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UNI GRAZ

Climate Change Graz

Field of Excellence
University of Graz

Folienset • KSK & Klimawandel • Balance CO_2 Veranst. 2025 • 14 Okt 2025

Weblink-IPCC Science supporting policy & society to cope with the climate crisis: https://ipcc.ch/ar6 **Physical Climate Science Basis, Impacts, Adaptation, Mitigation, etc.**

Weblinks-News: GCCI & Carbon Management to achieve the Paris climate goals: https//gcci.earth, https://carbmanage.earth, https://www.uni-graz.at/en/news/uni-graz-zeigt-vor

Anmerkung: dieses Folienset ist nur für persönliche Nutzung und beschränkte Weitergabe zur persönl. Info; eine offene Onlinestellung (über die Balance CO_2 TN hinaus) ist nicht gestattet.

Kohlenstoffkreislauf und Klimawandel: Aktuelle Wissensbasis und welche Netto-Null CO_2-Emissionen die globale Erwärmung stoppen

Gottfried Kirchengast

Founding Director & Lead Scientist Wegener Center for Climate and Global Change (WEGC) and Climate Physics Group at Institute of Physics, University of Graz, Austria; Founding Speaker of Field of Excellence Climate Change Graz and Speaker EO & Climate Strategies, University of Graz

Member in the Field Environment & Climate of the Austrian Academy of Sciences (ÖAW)

Representative of Science in the Austrian National Climate Committee (NKK)

Die Klimaschutz-Herausforderung: Übergang zu Netto-Null CO_2-Emissionen bis etwa 2050…

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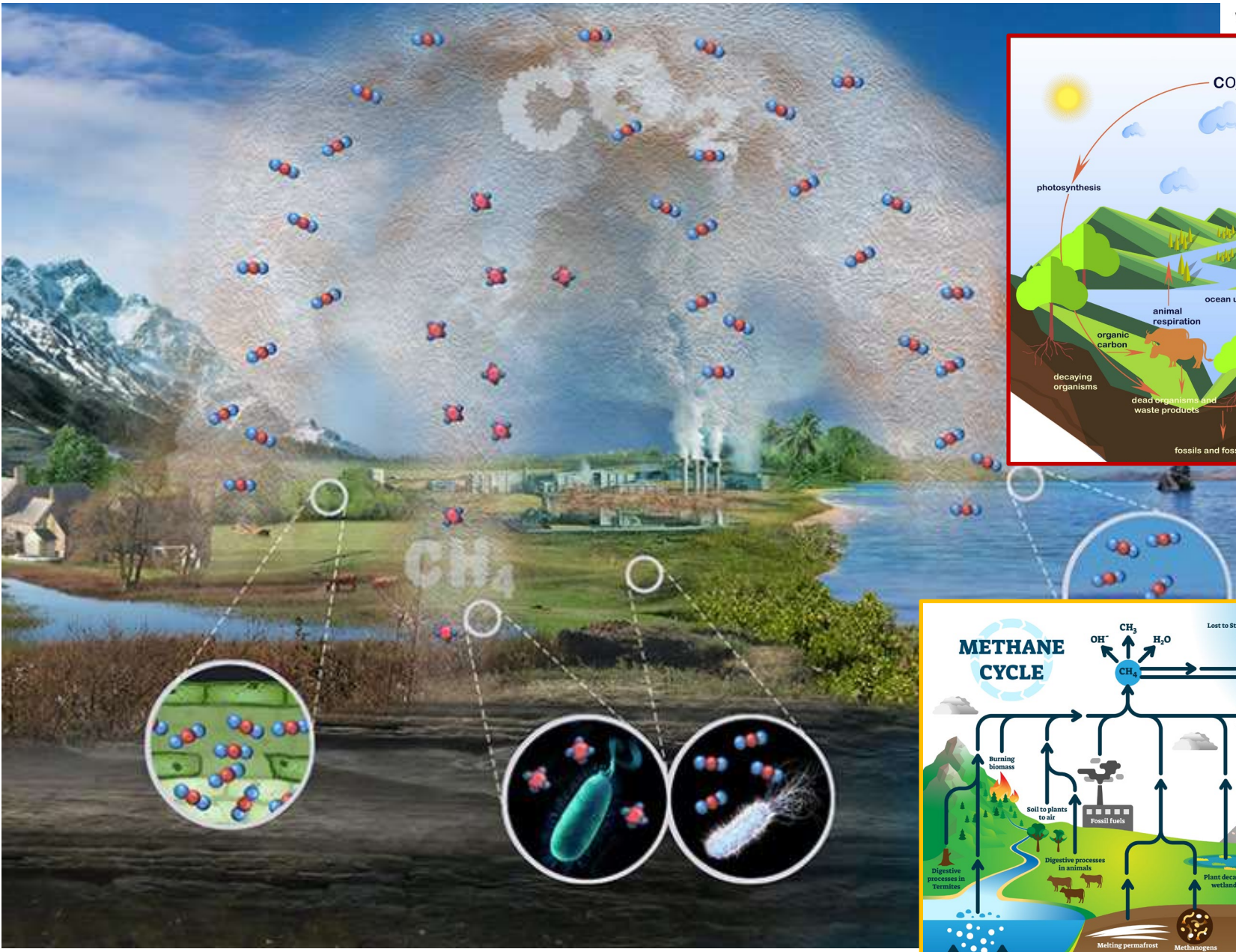

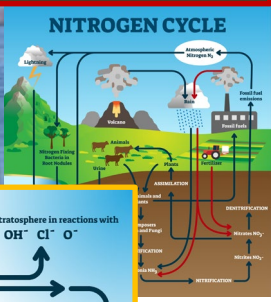

[Kaushik et al., Carbon Cycle & Changing Climate, EOS, 2020; insert figs: dreamstimepics-dl.2021]

Die Klimaschutz-Herausforderung: Übergang zu Netto-Null CO_2-Emissionen bis etwa 2050…

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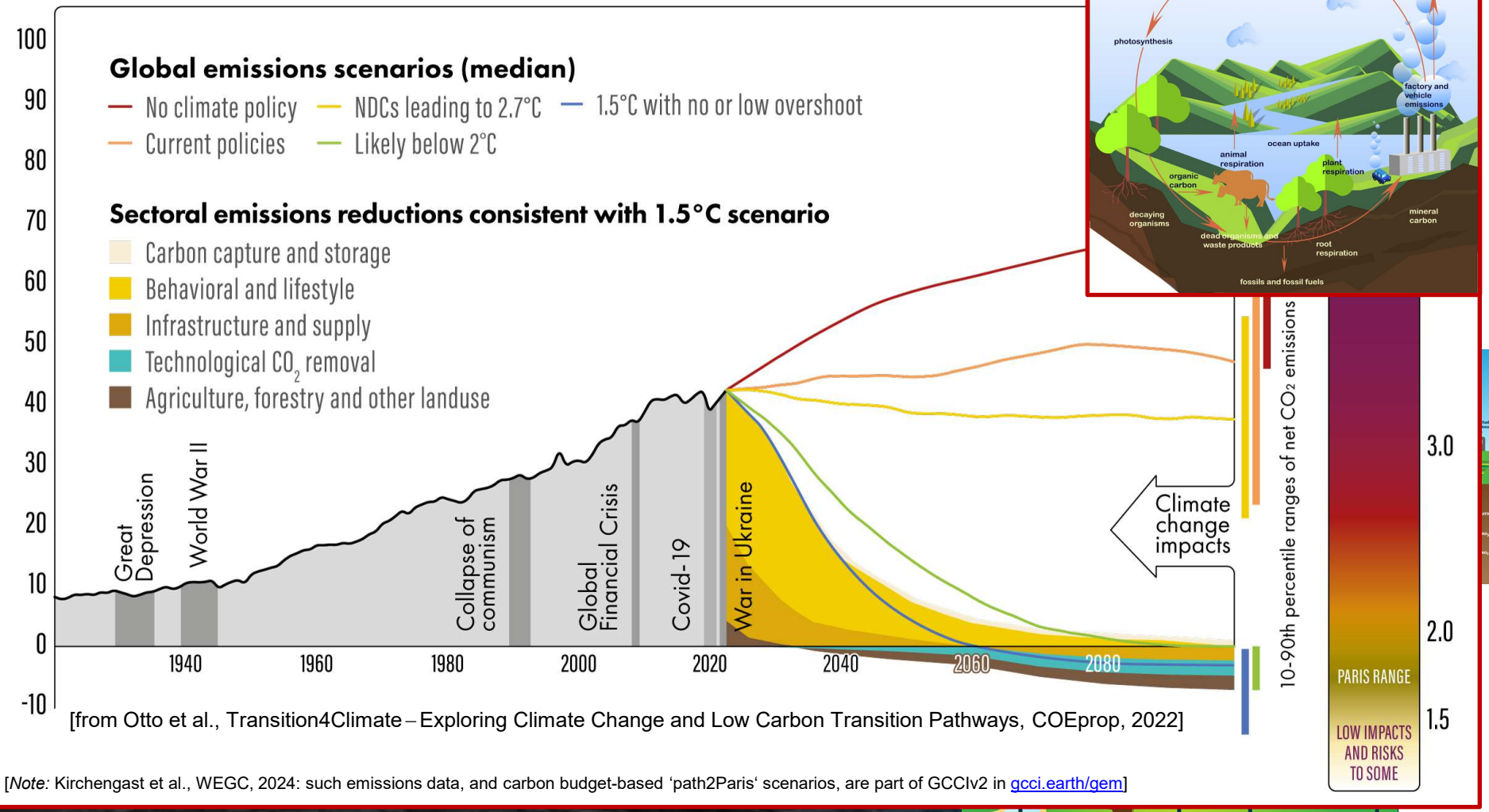
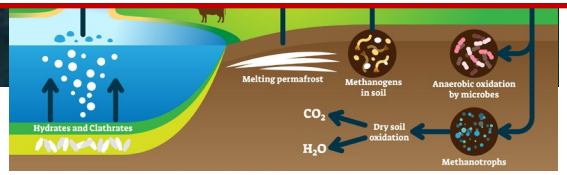
A quantitative intro look at the challenge of low carbon transition pathways…



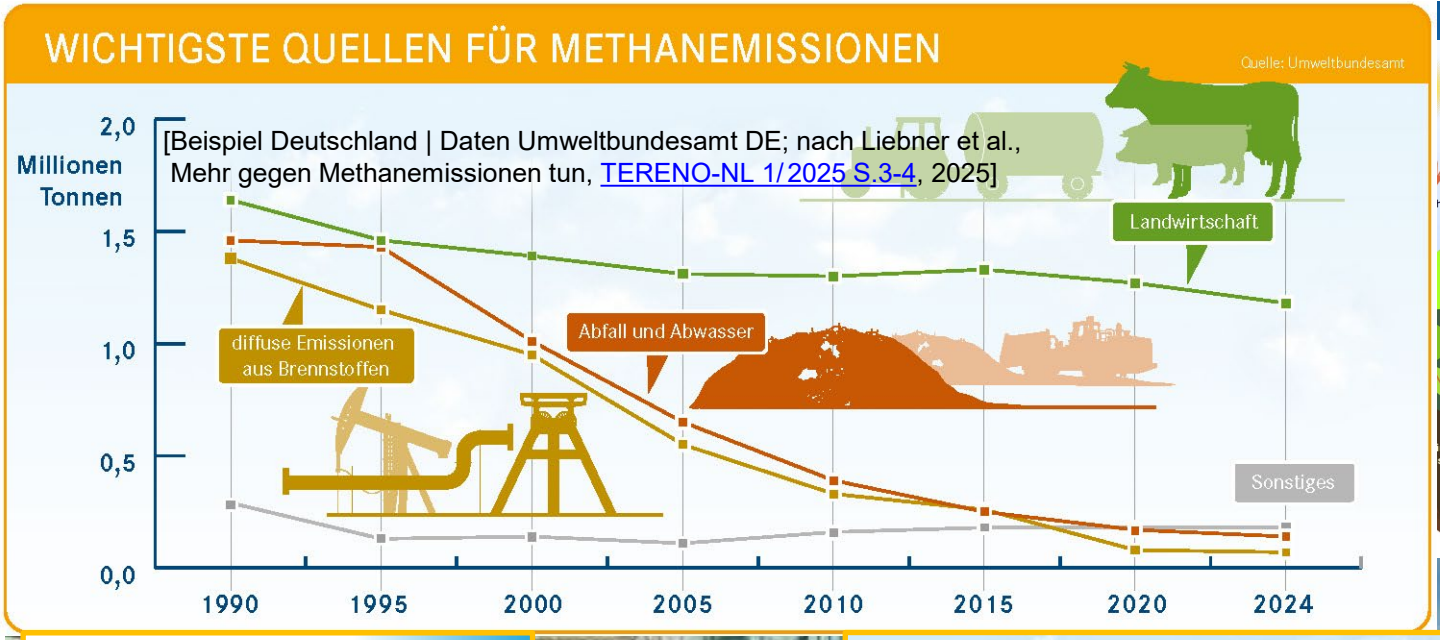
[from Otto et al., Transition4Climate – Exploring Climate Change and Low Carbon Transition Pathways, COEprop, 2022]

[*Note:* Kirchengast et al., WEGC, 2024: such emissions data, and carbon budget-based 'path2Paris' scenarios, are part of GCCIv2 in gcci.earth/gem]

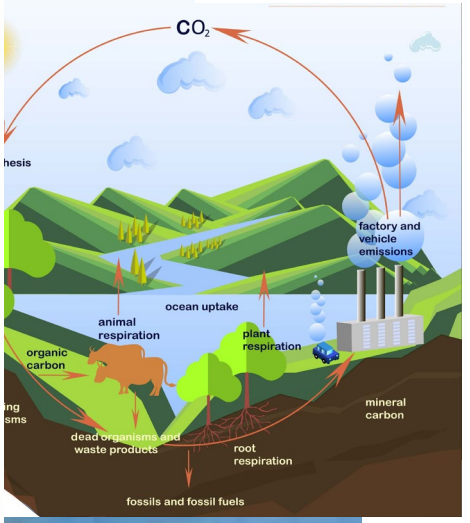


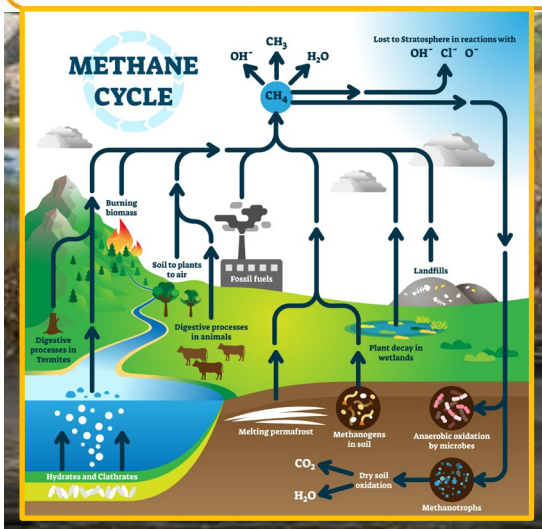
[Kaushik et al., Carbon Cycle & Changing Climate, EOS, 2020; insert figs: dreamstimepics-dl.2021]

Die Klimaschutz-Herausforderung: Übergang zu Netto-Null CO_2-Emissionen bis etwa 2050…



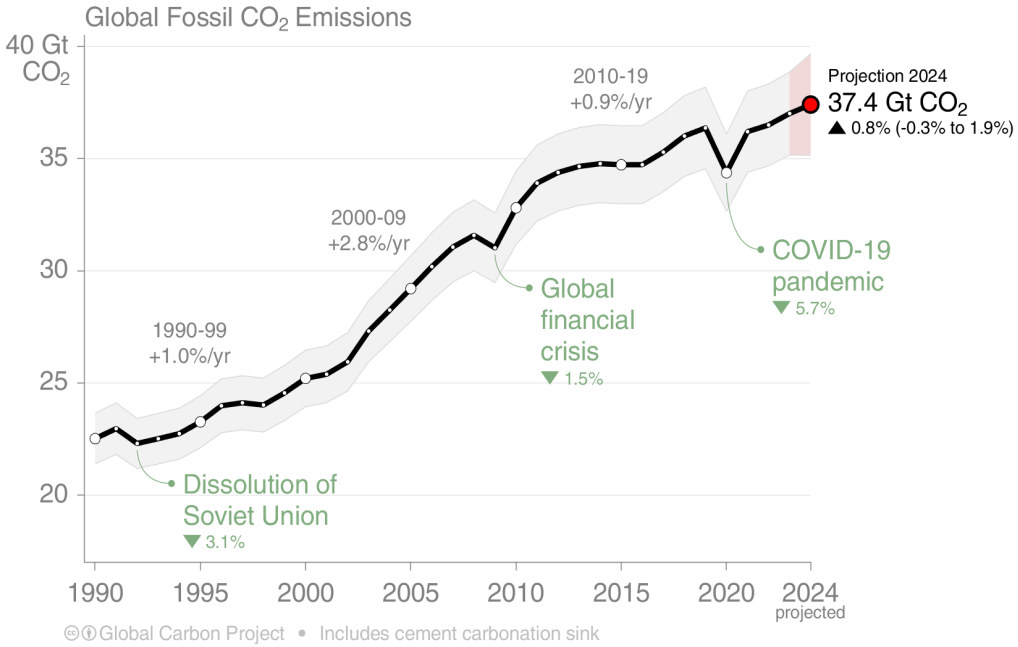
[Beispiel Deutschland | Daten Umweltbundesamt DE; nach Liebner et al., Mehr gegen Methanemissionen tun, TERENO-NL 1/2025 S.3-4, 2025]





[Kaushik et al., Carbon Cycle & Changing Climate, EOS, 2020; insert figs: dreamstimepics-dl.2021]

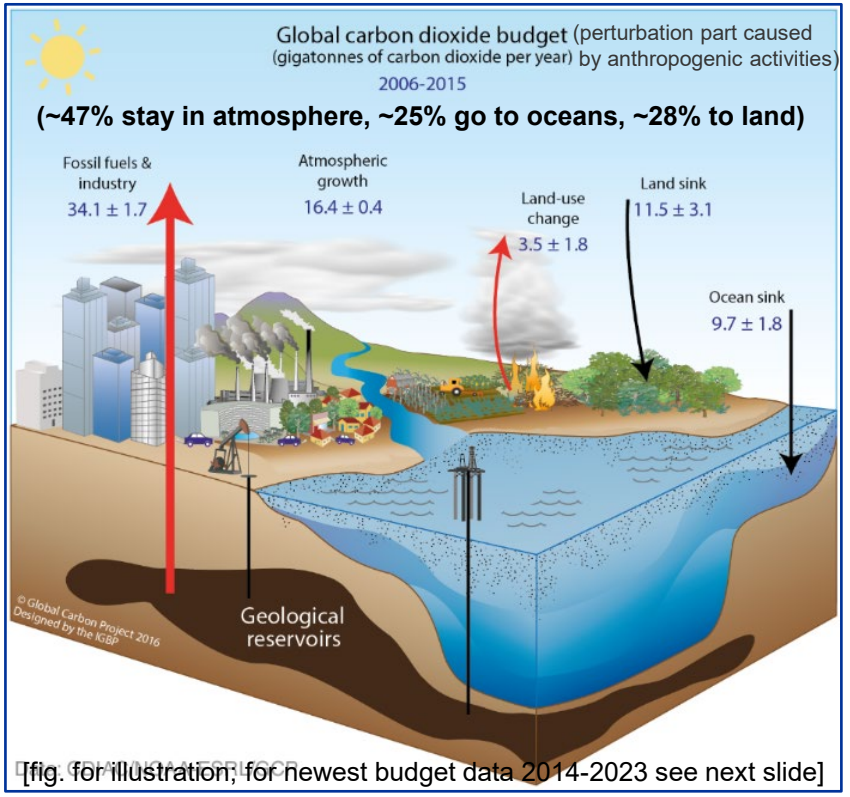
Over the most recent decade (2014-2023), and 2024 again, CO_2 emissions still rose higher than in any decade before – Quo Vadis?



[GCP-Global Carbon Project, 2024]

(land use change emissions add about 10 % to the fossil-fuel&cement CO_2 emissions shown)

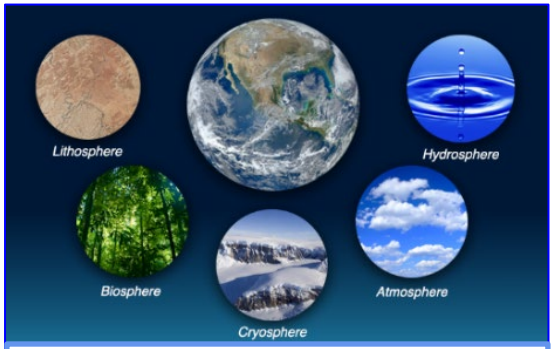
Where does the Carbon go? – especially the anthropogenic emissions of ~40 $GtCO_2$/yr that arise mainly from fossil fuel use?

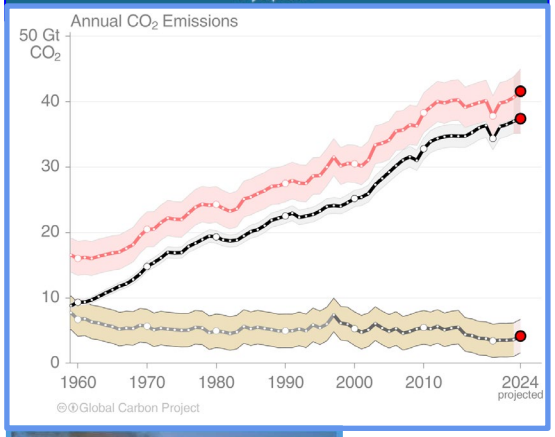


[fig. for illustration; for newest budget data 2014-2023 see next slide]

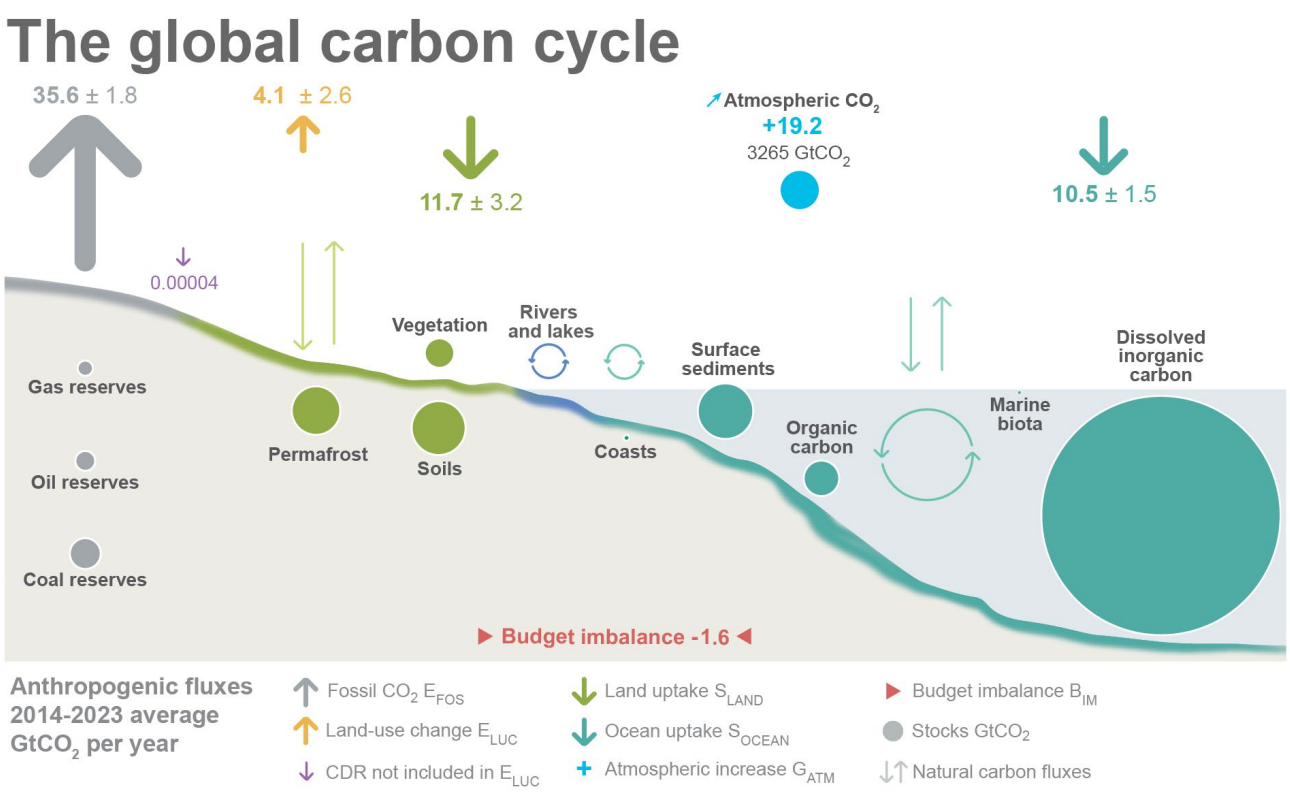
CO_2-Kreislauf & Klimawandel: Wo gehen die menschengemachten CO_2-Emissionen hin? (2)

Where does the carbon go? – the anthropogenic CO_2 emissions of ~40 $GtCO_2$ per year?





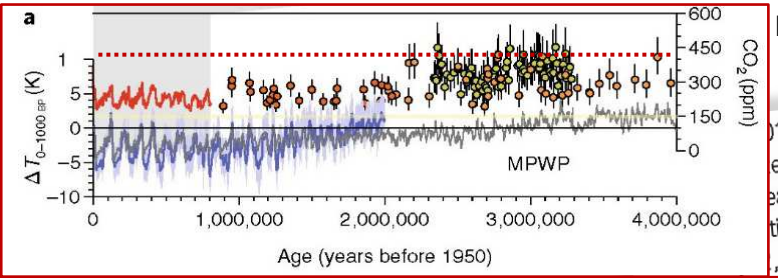
Perturbation of the global carbon cycle caused **by anthropogenic activities**; global annual average for the decade 2014–2023 ($GtCO_2$/yr)



The budget imbalance is the difference between the estimated emissions and sinks.
Source: Friedlingstein et al 2024; Global Carbon Project 2024

Where does the carbon go?

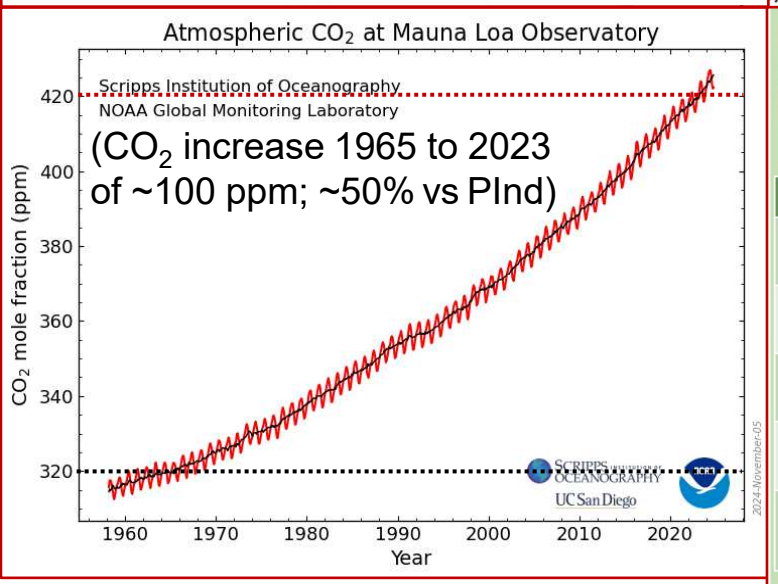
The CO_2 concentration in the atmosphere and the oceans is strongly increasing



[Fischer et al., 2018]

…19, atmospheric CO_2 concentrations were higher than at any time in at least 2 million years (*high confidence*), and …entrations of CH_4 and N_2O were higher than at any time in at least 800,000 years (*very high confidence*). Since 1750, …eases in CO_2 (47%) and CH_4 (156%) concentrations far exceed – and increases in N_2O (23%) are similar to – the natural …ti-millennial changes between glacial and interglacial periods over at least the past 800,000 years (*very high confidence*). …, 5.1, TS.2.2}

[IPCC AR6 WGI SPM, 2021]



[NOAA GML Web, 2024]

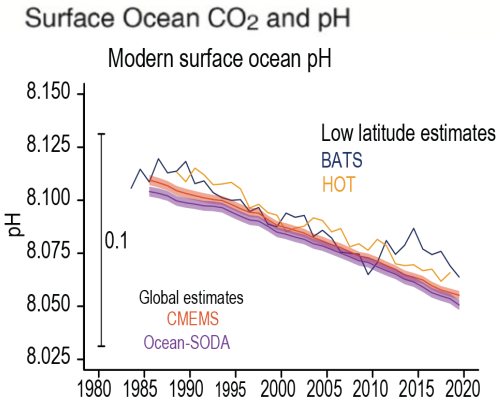
[*Note:* such CO_2 concentration data (and CO_2-equivalent concentration data), from 1960 to the present, are part of GCCIv2 in gcci.earth/cwm; variable https://gcci.earth/global/cwm/?var=GHG-annual-concentrations]

Table. Global annual surface mean abundances (2023) and trends of key greenhouse gases from the GAW in situ observational network for GHG. Units are concentrations in dry-air, and uncertainties are 68% confidence limits. The averaging method is described in GAW Report No. 184 [2].

	CO_2	CH_4	N_2O
2023 global mean abundance	420.0±0.1 ppm	1934±2 ppb	336.9±0.1 ppb
2023 abundance relative to 1750[a]	151%	265%	125%
2022–2023 absolute increase	2.3 ppm	11 ppb	1.1 ppb
2022–2023 relative increase	0.55%	0.57%	0.33%
Mean annual absolute increase over the past 10 years	2.4 ppm yr^{-1}	10.7 ppb yr^{-1}	1.07 ppb yr^{-1}

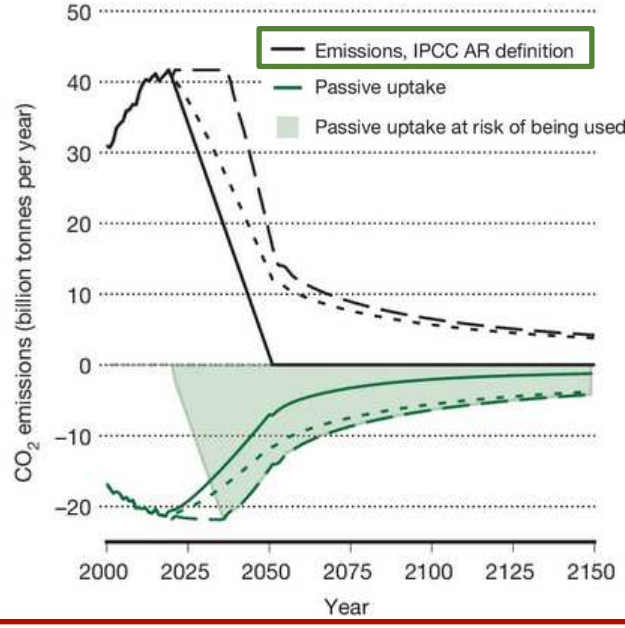
[a] Assuming a pre-industrial concentration of 278.3 ppm for CO_2, 729.2 ppb for CH_4 and 270.1 ppb for N_2O. The number of stations used for the analyses was 146 for CO_2, 153 for CH_4 and 112 for N_2O.

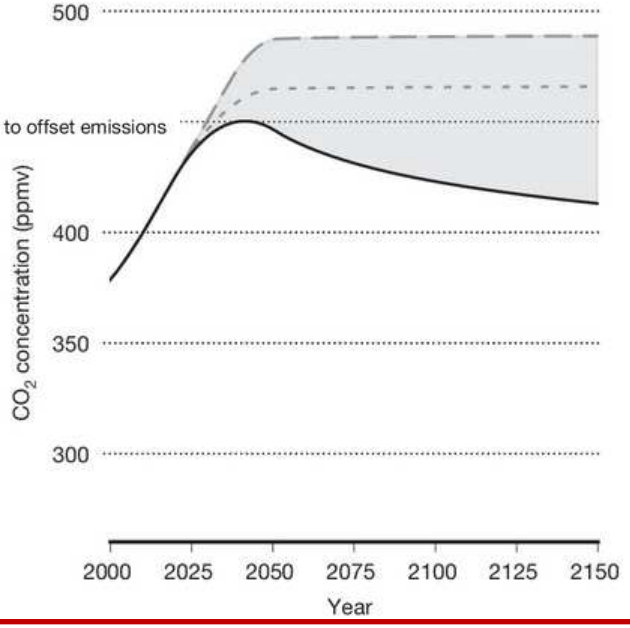
[WMO GHG Bull., 2024]



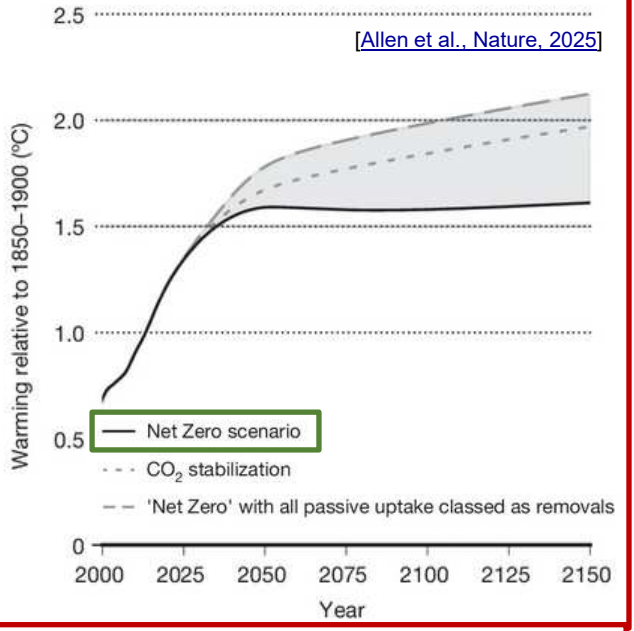
[IPCC AR6 WGI Report, 2021]

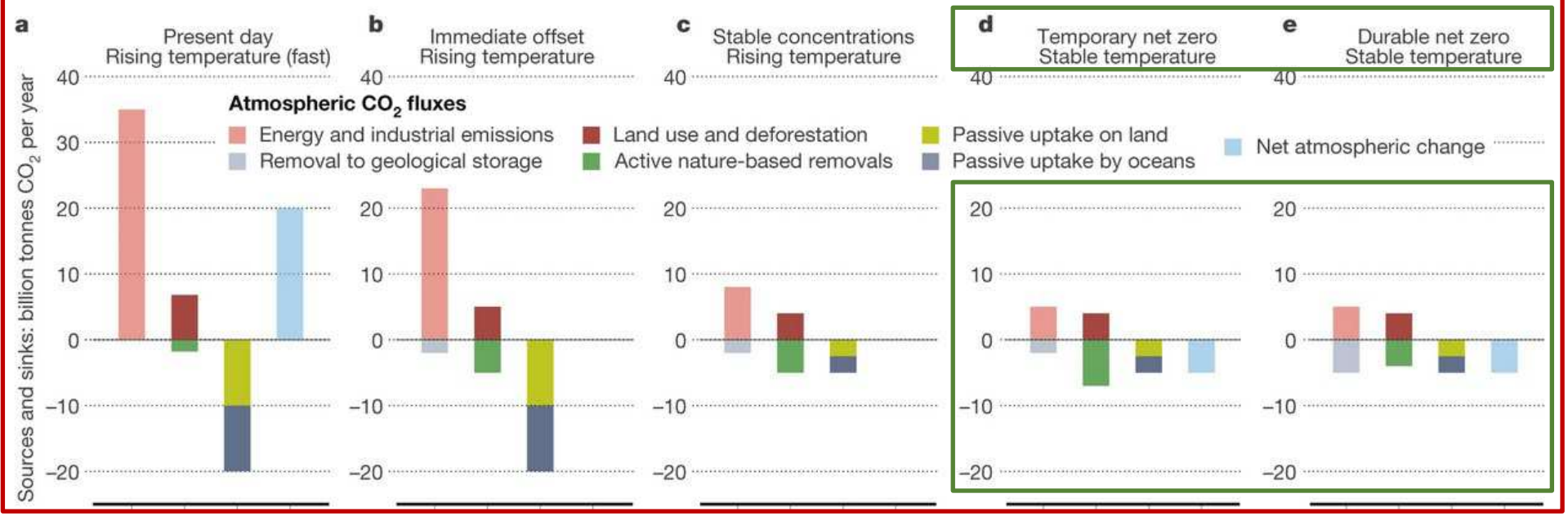
Die Schlüsselfrage: *Welche Netto-Null CO_2-Emissionen stoppen die globale Erwärmung?*





[Allen et al., Nature, 2025]



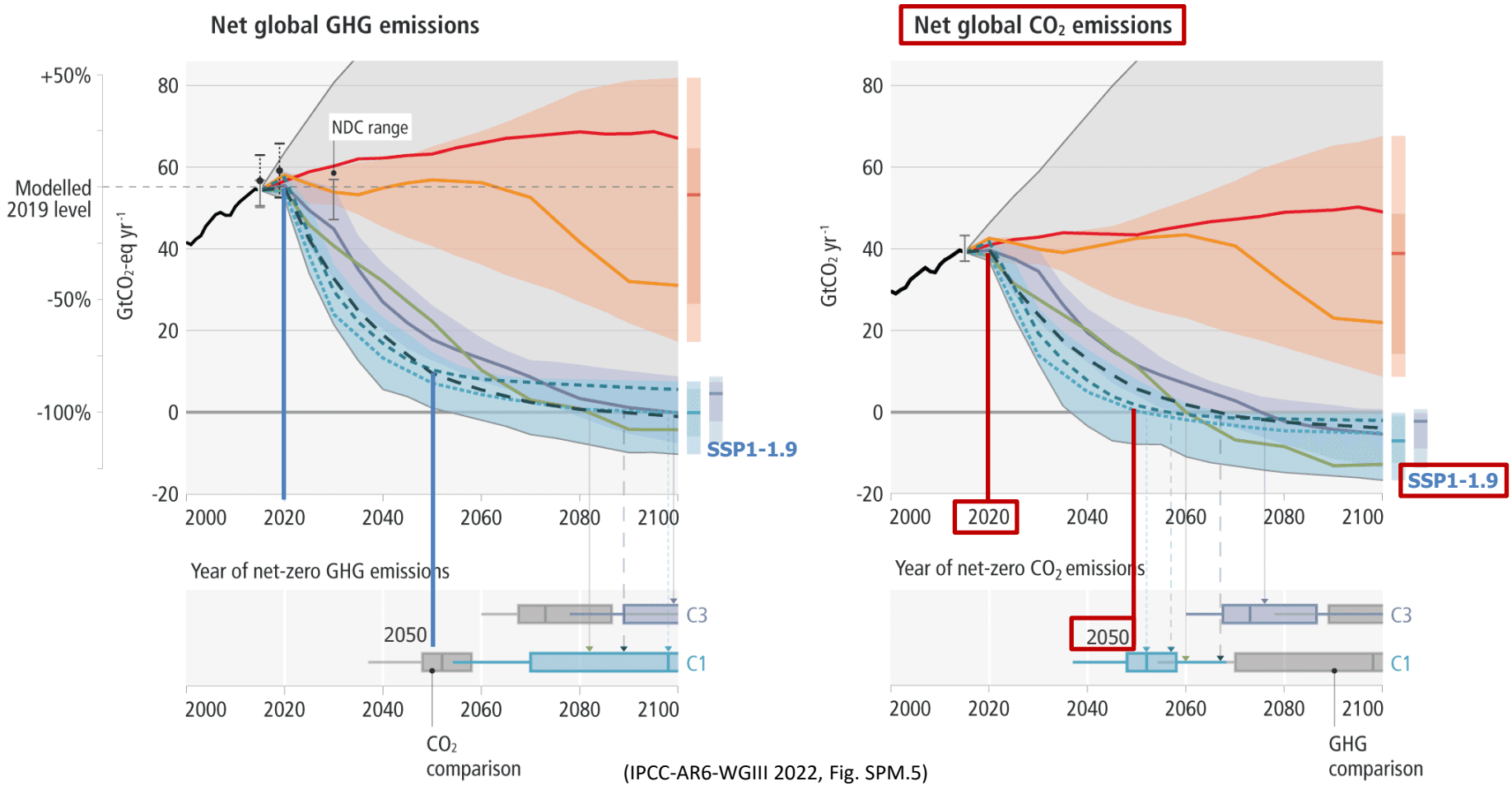


Perspektiven: Was lernen wir für den Klimaschutz?

Climate action: novel approaches to fair contributions to reach the Paris goals…

Turning to action: CO_2 emissions need to reach *Net-Zero near 2050*

Modelled mitigation pathways that limit warming to 1.5°C, and 2°C, involve deep, rapid and sustained emissions reductions.



(IPCC-AR6-WGIII 2022, Fig. SPM.5)

Perspektiven: Was lernen wir für den Klimaschutz?

Climate action: novel approaches to fair contributions to reach the Paris goals…

Frame the action: Carbon budgets need be *allocated in a fair manner*

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Fairness critically conditions the carbon budget allocation across countries

https://doi.org/10.1016/j.gloenvcha.2022.102481 (March 2022)

Keith Williges [a,c,*], Lukas H. Meyer [c,*], Karl W. Steininger [a,b], Gottfried Kirchengast [a,d]

[a] Wegener Center for Climate and Global Change, University of Graz, Brandhofgasse 5, Graz A-8010, Austria
[b] Department of Economics, University of Graz, Universitaetsstrasse 15, Graz A-8010, Austria
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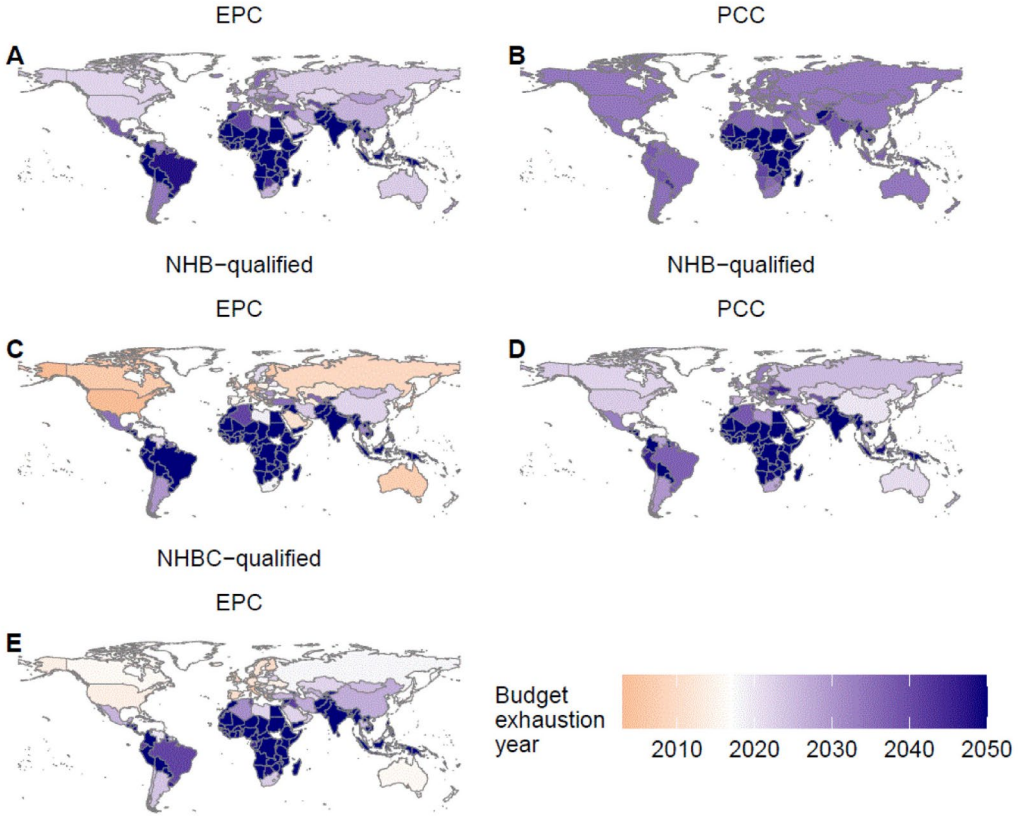
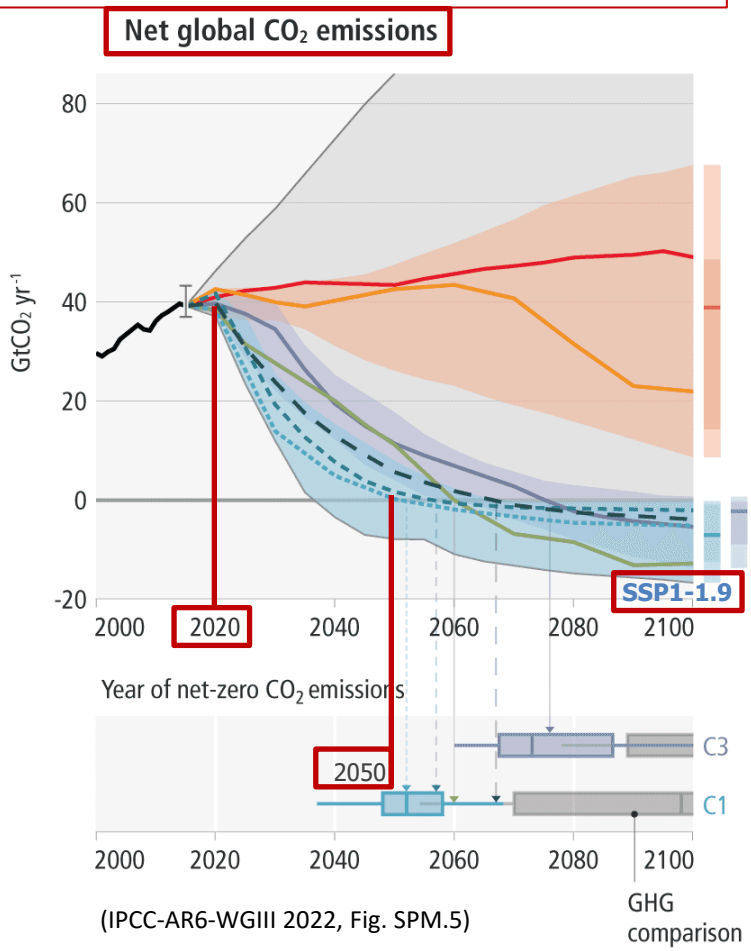
Remaining CO_2 budget availability across countries for different sharing principles *(EPC…Equal-per-capita, PCC…Per-capita-convergence)*





(IPCC-AR6-WGIII 2022, Fig. SPM.5)

[*Note:* Kirchengast et al., WEGC, 2024: such carbon budget-based 'paths2Paris' are part of GCCIv2 in gcci.earth/gem]

Go for the Action–Beispiel Österreich: Welche Reduktionsziele hier?

A 1.5°C-oriented max. 1000 $MtCO_2eq$ 2017-2050 budget requires GHG emission reductions of more than 55% until 2030 and over 90% to be achieved near 2040, in accordance with the European Green Deal and Paris climate goals…

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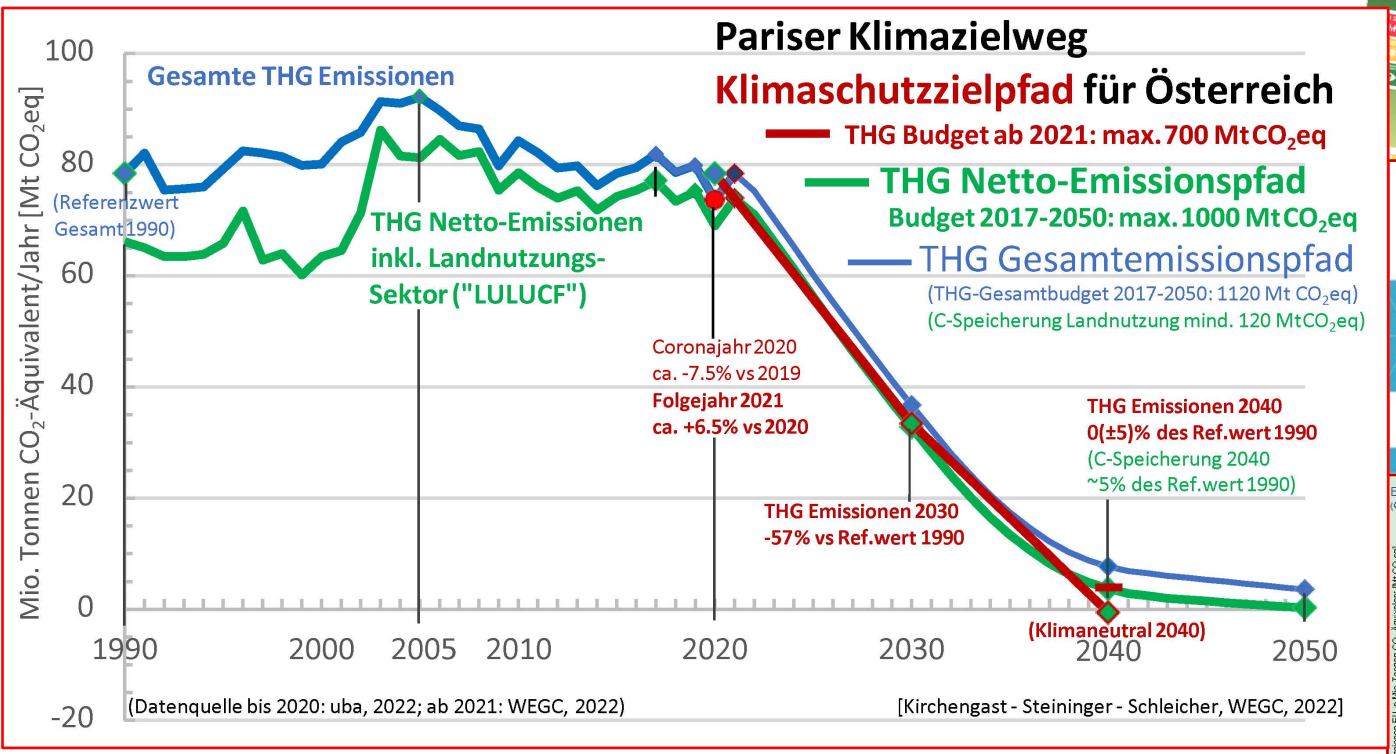

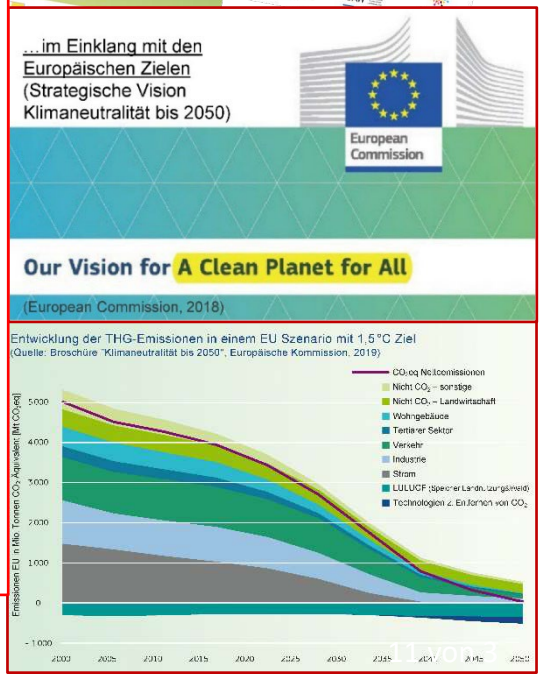

[*Anm.:* aktuelle THG-Emissionsdaten für Österreich, von 1990 bis 2024 und mit Zielpfaden bis 2050, sind als Teil von GCCIv2 via gcci.at/gem verfügbar; Direktlink zur Variable: gcci.earth/austria/gem/?var=GHG-annual-emissions]

[Kirchengast et al., Ref-NEKP, 2019; online via ccca.ac.at/refnekp; Kirchengast-Steininger THG statement online via wegcenter.uni-graz.at/downloads/2022]
(Kirchengast et al. WEGC RB1-2021; direct-link https://doi.org/10.25364/23.2021.1; online intro-infos via wegcenter.uni-graz.at/carbon-management)

Carbon Management (CM): ein neuer Lösungsansatz zur Erreichung der Pariser Klimaziele…

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Carbon Management: a new approach to achieve Paris-compliant climate goals
and Uni Graz Institutional Carbon Management as a role model

Gottfried Kirchengast, Julia Danzer, Stefanie Hölbling

April 2021

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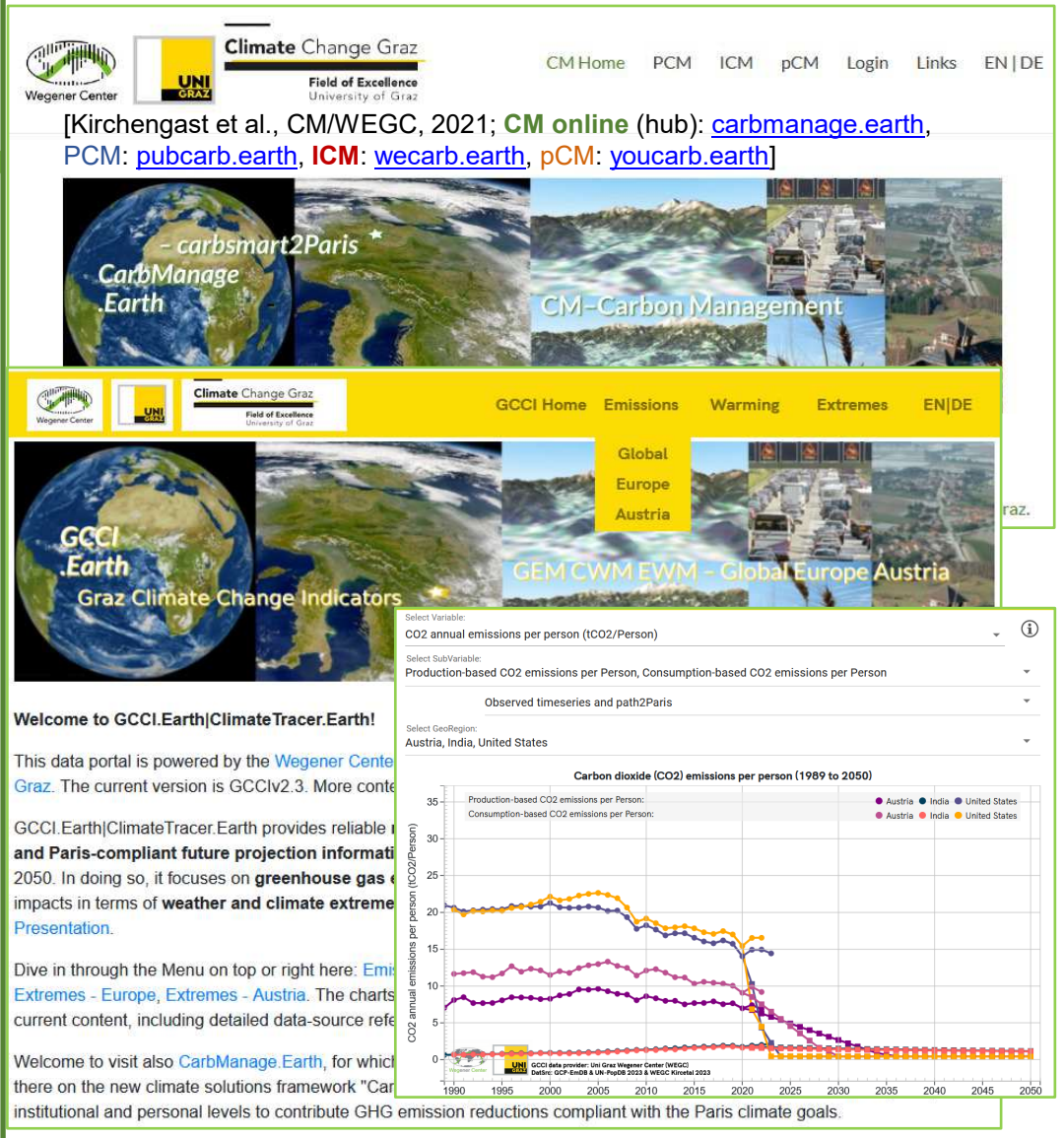
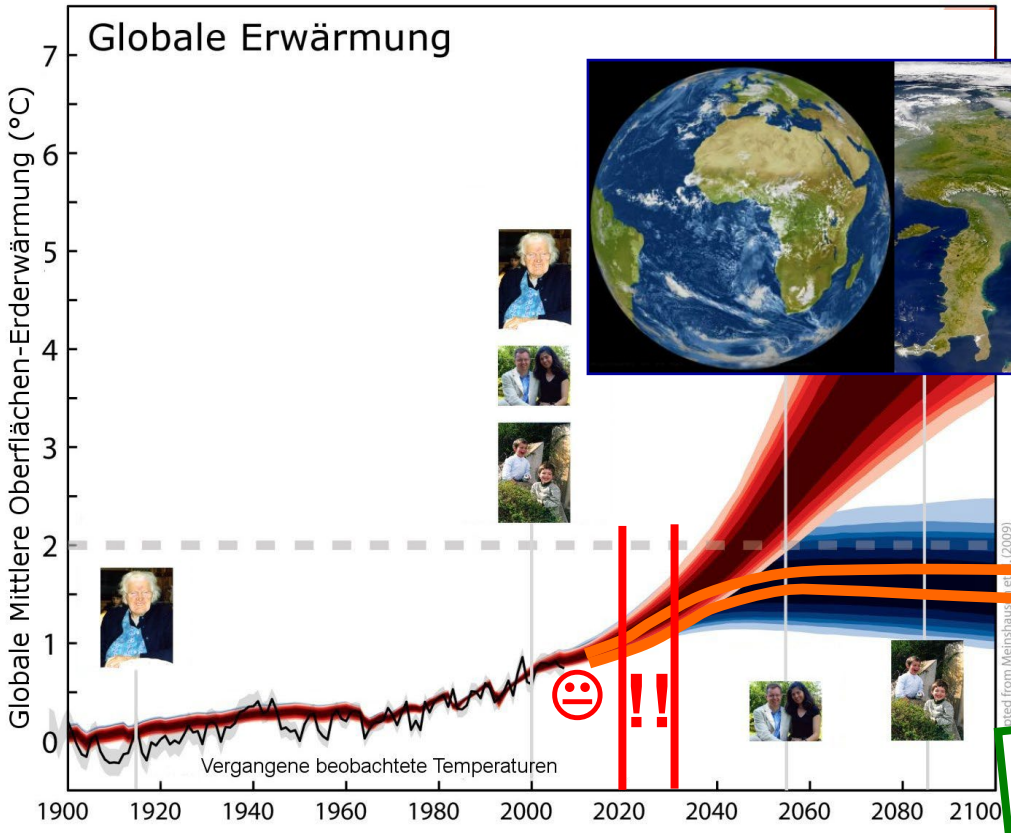
[Kirchengast et al. WEGC RB1-2021; accessible online (including individual-sections access) via https://doi.org/10.25364/23.2021.1;
Wegener Center CM website – entry page: wegcenter.uni-graz.at/carbon-management]



[Kirchengast et al., CM/WEGC, 2021; **CM online** (hub): carbmanage.earth,
PCM: pubcarb.earth, **ICM**: wecarb.earth, pCM: youcarb.earth]

[Kirchengast et al., GCCI/WEGC, 2024; GCCI Emissions Monitoring: gcci.earth/gem]

=> FACT: der aktuelle Wissensstand zum Kohlenstoffkreislauf und Klimawandel liefert starke Fakten wie nie – daher ernst nehmen: Klimaschutz zur Erreichung der Pariser Klimaziele ist essenziell!



"Wir alle brauchen Verstand, Mut und Herz. Meistens mehr davon. Gönnen wir uns gern mehr davon!"

Danke für Ihre Aufmerksamkeit! ☺