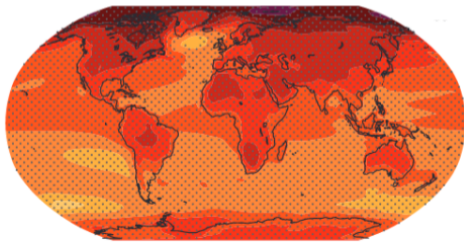


Klima der Zukunft: Die Welt und Baden-Württemberg

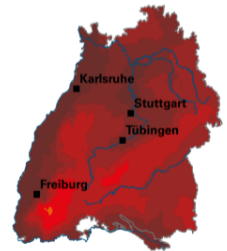
Kira Rehfeld, Universität Tübingen, 2022-02-18



–2 –1,5 –1 –0,5 0 0,5 1 1,5 2 3 4 5 7 9 11 (°C)
MAT, 2081-2100 rel. to 1986-2005 RCP8.5 (oben), IPCC AR5-SYR



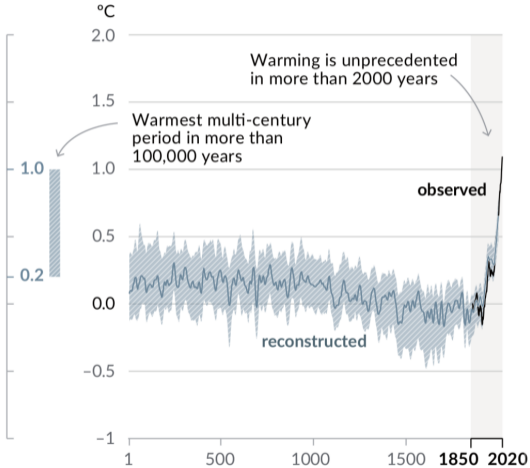
Änderungssignal Temperatur [K]
MAT, 2100 rel. to 1971-2000 RCP8.5, Reklies-DE



Jahresmitteltemperatur [°C]
MAT, rel. to 1971-2000 RCP8.5 (LUBW/Reklies-DE)

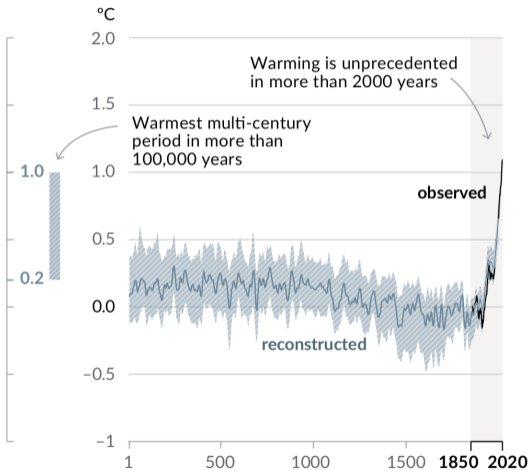
Changes in global surface temperature relative to 1850–1900

(a) Change in global surface temperature (decadal average)
as **reconstructed** (1–2000) and **observed** (1850–2020)

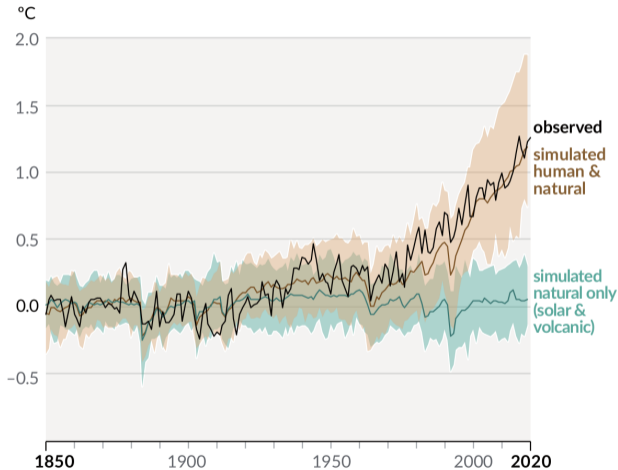


Changes in global surface temperature relative to 1850–1900

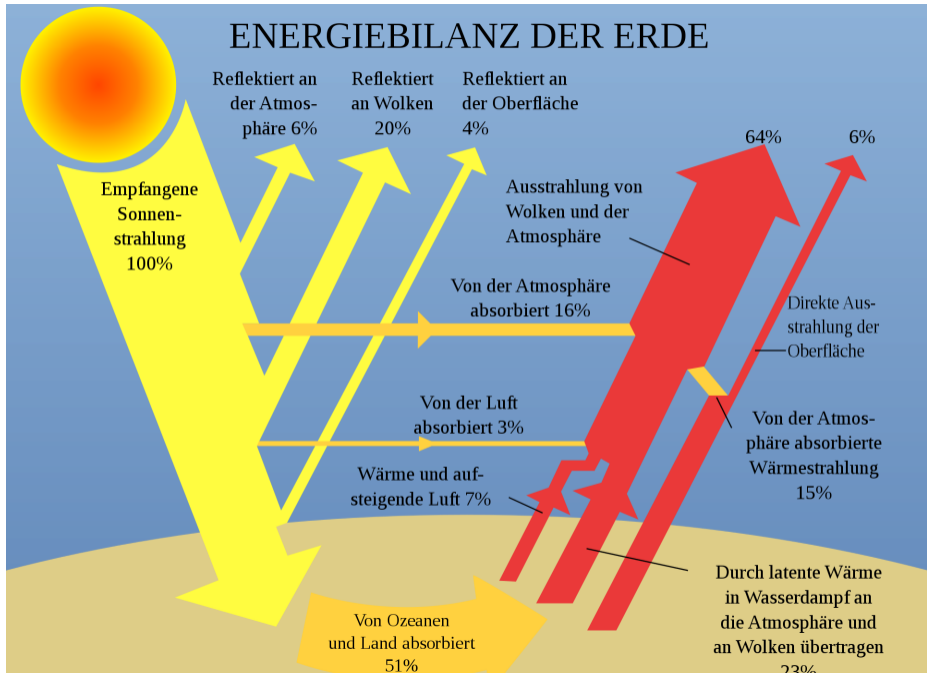
(a) Change in global surface temperature (decadal average) as **reconstructed** (1–2000) and **observed** (1850–2020)



(b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850–2020)



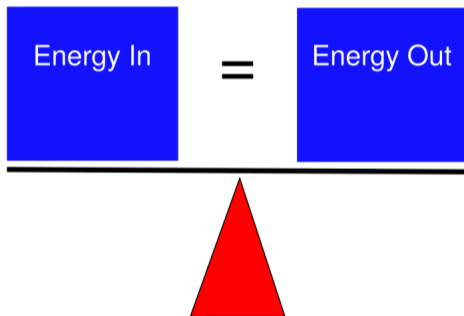
ENERGIEBILANZ DER ERDE



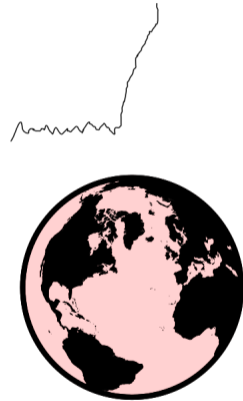
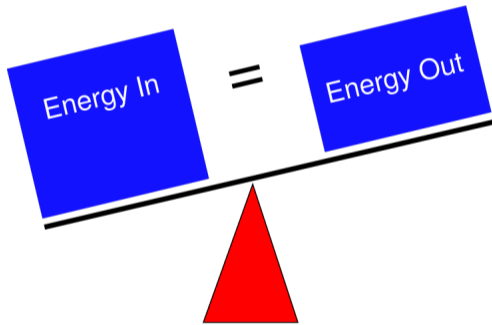
Energieungleichgewicht \Rightarrow Erwärmung



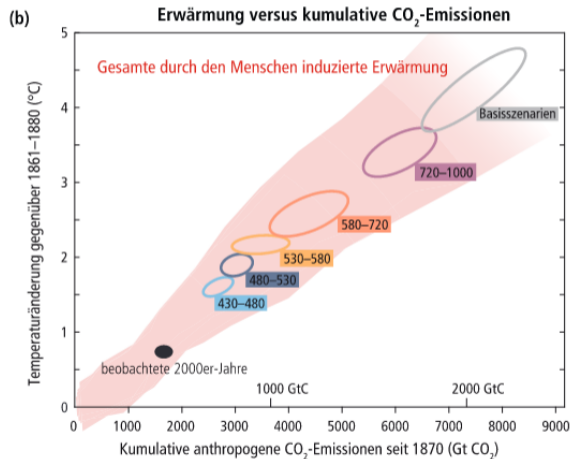
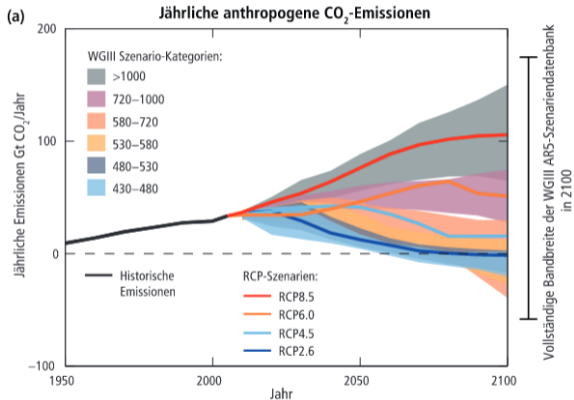
Energieungleichgewicht \Rightarrow Erwärmung



Energieungleichgewicht \Rightarrow Erwärmung



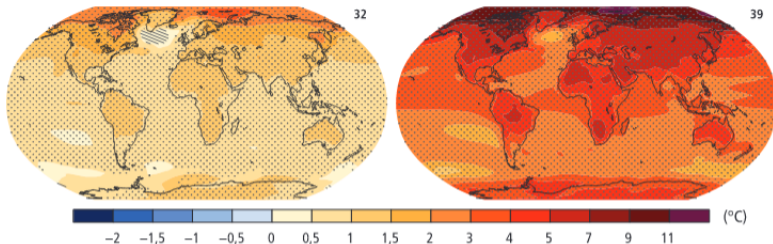
Emissionen und Erwärmung



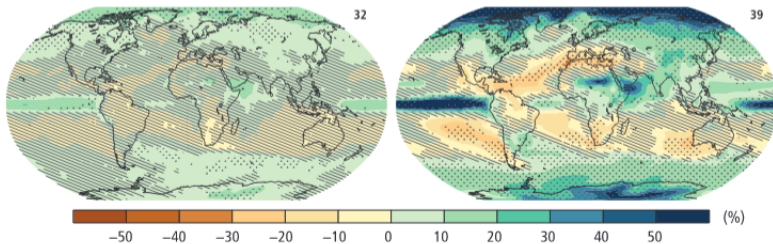
RCP2.6

RCP8.5

(a) Änderung der mittleren Erdoberflächentemperatur (2081–2100 gegenüber 1986–2005)



(b) Änderung des mittleren Niederschlags (2081–2100 gegenüber 1986–2005)



Option A RCP8.5

‘Business-as-usual’ \Rightarrow
 $8.5 \frac{W}{m^2}$ zus.
 Strahlungsantrieb im Jahr
 2100

Option B RCP2.6

Zeitnah Netto-negative
 Emissionen $\Rightarrow 2.6 \frac{W}{m^2}$ zus.
 Strahlungsheizung im Jahr
 2100

Änderung der Oberflächentemperatur T_s :

$$\Delta T_s \approx \lambda \Delta F,$$

mit λ Klimasensitivität in $[KW^{-1} m^2]$;

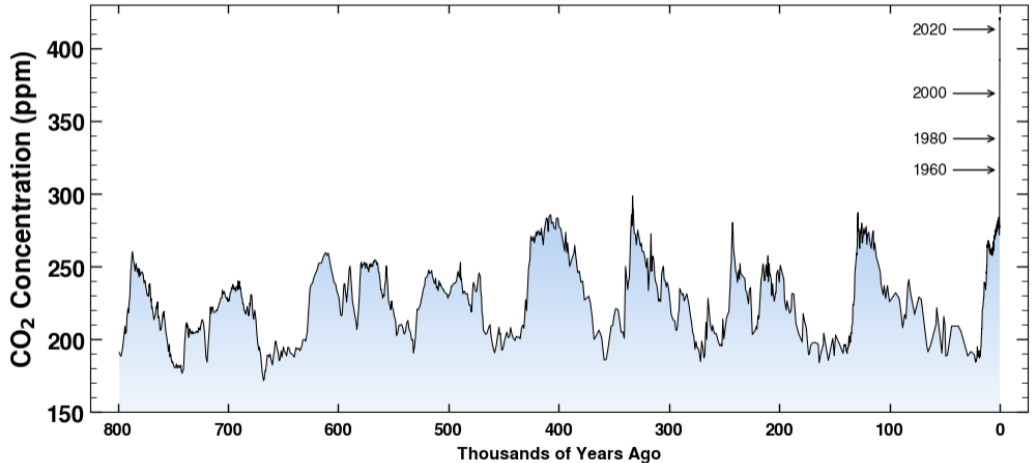
$$\Delta F = 5,35 \frac{W}{m^2} \cdot \ln \frac{C}{C_0};$$

$C_{(0)}$ CO₂-Konzentration in ppm

CO₂ in der Atmosphäre

February 15, 2022

Ice-core data before 1958. Mauna Loa Data after 1958.

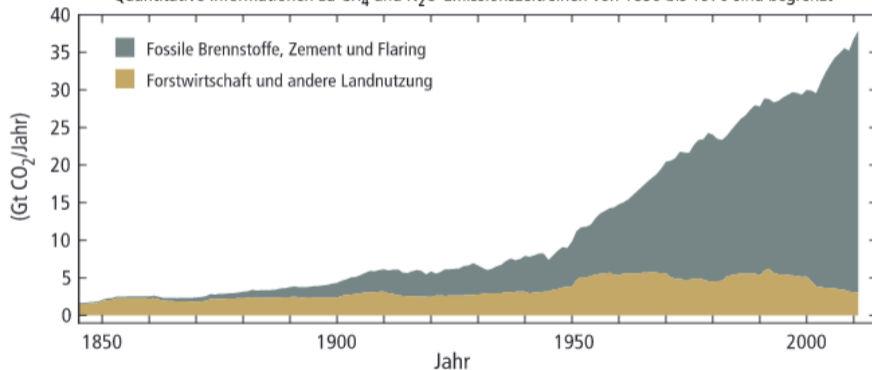


Aktuelle Messungen: <https://keelingcurve.ucsd.edu/>

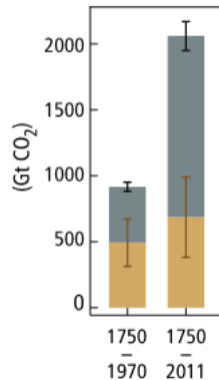
Woher kommen die Emissionen?

Globale anthropogene CO₂-Emissionen

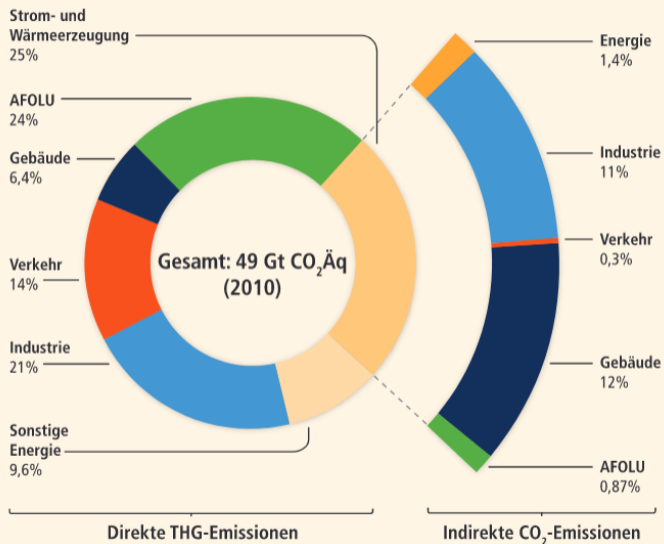
Quantitative Informationen zu CH₄ und N₂O-Emissionszeitreihen von 1850 bis 1970 sind begrenzt

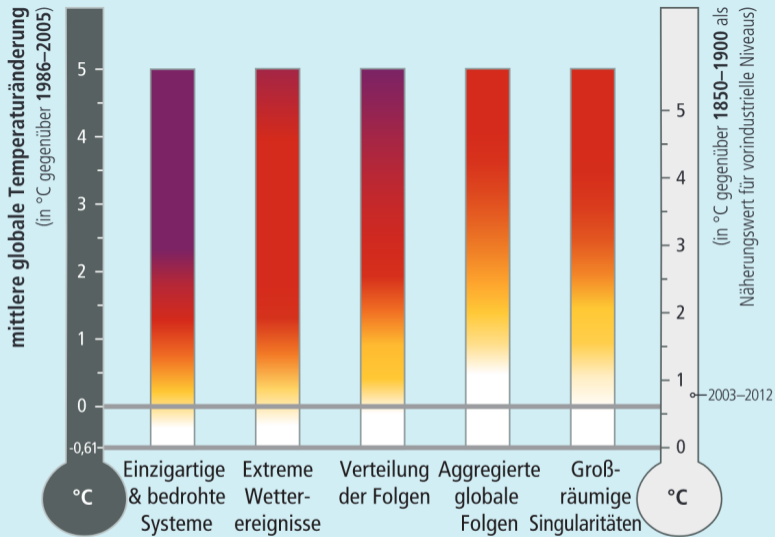


Kumulative CO₂-Emissionen



Treibhausgasemissionen nach Wirtschaftssektoren





Grad des zusätzlichen Risikos aufgrund des Klimawandels

Nicht nachweisbar

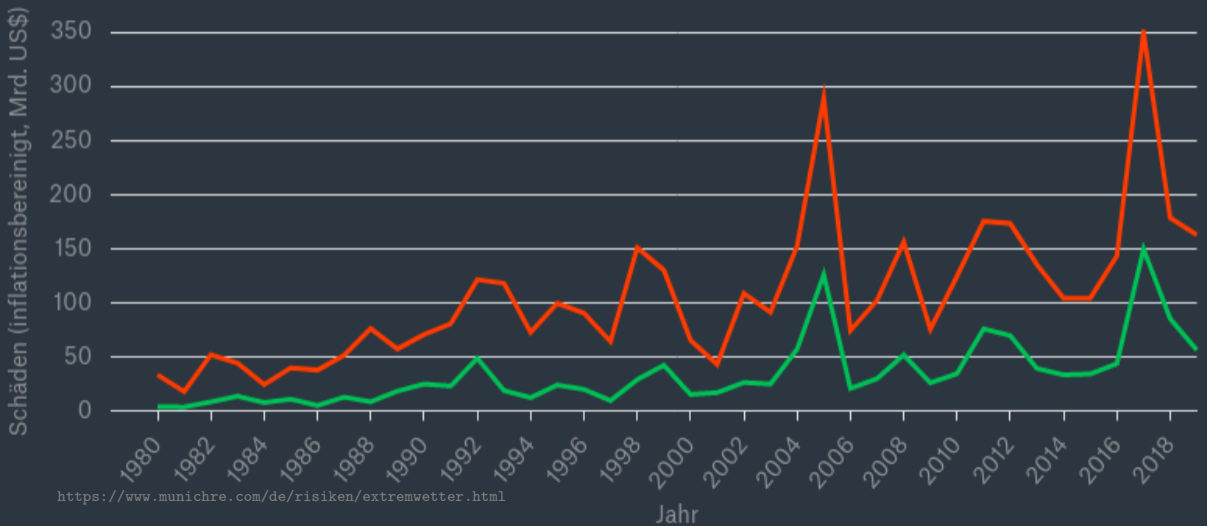
Moderat

Hoch

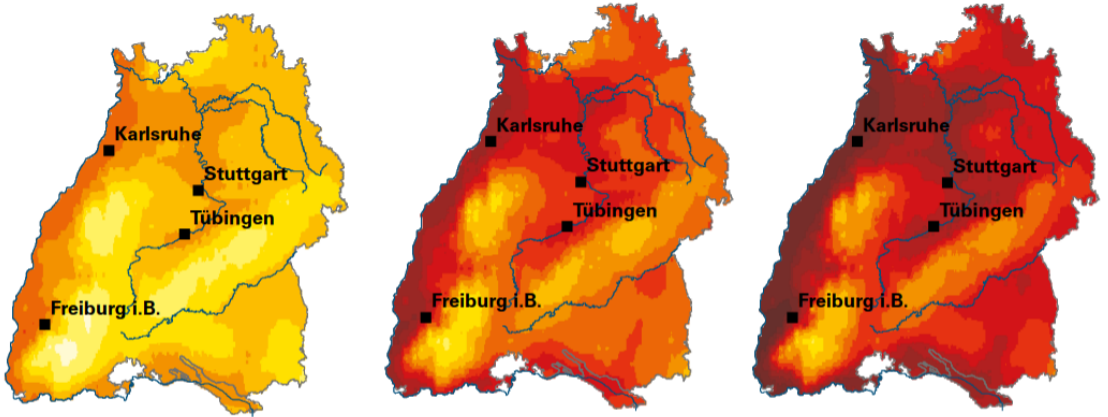
Sehr hoch

Schäden durch wetterbedingte Naturkatastrophen weltweit 1980-2019

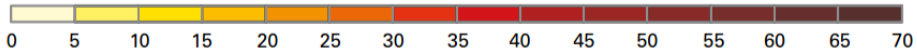
Gesamtschäden Versicherte Schäden



2071 - 2100

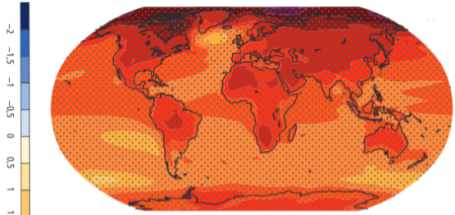


Anzahl Heißer Tage

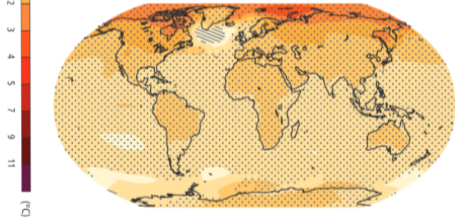


LUBW

RCP8.5



RCP2.5

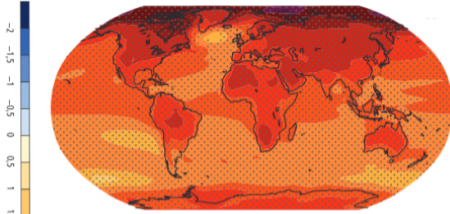


MAT, 2081-2100 rel. to 1986-2005

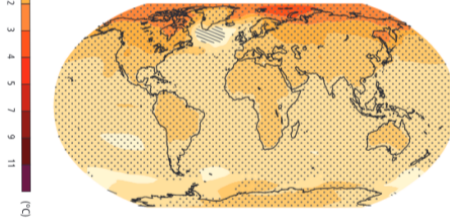
RCP8.5 (oben) vs.

RCP2.5 (unten), IPCC AR5-SYR

RCP8.5



RCP2.5



RCP8.5



RCP2.5



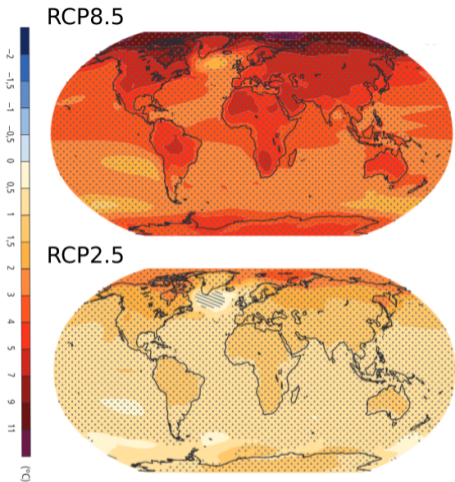
MAT, 2081-2100 rel. to 1986-2005 MAT, 2100 rel. to 1971-2000

RCP8.5 (oben) vs.

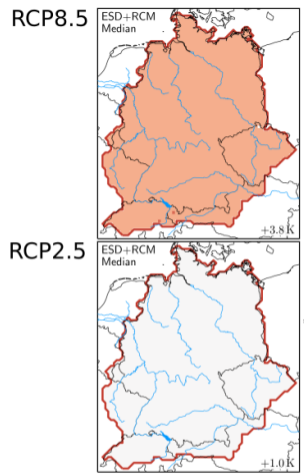
RCP8.5 (oben) vs.

RCP2.5 (unten), IPCC AR5-SYR

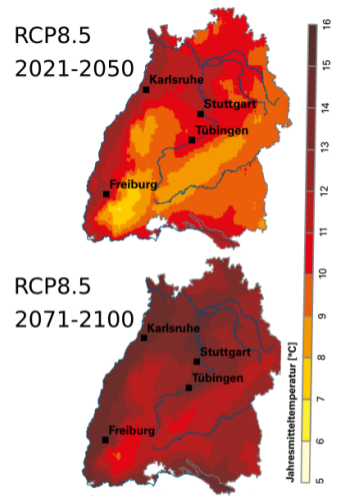
RCP2.5 (unten), Reklies-DE



MAT, 2081-2100 rel. to 1986-2005
 RCP8.5 (oben) vs.
 RCP2.5 (unten), IPCC AR5-SYR



MAT, 2100 rel. to 1971-2000
 RCP8.5 (oben) vs.
 RCP2.5 (unten), Reklies-DE



MAT, rel. to 1971-2000
 RCP8.5 (LUBW/Reklies-DE)



Ein angenehmes Klima in der Zukunft ist möglich!
⇒ **ENROADS Simulation: Florian Kapmeier**

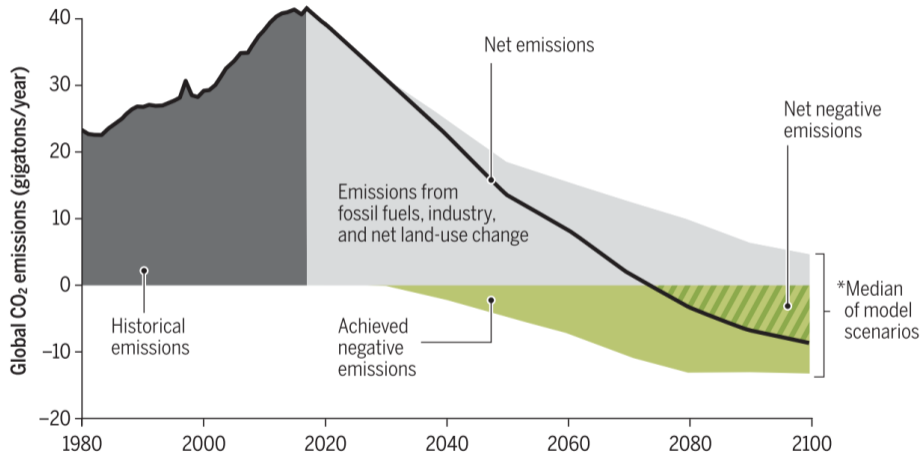
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- Rehfeld, K. et al. (2020). "Variability of surface climate in simulations of past and future". In: *Earth Syst. Dyn.* 11.2. DOI: 10.5194/esd-11-447-2020. URL: <https://esd.copernicus.org/articles/11/447/2020/>.
- Rosen, J. (2018). "The carbon harvest". In: *Science (80-.)*. 359.6377. DOI: 10.1126/SCIENCE.359.6377.733. URL: http://science.sciencemag.org/content/359/6377/733?utm%7B%5C_%7Dcampaign=toc%7B%5C_%7Dsci-mag%7B%5C_%7D2018-02-15%7B%5C%7Det%7B%5C_%7Drid=35368906%7B%5C%7Det%7B%5C_%7Dcid=1852983.

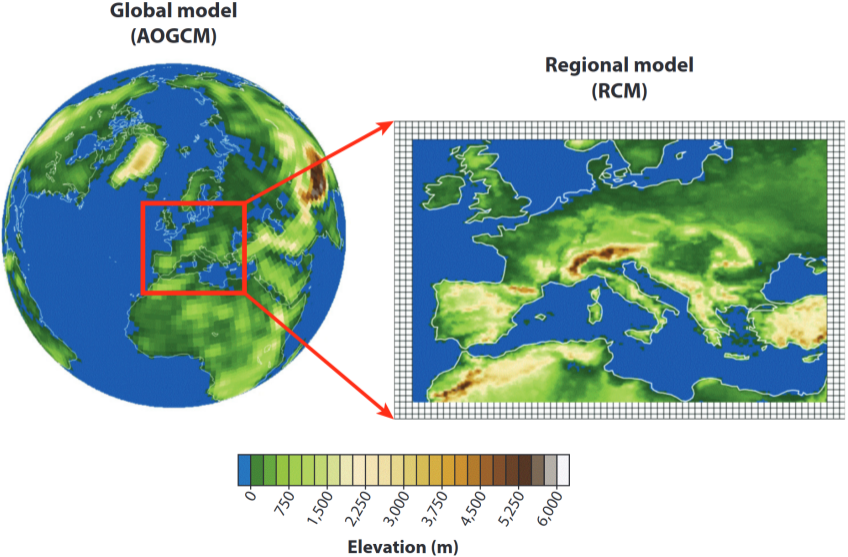
Nützliche Ressourcen

- <https://pd.lubw.de/10200>, <https://www.lubw.baden-wuerttemberg.de/klimawandel-und-anpassung/klimawandel>
- <https://www.ipcc.ch/>
- <https://interactive-atlas.ipcc.ch/>
- https://www.dwd.de/DE/klimaumwelt/klimaatlas/klimaatlas_node.html
- <https://www.umweltbundesamt.de/themen/klima-energie/klimafolgen-anpassung/werkzeuge-der-anpassung/tatenbank>
- <https://www.umweltbundesamt.de/sites/default/files/medien/515/dokumente/4298.pdf> Kosten und Nutzen von Anpassungsmaßnahmen (2012)

Entwicklungspfade kompatibel mit Paris-Agreement



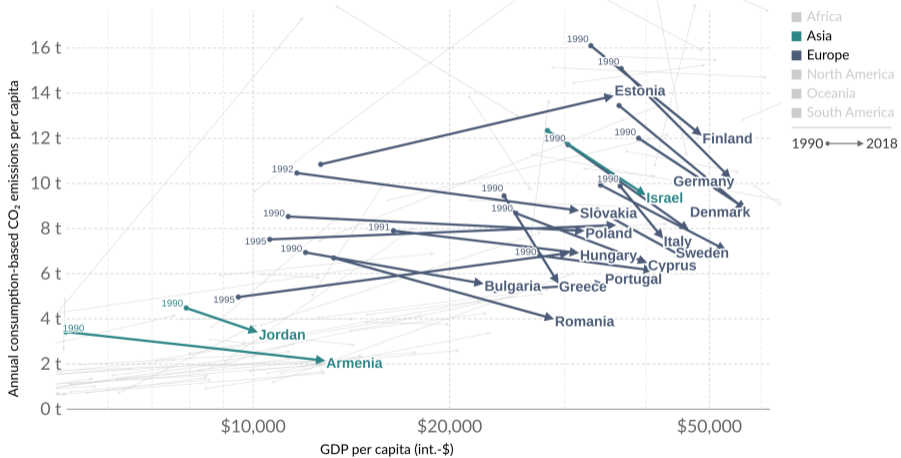
Von Globalen zu Regionalen Skalen



Giorgi et al., 2015

Consumption-based CO₂ emissions per capita vs GDP per capita

- Consumption-based emissions are domestic emissions adjusted for trade. If a country imports goods the CO₂ emissions needed to produce such goods are added to its domestic emissions; if it exports goods then this is subtracted.
- GDP per capita is adjusted for price differences between countries (PPP) and over time (inflation).



Source: Our World in Data based on the Global Carbon Project, Data compiled from multiple sources by World Bank

<https://ourworldindata.org/go2and70ton-greener-gas-emissions-ppcs-gdppc>

