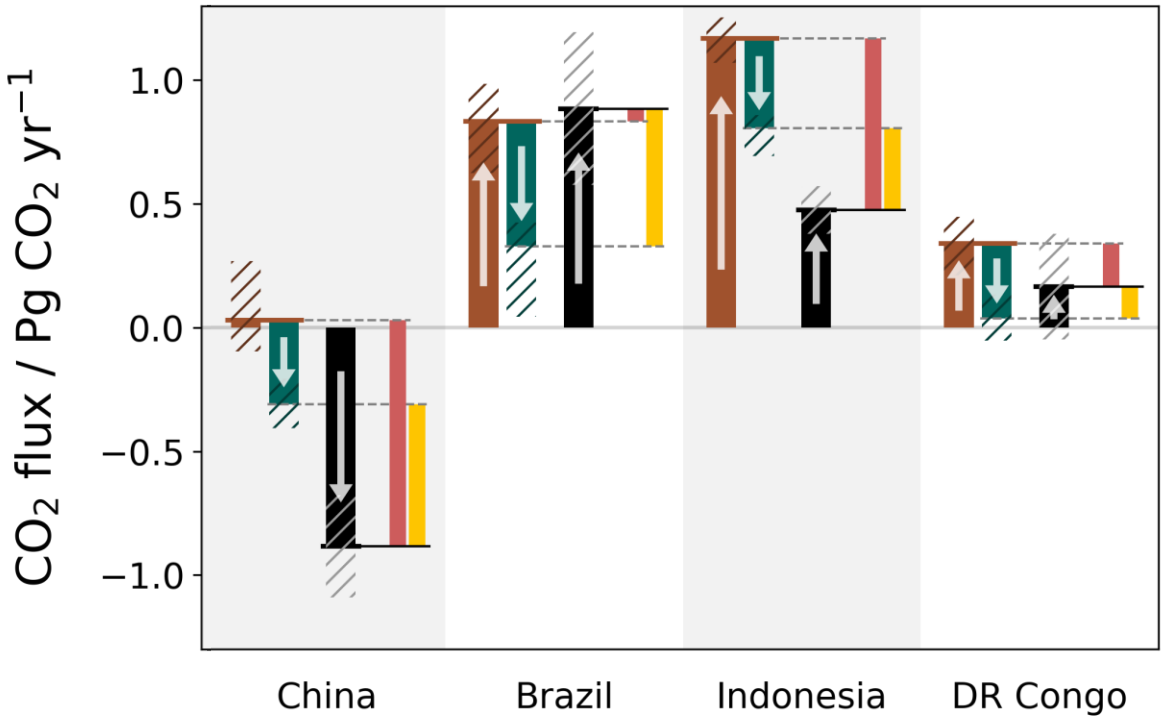
Results: Eight exemplary regions/countries



2001-2015

Results: Potential explanations for remaining gaps

- **China**: Incomplete representation of afforestation in bookkeeping models
- **Brazil**: Mismatch in gross deforestation areas; natural disturbance not sufficiently considered in models
- **Indonesia**: Anthropogenic degradation underestimated in National GHG Inventory
- **DR Congo**: Estimates from different national reports uncertain and incomplete



2001-2015

anthropogenic LULUCF flux
natural land flux (in managed forests)
LULUCF flux from NGHGIs
gap before including natural land flux
gap after including natural land flux

Implications and potentials

1. Climate mitigation:
   - Need for consistent estimations of anthropogenic land-use CO_2 fluxes
   - Mitigation activities only sustainable if creating CO_2 sinks additional to natural fluxes

2. Remote-sensing products:
   - Deliver independent and spatially explicit estimates of land use and land cover change, changes in biomass, managed forest areas
   - Near real-time availability might provide a temporal extension of country reports, which are usually published with a lag of several years

Conclusions and outlook

Schwingshackl et al.: Separating natural and land-use CO_2 fluxes at country-level to reconcile land-based mitigation estimates (*in review*)

1. Separating natural and land-use CO_2 fluxes **at country-level is possible** by means of models (bookkeeping + DGVMs)
2. Including natural CO_2 fluxes in managed forests **considerably reduces gap** in most investigated countries (by up to 70%)
3. Potential **improvements**:

   NGHGIs: More complete data on deforestation and anthropogenic degradation

   Models: Better representation of afforestation and natural disturbance