GLOBAL CARBON project

GLOBAL CARBON BUDGET 2022

The GCP is a Global Research Project of futureearth Research. Innovation. Sustainability. and a Research Partner of WCRP World Climate Research Programme

Published on 11 November 2022

PowerPoint version 0.6 (3 November 2022)

Contributors 105 people | 80 organisations | 18 countries

Earth Syst. Sci. Data, 14, 4811–4900, 2022
https://doi.org/10.5194/essd-14-4811-2022

Open Access Earth System Science Data

Global Carbon Budget 2022

Pierre Friedlingstein[1,2], Michael O'Sullivan[1], Matthew W. Jones[3], Robbie M. Andrew[4], Luke Gregor[5], Judith Hauck[6], Corinne Le Quéré[3], Ingrid T. Luijkx[7], Are Olsen[8,9], Glen P. Peters[4], Wouter Peters[7,10], Julia Pongratz[11,12], Clemens Schwingshackl[11], Stephen Sitch[1], Josep G. Canadell[13], Philippe Ciais[14], Robert B. Jackson[15], Simone R. Alin[16], Ramdane Alkama[17], Almut Arneth[18], Vivek K. Arora[19], Nicholas R. Bates[20,21], Meike Becker[8,9], Nicolas Bellouin[22], Henry C. Bittig[23], Laurent Bopp[2], Frédéric Chevallier[14], Louise P. Chini[24], Margot Cronin[25], Wiley Evans[26], Stefanie Falk[11], Richard A. Feely[16], Thomas Gasser[27], Marion Gehlen[14], Thanos Gkritzalis[28], Lucas Gloege[29,30], Giacomo Grassi[17], Nicolas Gruber[5], Özgür Gürses[6], Ian Harris[31], Matthew Hefner[32,33], Richard A. Houghton[34], George C. Hurtt[24], Yosuke Iida[35], Tatiana Ilyina[12], Atul K. Jain[36], Annika Jersild[12], Koji Kadono[35], Etsushi Kato[37], Daniel Kennedy[38], Kees Klein Goldewijk[39], Jürgen Knauer[40,41], Jan Ivar Korsbakken[4], Peter Landschützer[12,28], Nathalie Lefèvre[42], Keith Lindsay[43], Junjie Liu[44], Zhu Liu[45], Gregg Marland[32,33], Nicolas Mayot[3], Matthew J. McGrath[14], Nicolas Metzl[42], Natalie M. Monacci[46], David R. Munro[47,48], Shin-Ichiro Nakaoka[49], Yosuke Niwa[49,40], Kevin O'Brien[51,16], Tsuneo Ono[52], Paul I. Palmer[53,54], Naiqing Pan[55,56], Denis Pierrot[57], Katie Pocock[26], Benjamin Poulter[58], Laure Resplandy[59], Eddy Robertson[60], Christian Rödenbeck[61], Carmen Rodriguez[62], Thais M. Rosan[1], Jörg Schwinger[63,9], Roland Séférian[64], Jamie D. Shutler[1], Ingunn Skjelvan[63,9], Tobias Steinhoff[65], Qing Sun[66], Adrienne J. Sutton[16], Colm Sweeney[48], Shintaro Takao[49], Toste Tanhua[65], Pieter P. Tans[67,68], Xiangjun Tian[69], Hanqin Tian[56], Bronte Tilbrook[70,71], Hiroyuki Tsujino[50], Francesco Tubiello[72], Guido R. van der Werf[73], Anthony P. Walker[74], Rik Wanninkhof[57], Chris Whitehead[75], Anna Willstrand Wranne[76], Rebecca Wright[3], Wenping Yuan[77], Chao Yue[78], Xu Yue[79], Sönke Zaehle[61], Jiye Zeng[49], and Bo Zheng[80]

https://doi.org/10.5194/essd-14-4811-2022

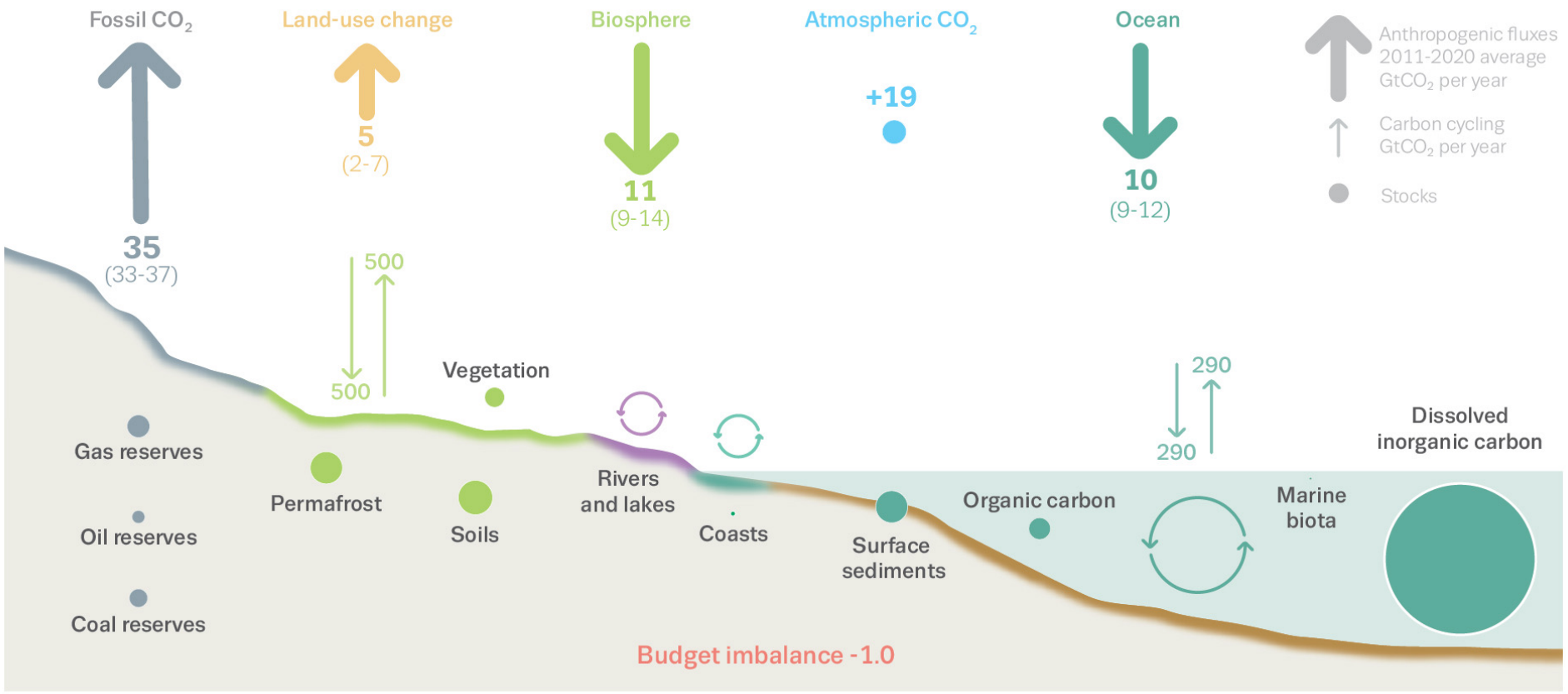
http://www.globalcarbonproject.org/carbonbudget
http://www.globalcarbonbudget.org/

www.globalcarbonatlas.org

Published on 11 November 2022

Anthropogenic perturbation of the global carbon cycle

global annual average for the decade 2012–2021 ($GtCO_2$/yr)



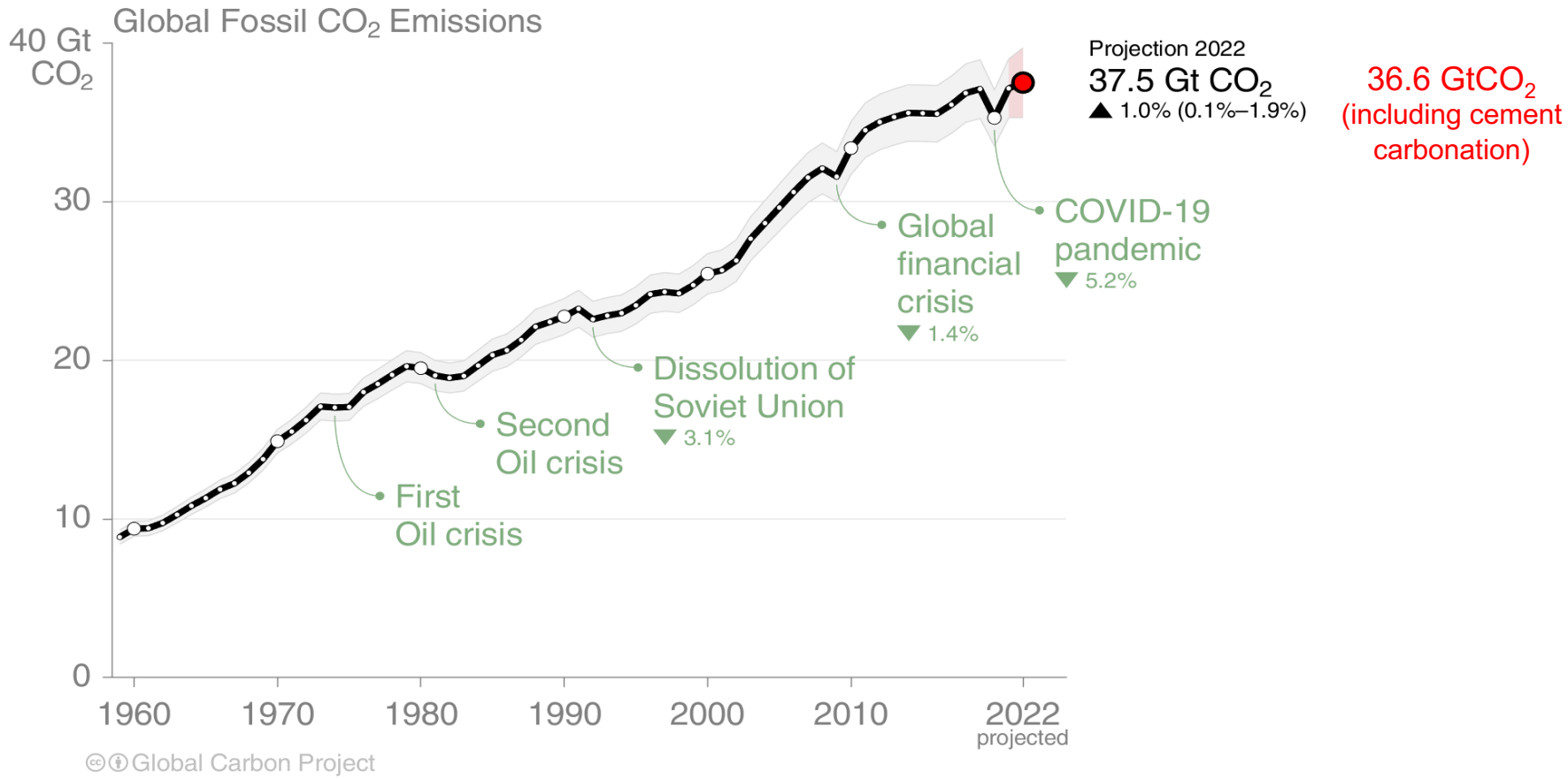
The budget imbalance is the difference between the estimated emissions and sinks.

Source: NOAA-ESRL; Friedlingstein et al 2022; Canadell et al 2021 (IPCC AR6 WG1 Chapter 5); Global Carbon Project 2022

Global Fossil CO_2 Emissions

Global Fossil CO_2 Emissions

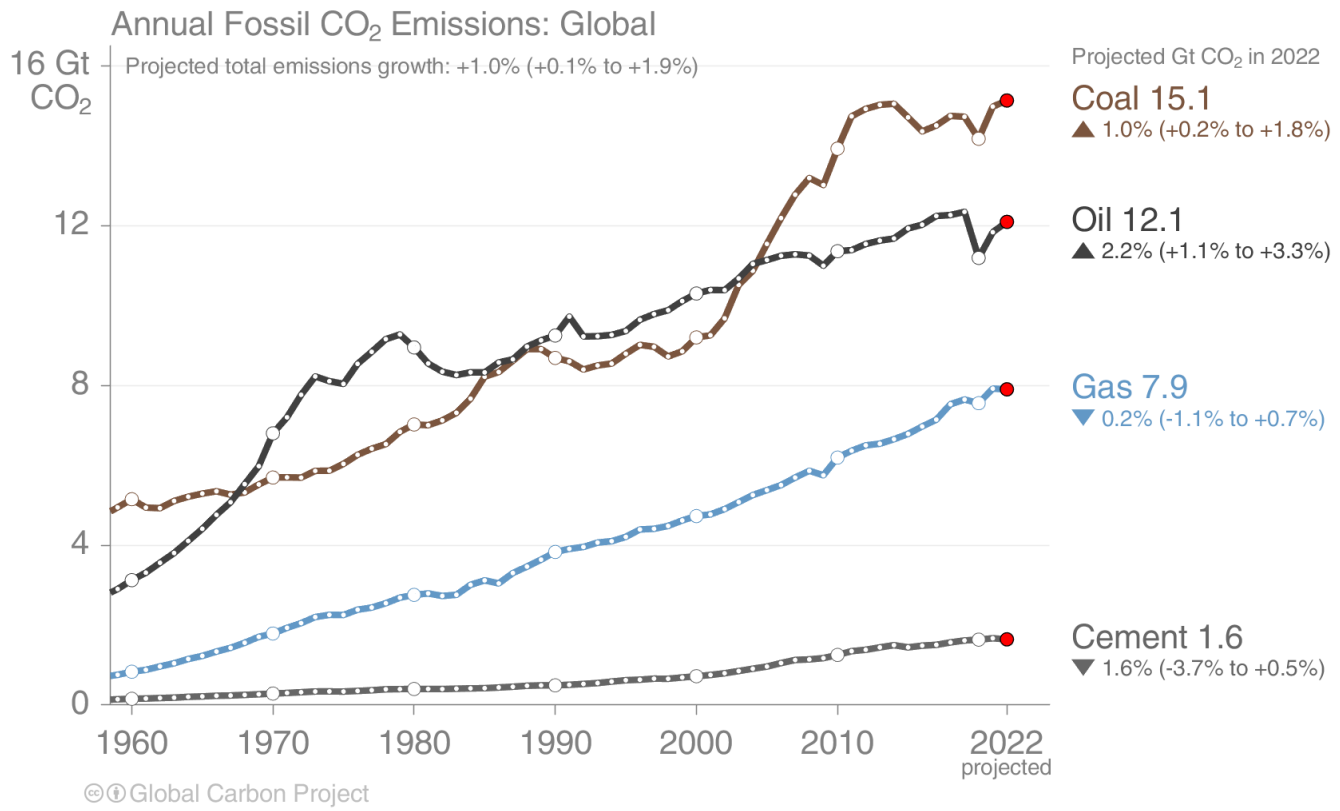
Emissions are set to grow 1% [0.1 to 1.9%] in 2022.
The rate of increase has slowed from 3% per year in the 2000s to about 0.5% per year in the past decade.



The 2022 projection is based on preliminary monthly data and modelling
When including cement carbonation, projected 2022 fossil emissions reach 36.6 $GtCO_2$
Source: Friedlingstein et al 2022; Global Carbon Project 2022

Fossil CO_2 Emissions by source

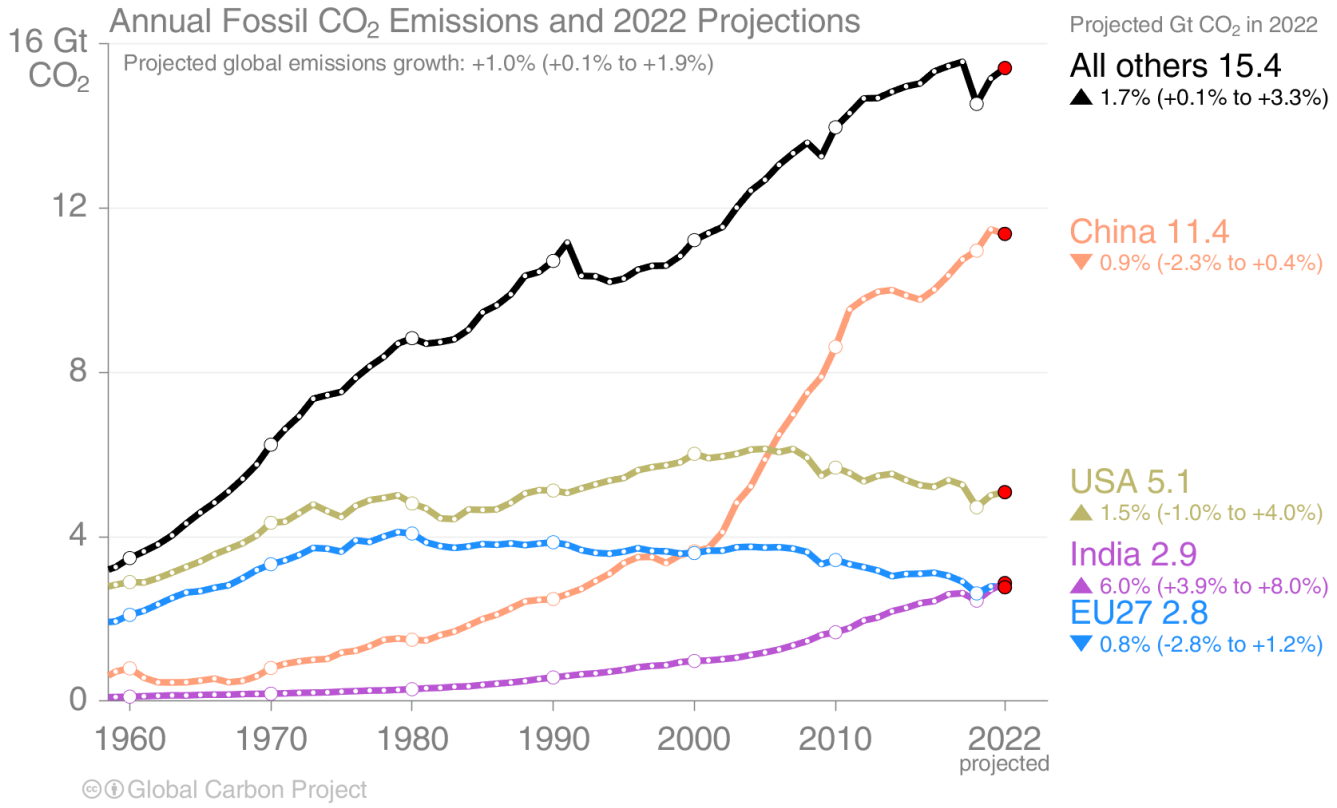
Global fossil CO_2 emissions from coal are expected to rise & may lead to a new global peak.
Emissions from oil expected to grow mainly from international aviation, but still remain below 2019 levels.
Emissions from gas are set for an small decline in 2022.



The 2022 projections are based on preliminary monthly data and modelling.
Source: Friedlingstein et al 2022; Global Carbon Project 2022

Fossil CO_2 Emissions by country

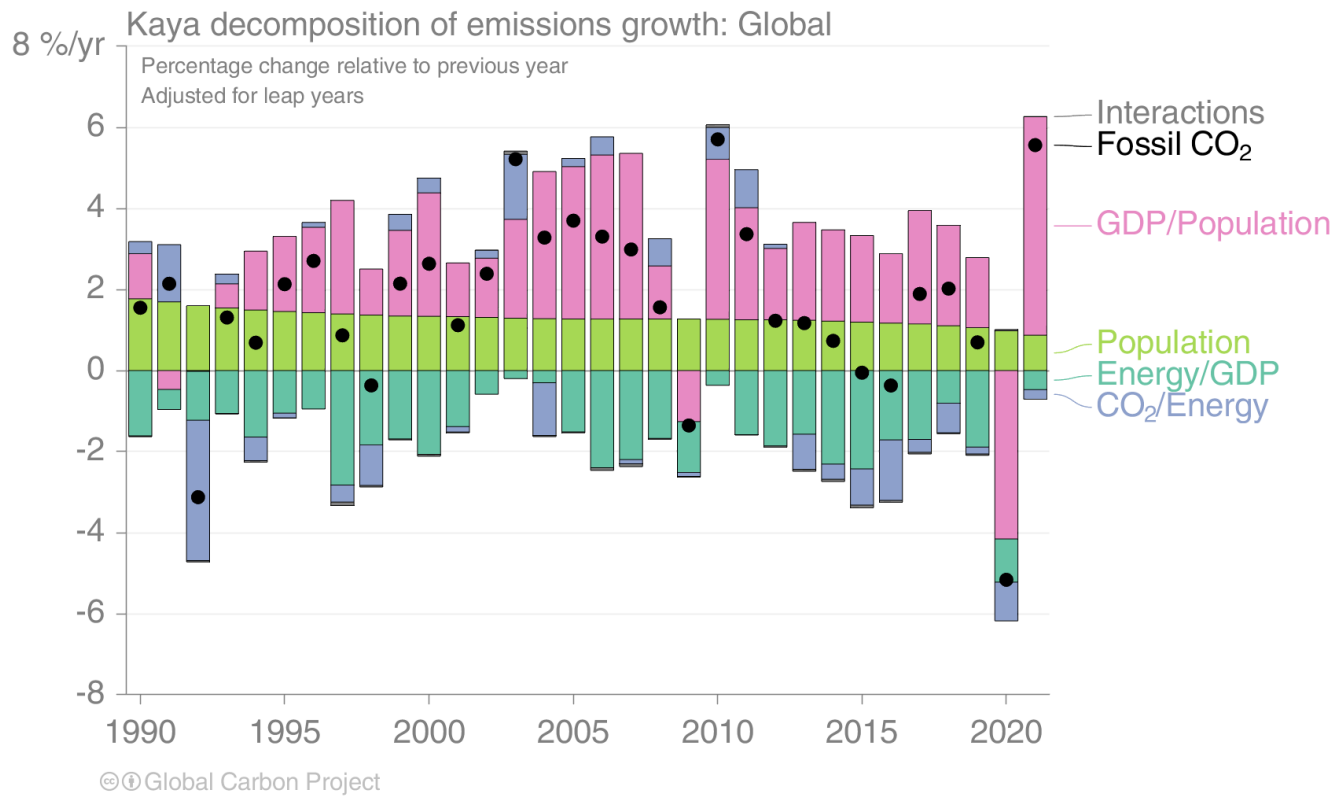
In 2022 the largest increases are in India, Rest of World (primarily aviation), and the USA.
Emissions are projected to decline in China and the EU27
Fossil CO_2 emissions decreased in 24 countries during the past decade



The 2022 projections are based on preliminary monthly data and modelling.
Source: Friedlingstein et al 2022; Global Carbon Project 2022

Fossil CO_2 emissions — Kaya decomposition to 2021

Globally: Decarbonisation (decrease in CO_2/energy) and declines in energy per GDP are largely responsible for the reduced growth rate in emissions over the last decade

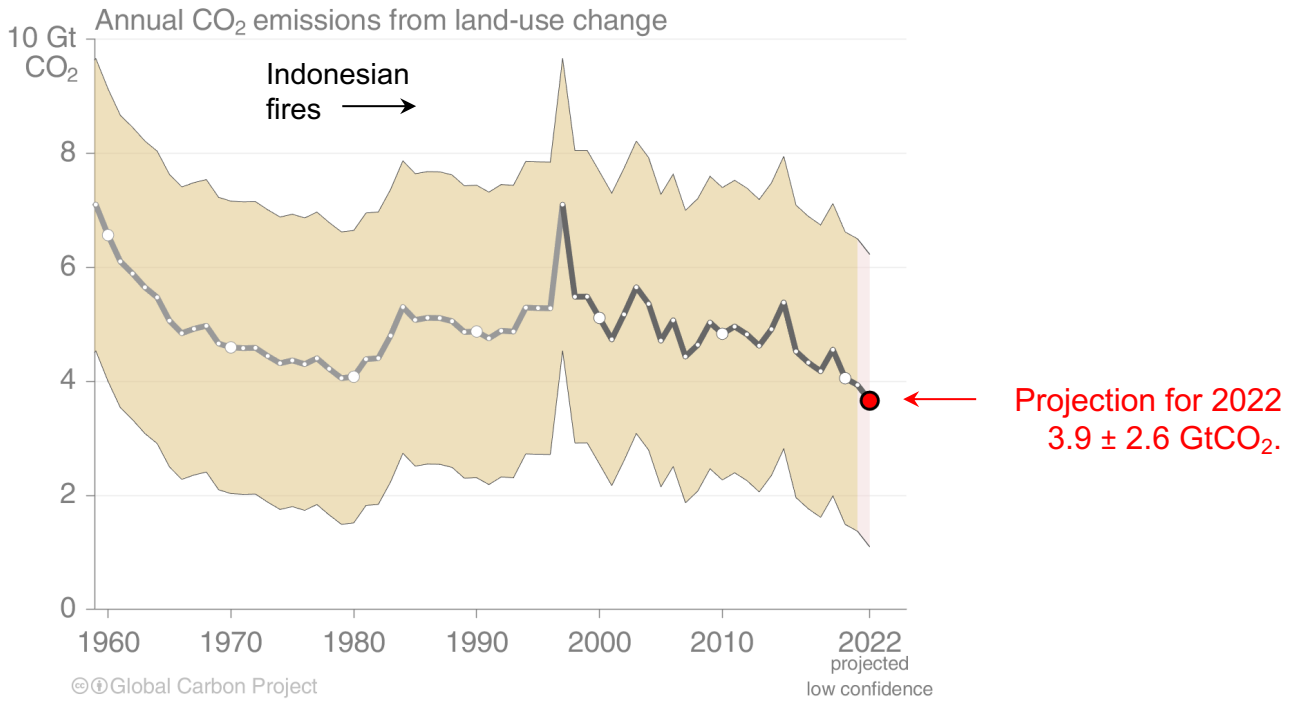


Source: Friedlingstein et al 2022; Global Carbon Project 2022

Land-use Change Emissions

Land-use change CO_2 emissions

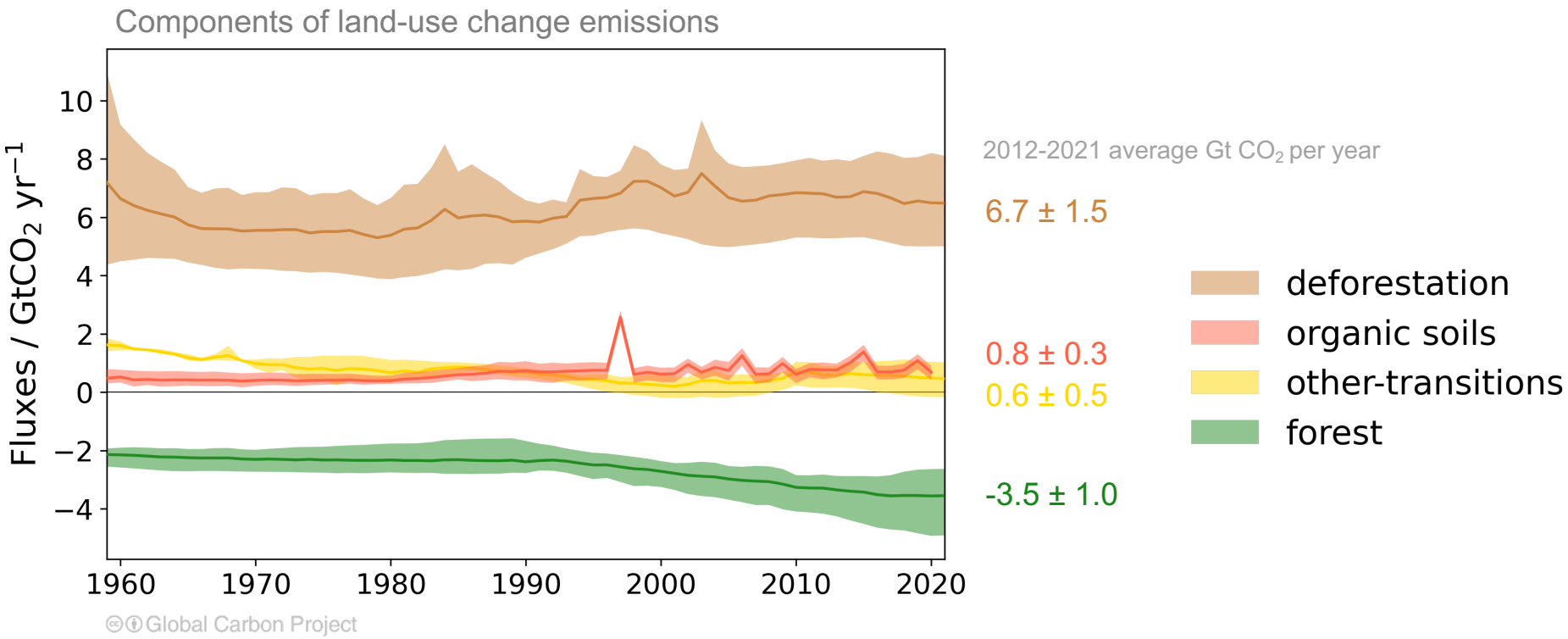
Land-use change emissions are projected to be 3.9 $GtCO_2$ in 2022, ten times less than fossil emissions.
There is a small but uncertain decline in the past two decades.



Estimates from three bookkeeping models
Source: Friedlingstein et al 2022; Global Carbon Project 2022

Drivers of land-use change CO_2 emissions

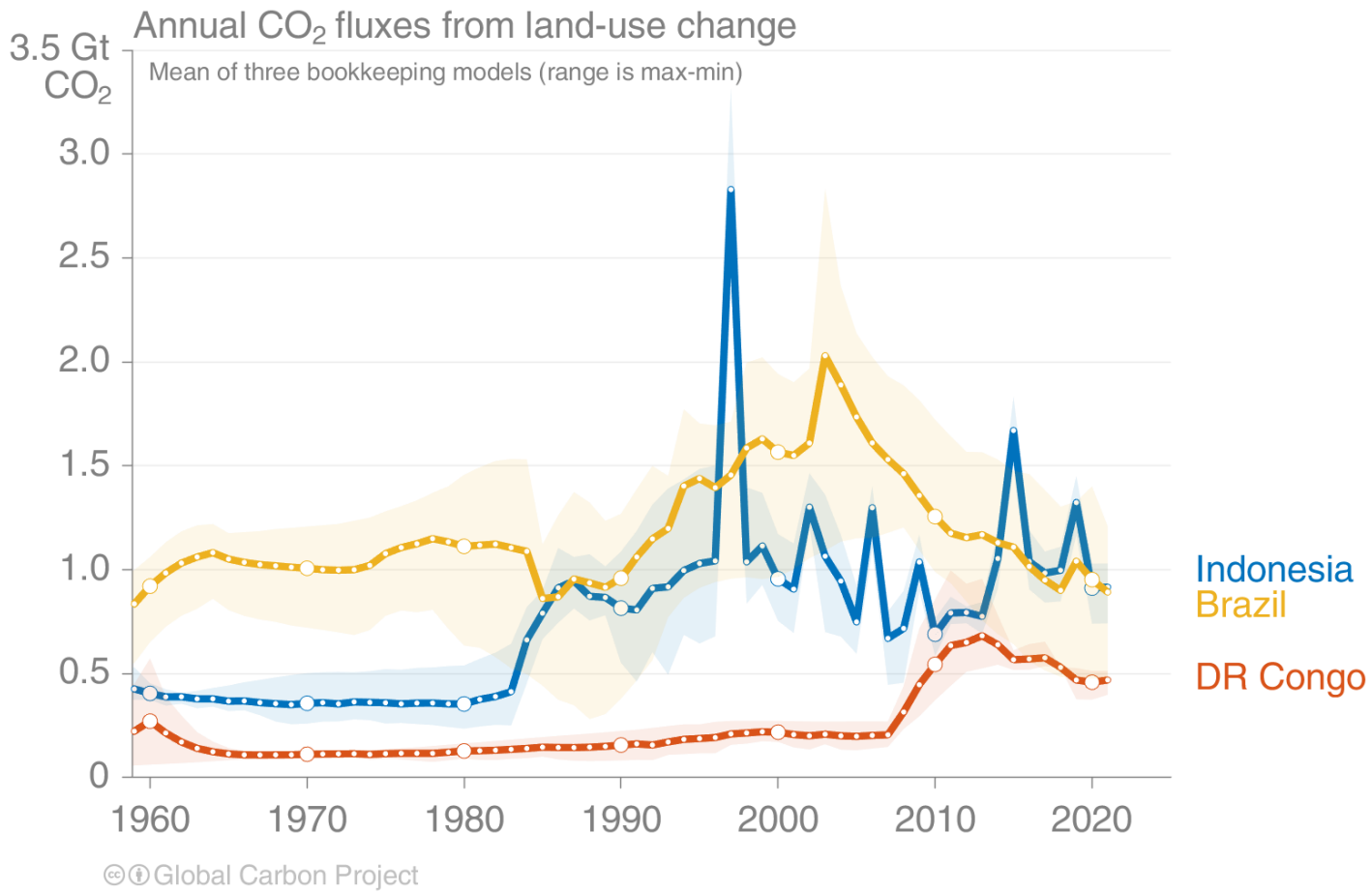
Deforestation, the main driver of land-use emissions, remains high in the last decade.
Removals through re/afforestation counterbalance approximately half the deforestation emissions.



Estimates from three bookkeeping models
Source: Friedlingstein et al 2022; Global Carbon Project 2022

Land-use change CO_2 emissions

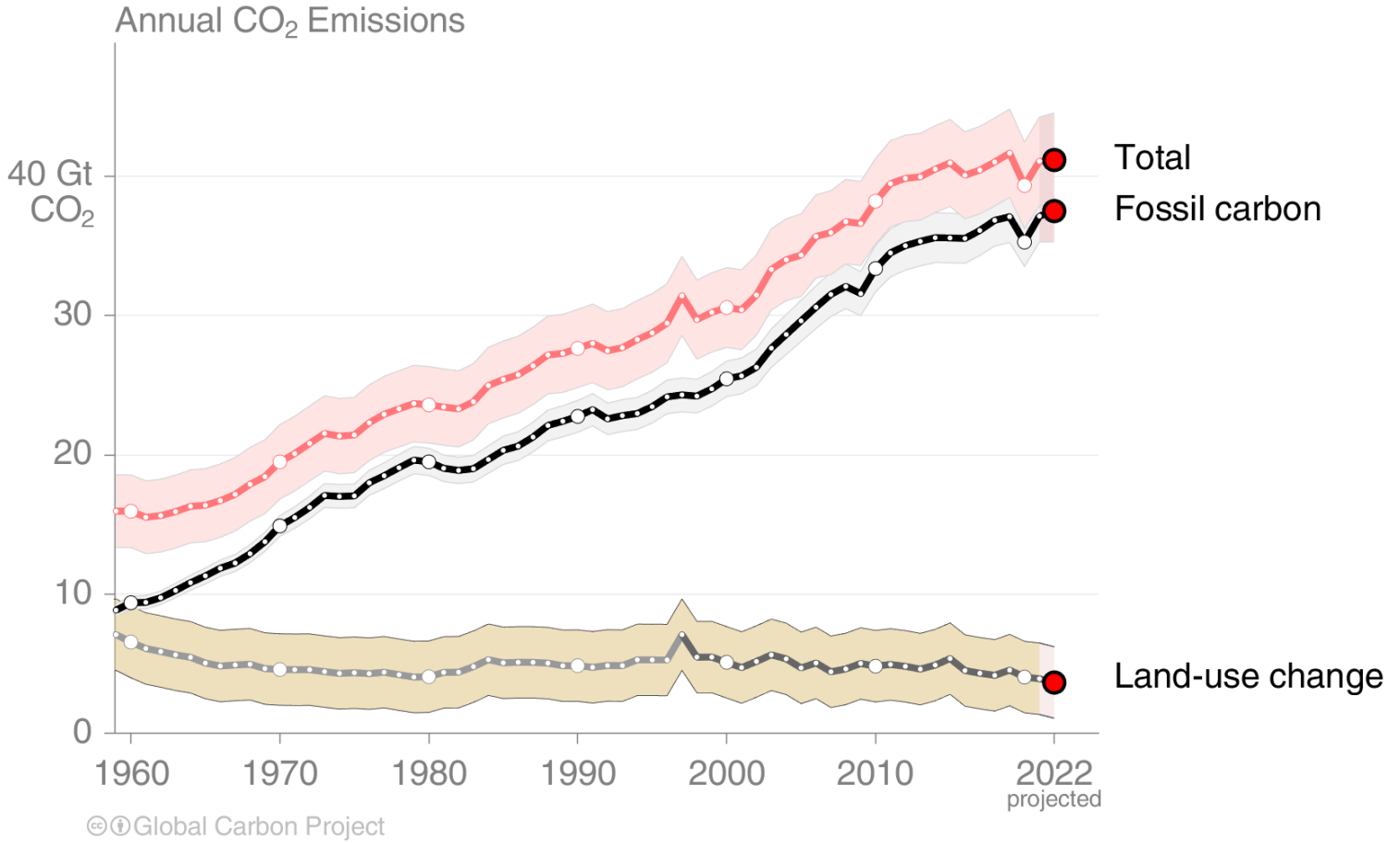
Indonesia, Brazil, the Democratic Republic of the Congo combined contribute 58% of the global total land-use change CO_2 emissions.



The peak in Indonesia in 1997 was the Indonesian peat fires
Estimates from three bookkeeping models
Source: Friedlingstein et al 2022; Global Carbon Project 2022

Total global CO_2 emissions

Total global CO_2 emissions of **40.6** are projected for 2022.
Emissions remain high but approximately flat since 2015, but this trend is uncertain.

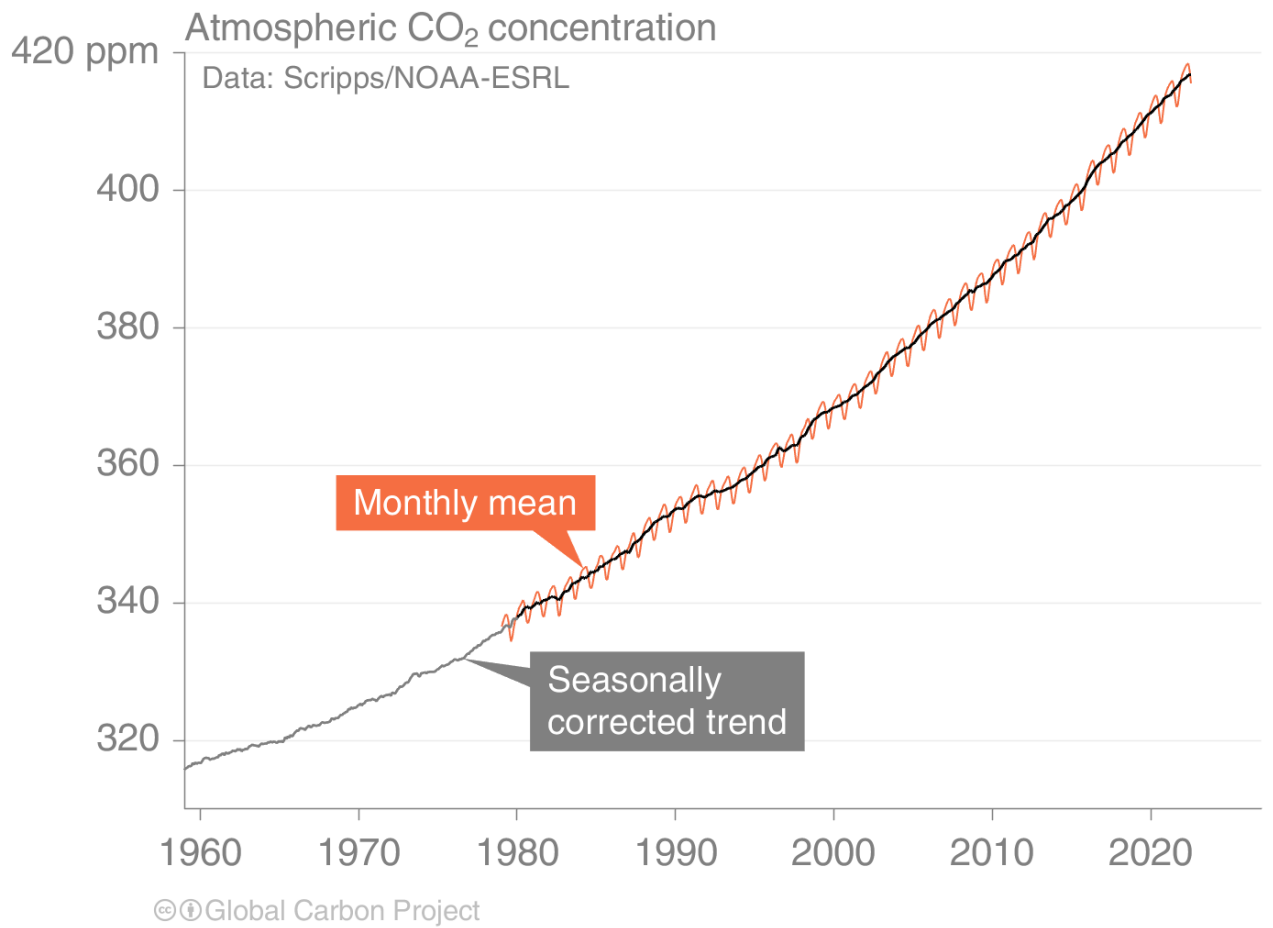


Source: Friedlingstein et al 2022; Global Carbon Project 2022

Closing the Global Carbon Budget

Atmospheric CO_2 concentration

The global CO_2 concentration increased from ~277 ppm in 1750 to 417.2 ppm in 2022 (up 51%)

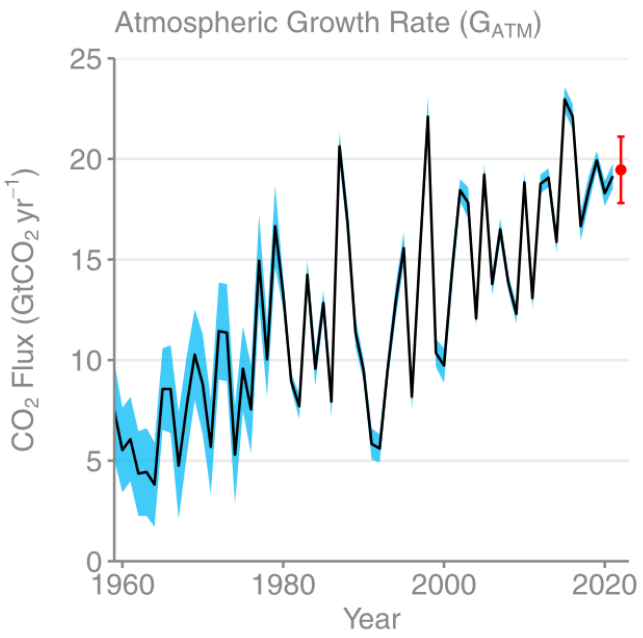


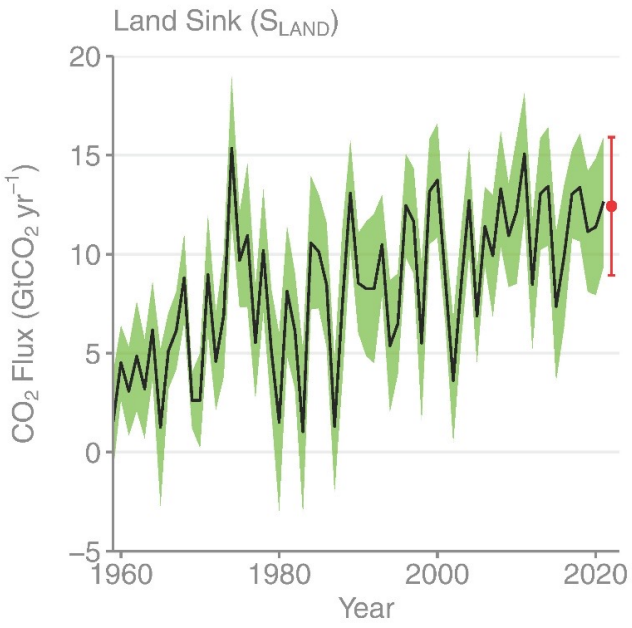
Globally averaged surface atmospheric CO_2 concentration. Data from: NOAA-ESRL after 1980; the Scripps Institution of Oceanography before 1980

Source: NOAA-ESRL; Scripps Institution of Oceanography; Friedlingstein et al 2022; Global Carbon Project 2022

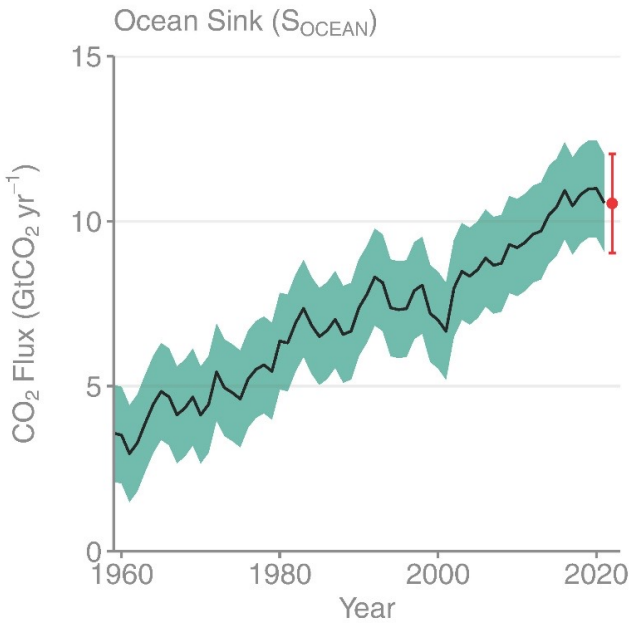
Changes in the partitioning of the emissions over time

The ocean and land sinks have continued to grow with increasing atmospheric CO_2 and to take up around half of the emissions. Climate change is already reducing these growths by about 4% (ocean sink) and 17% (land sink).





29% of total emissions



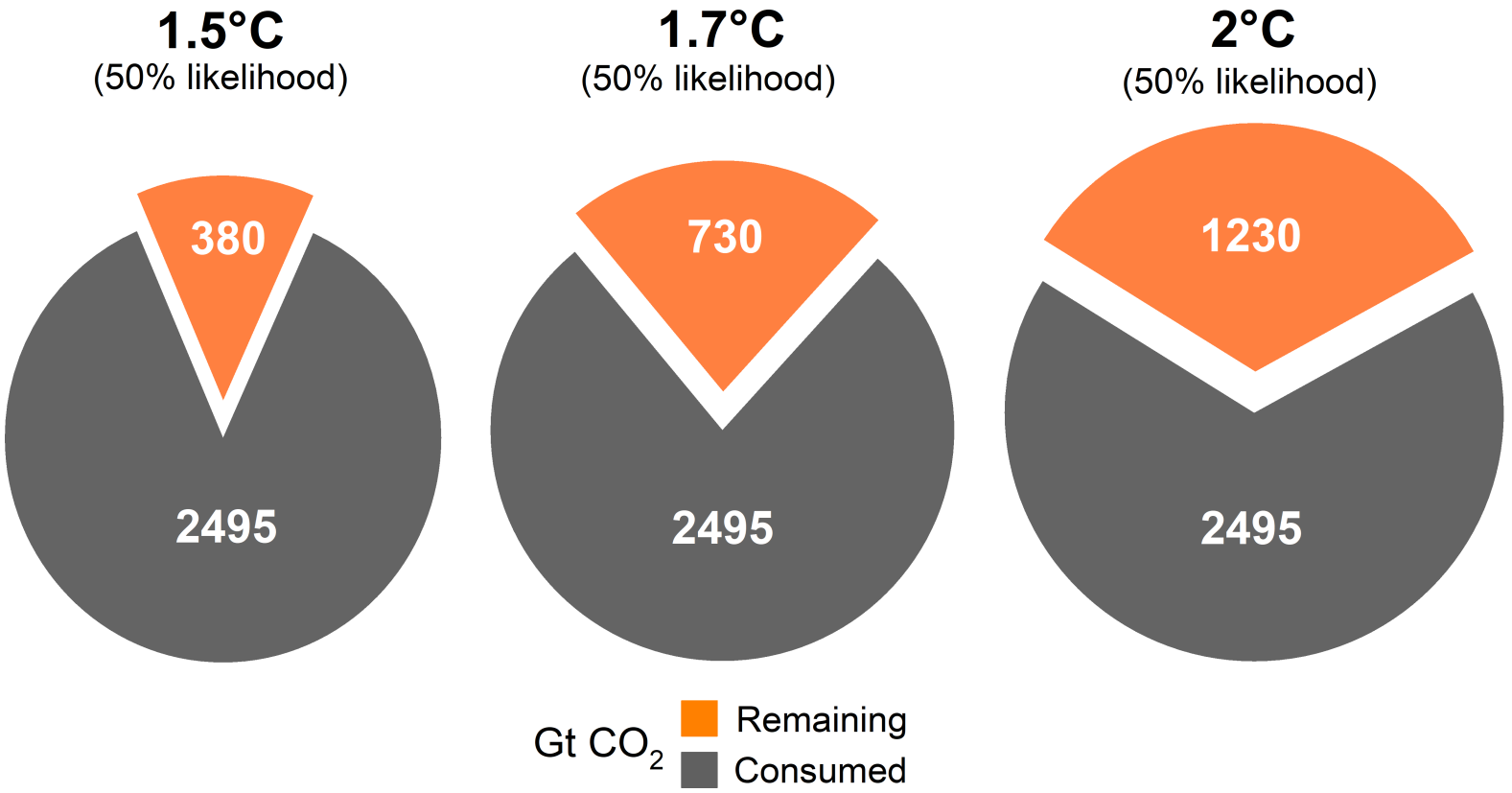
26% of total emissions

Source: Friedlingstein et al 2022; Global Carbon Project 2022

Tracking progress towards mitigation targets

Remaining carbon budget

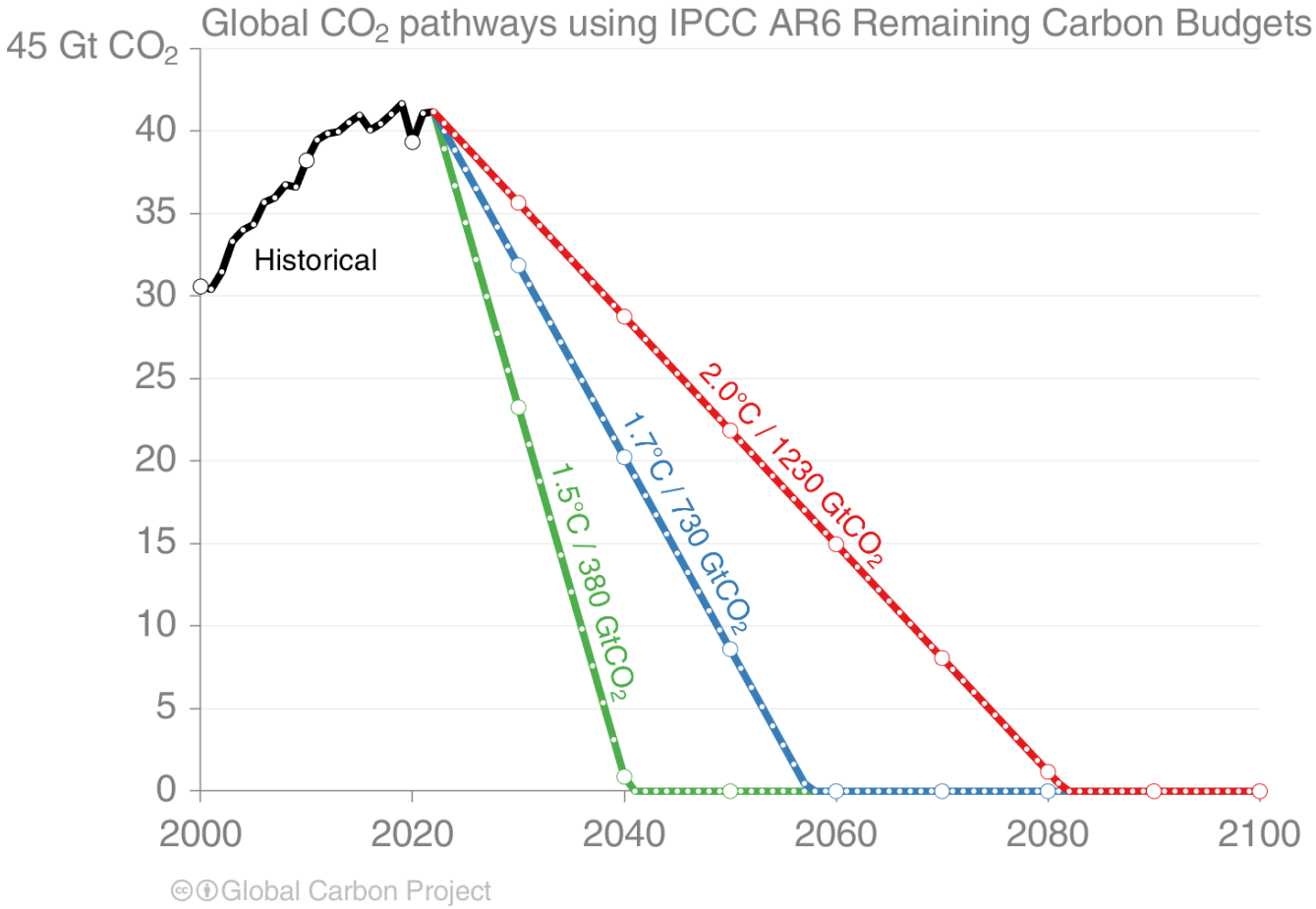
The remaining carbon budget for a 50% likelihood to limit global warming to 1.5°C , 1.7°C and 2°C has reduced to an equivalent of 9, 18 and 30 years from 2023 (at 2022 emissions levels).
2495 $GtCO_2$ have been emitted since 1850.



The remaining carbon budgets are updated from IPCC AR6 WG1 by removing additional historical emissions since 1 January 2020.
Quantities are subject to additional uncertainties e.g., future mitigation choices of non-CO_2 emissions.
Source: IPCC AR6 WG1; Friedlingstein et al 2022; Global Carbon Budget 2022

Remaining carbon budget

Global CO_2 emissions must reach net zero to limit global warming.
Reaching net zero CO_2 emissions by 2050 would require a decrease of about 1.4 $GtCO_2$ each year, comparable to the COVID-related 2020 fall.



Source: Friedlingstein et al 2022; Global Carbon Project 2022

Acknowledgements

Acknowledgements

The work presented in the **Global Carbon Budget 2022** has been possible thanks to the contributions of **hundreds of people** involved in observational networks, modeling, and synthesis efforts.

We thank the institutions and agencies that provide support for individuals and funding that enable the collaborative effort of bringing all components together in the carbon budget effort.

We thank the sponsors of the GCP and GCP support and liaison offices.

We also want thank the EU/H2020 projects 4C (821003) and VERIFY (776810) that supported this coordinated effort as well as each of the many funding agencies that supported the individual components of this release. A full list in provided in Table A9 of Friedlingstein et al. 2022.

https://essd.copernicus.org/articles/14/4811/2022/

We also thanks the Fondation BNP Paribas for supporting the Global Carbon Atlas and the Integrated Carbon Observation System (ICOS) for hosting our data.

This presentation was created by Robbie Andrew and Pierre Friedlingstein with Pep Canadell, Glen Peters and Corinne Le Quéré in support of the international carbon research community.

License

Global Carbon Project

Our intention is that these figures and data are used. That's why they're released under the *Creative Commons Attribution 4.0 International license*. Simply put, you may freely copy and modify these figures and data, and use them in both commercial and non-commercial works, as long as you give credit to the Global Carbon Project.

If you're just tweeting a figure or using a figure in a presentation, then it already says at the bottom that it's by the Global Carbon Project, so you're good to go! If you use the data directly or modify the figure then you will need to make sure the attribution is in place.

For details on the license, visit the Creative Commons website.

Suggested citation for use in a book: "Used with permission of the Global Carbon Project under the Creative Commons Attribution 4.0 International license."