



Climate Change

Compiled by:
Dr. Frank Kreienkamp, Deutscher Wetterdienst

2023-06-06
GEM Camp

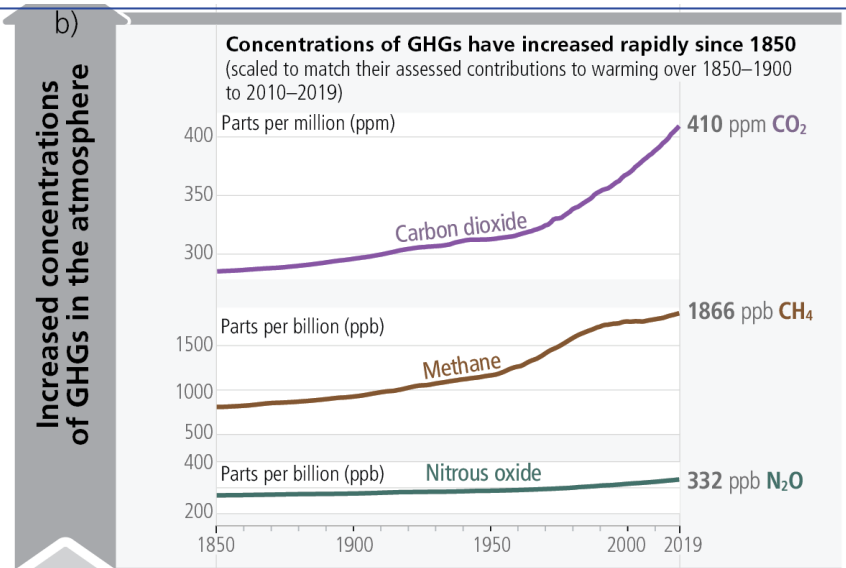
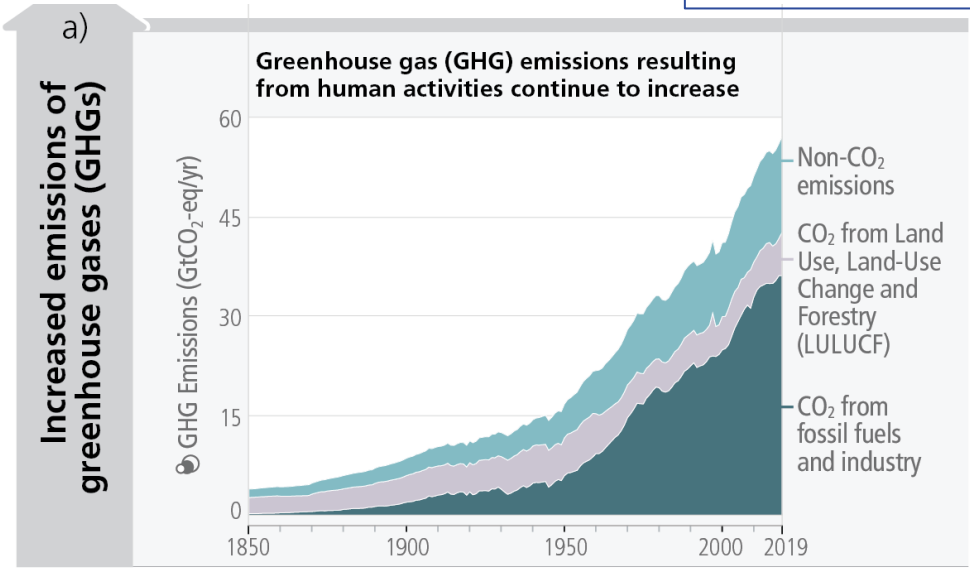
Kim Frederic Albrecht

Quelle: Ed Hawkins/DWD

Climate Change



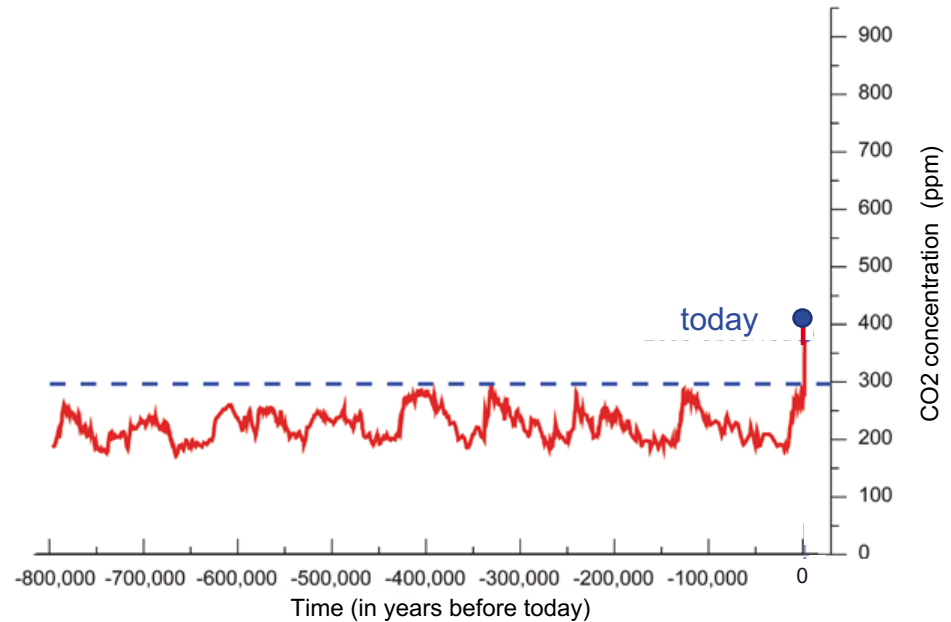
Current :
 CO₂-level 424 ppm (<https://www.co2.earth/daily-co2>)
 Methane 1922 ppb (<https://www.methanelevels.org/>)



Source: IPCC AR6 SPM Figure 2.1
 © Intergovernmental Panel on Climate Change, 2023



CO₂ concentration over the last 800,000 years



Quelle: Lüthi et al., Tans, IIASA

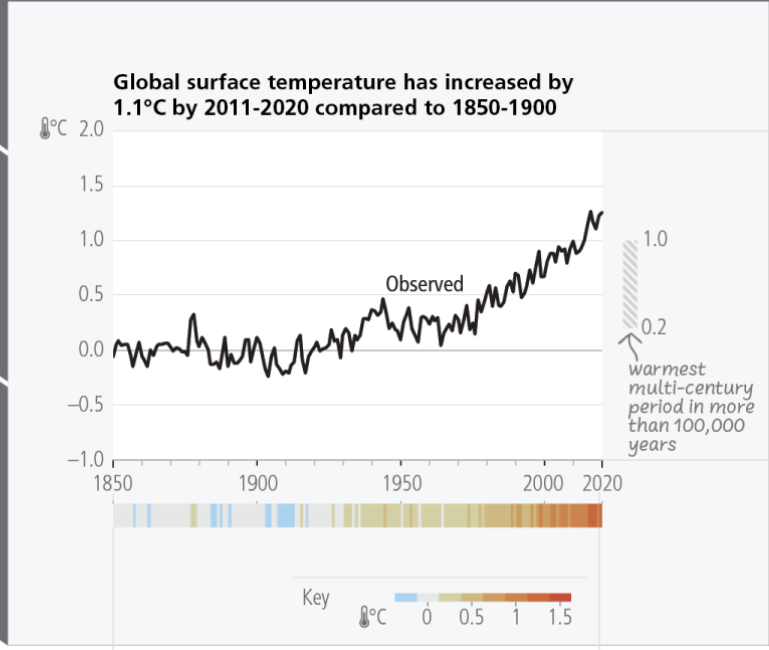


Roger Revelle and
Hans Suess, 1957

„ . . . human beings are now carrying out a large scale geophysical experiment of a kind that could not have happened in the past ...“

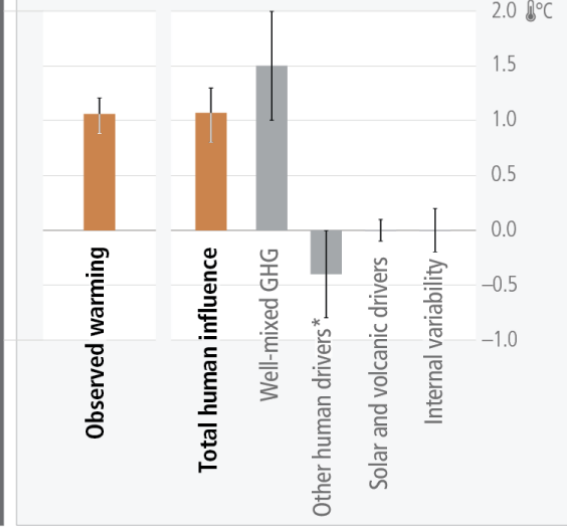


c) Changes in global surface temperature



d) Humans are responsible

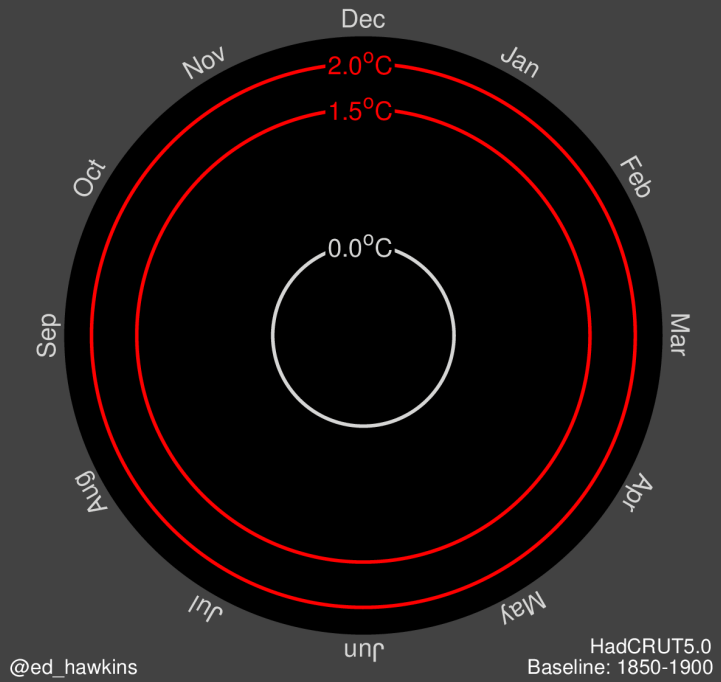
Observed warming is driven by emissions from human activities with GHG warming partly masked by aerosol cooling 2010-2019 (change from 1850-1900)



Source: IPCC AR6 SPM Figure 2.1
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Global annual mean temperature since 1850 as a spiral

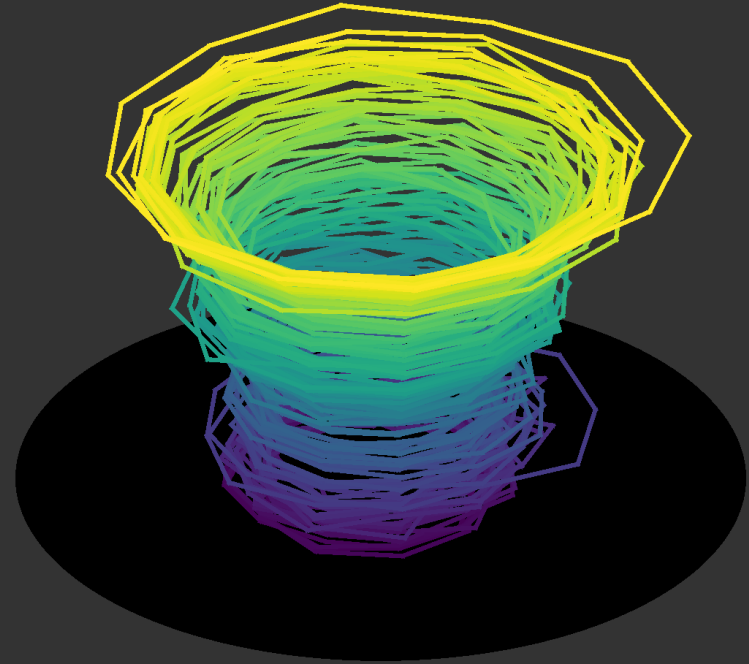


@ed_hawkins

Source: <https://www.climate-lab-book.ac.uk/spirals/>



Global temperatures since 1850: an artistic representation



@ed_hawkins

Source: <https://www.climate-lab-book.ac.uk/spirals/>



world weather attribution

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Limited net role for climate change in heavy spring rainfall in Emilia-Romagna

During May 2023, the North Italian region of Emilia-Romagna, particularly the provinces of Bologna, Ravenna, Forlì-Cesena, Rimini, experienced severe flooding, following three separate heavy rainfall events on the 2nd, 10th, and 16th of May.

Latest analyses



Extreme humid heat in South Asia in April 2023, largely driven by climate



Extreme April heat in Spain, Portugal, Morocco & Algeria almost



Human-induced climate change increased drought severity in Horn of Africa



Cold spells

Unusual cold spells can occur even in a warming world, and cause disruption to transport, energy & food supplies.



Drought

Drought affects people in many ways, from reduced water & food supplies to increasing the risk of wildfires.



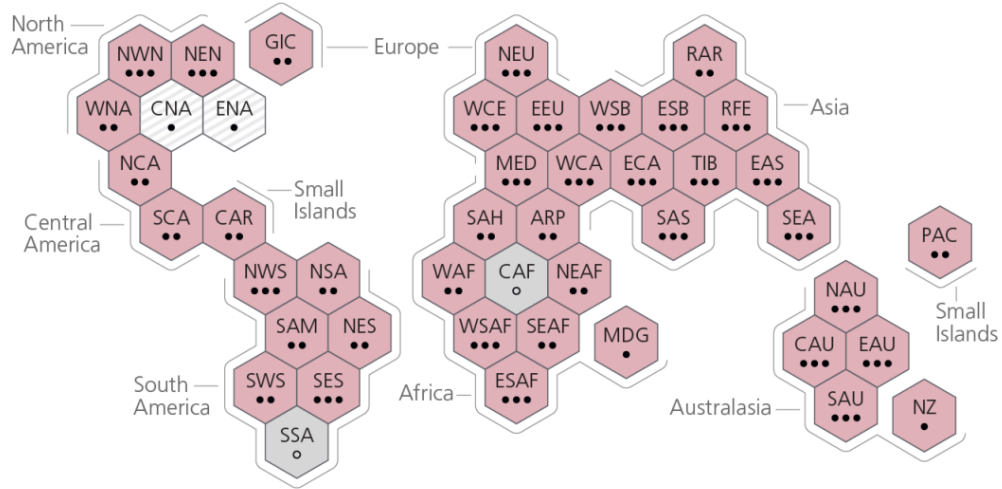
Extreme rainfall


Rainfall events from a major storm or hurricane, or intense localised downpours can lead to flooding in any type of location.

Climate change has impacted human and natural systems across the world with those who have generally least contributed to climate change being most vulnerable

a) Synthesis of assessment of observed change in hot extremes, heavy precipitation and drought, and confidence in human contribution to the observed changes in the world's regions

Hot extremes ← including heatwaves



Dimension of Risk:  Hazard

Key

Type of observed change since the 1950s

- Increase (Pink hexagon)
- Decrease (Teal hexagon)
- Limited data and/or literature (Grey hexagon)
- Low agreement in the type of change (Hatched hexagon)

Confidence in human contribution to the observed change

- High (Three dots)
- Medium (Two dots)
- Low due to limited agreement (One dot)
- Low due to limited evidence (Open circle)

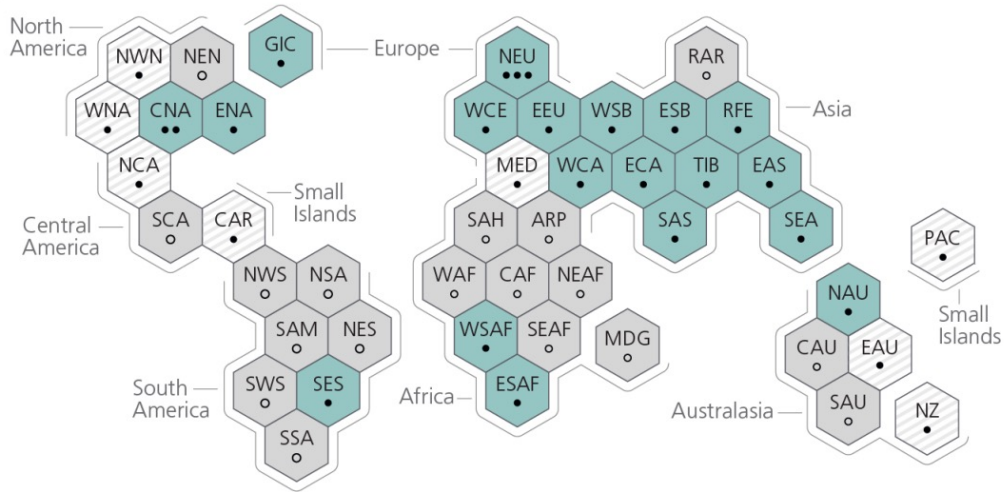
Source: IPCC AR6 SPM Figure 2.3
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Climate change has impacted human and natural systems across the world with those who have generally least contributed to climate change being most vulnerable

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Heavy precipitation



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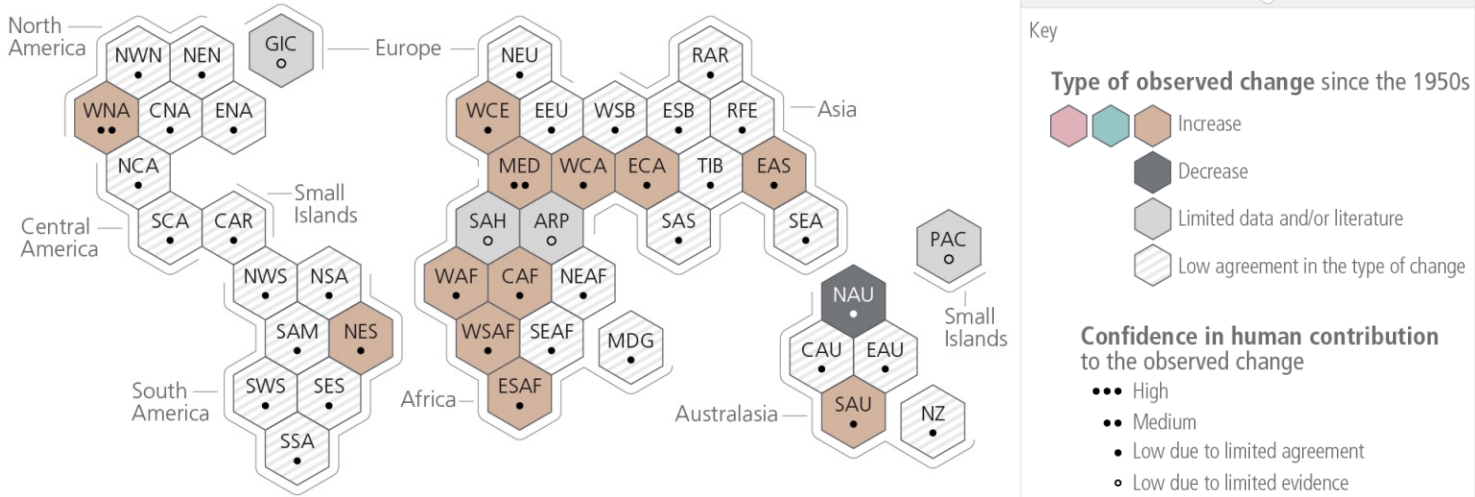
Source: IPCC AR6 SPM Figure 2.3
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Climate change has impacted human and natural systems across the world with those who have generally least contributed to climate change being most vulnerable

a) Synthesis of assessment of observed change in hot extremes, heavy precipitation and drought, and confidence in human contribution to the observed changes in the world's regions

Agricultural and ecological drought



Source: IPCC AR6 SPM Figure 2.3
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Tipping Elements (often called: Tipping Points)

big risks in the
Earth System



The geographical distribution of global and regional tipping elements, color-coded according to the best estimate for their temperature thresholds, beyond which the element would likely be 'tipped'. Figure designed at PIK, based on Armstrong McKay et al., Science (2022).



Tipping points - problems

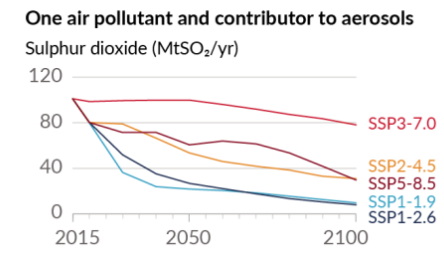
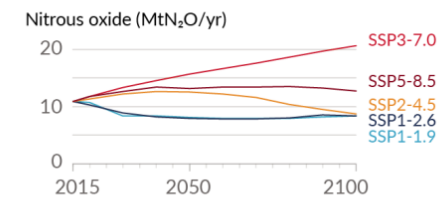
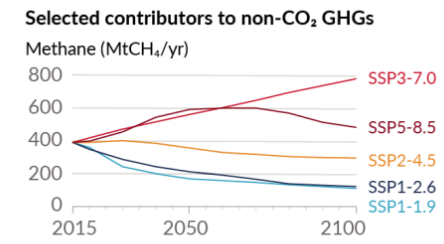
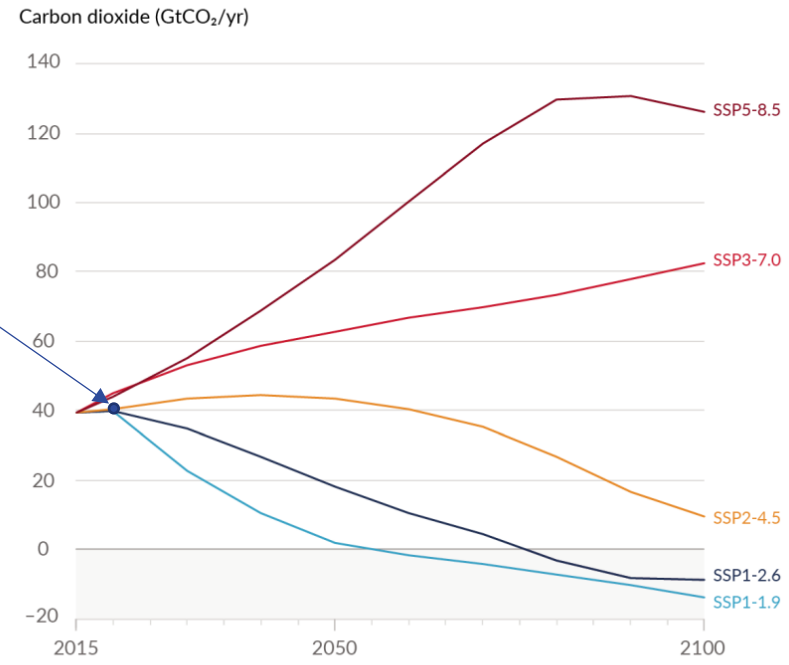
- The word “point” implies the rapidity of an unbalanced cart toppling over
 - Components of the Earth system are sluggish on human time scales, and thus many Earth system components tip over the course of decades, if not centuries or millennia.
- The word “point,” too, is bound to imply a single, precise, known critical threshold beyond which Earth system components tip
 - critical thresholds are rarely precisely known
- No fixed list
 - Arctic summer sea ice, regional monsoons, seafloor methane hydrates, and El Niño have mostly been stricken from lists of tipping elements. In some cases proposed tipping elements have replaced them.

There is no "Day after tomorrow" scenario



2022: 41.06 GtCO₂ fossil fuels and land use change
(<https://ourworldindata.org/co2-emissions>)

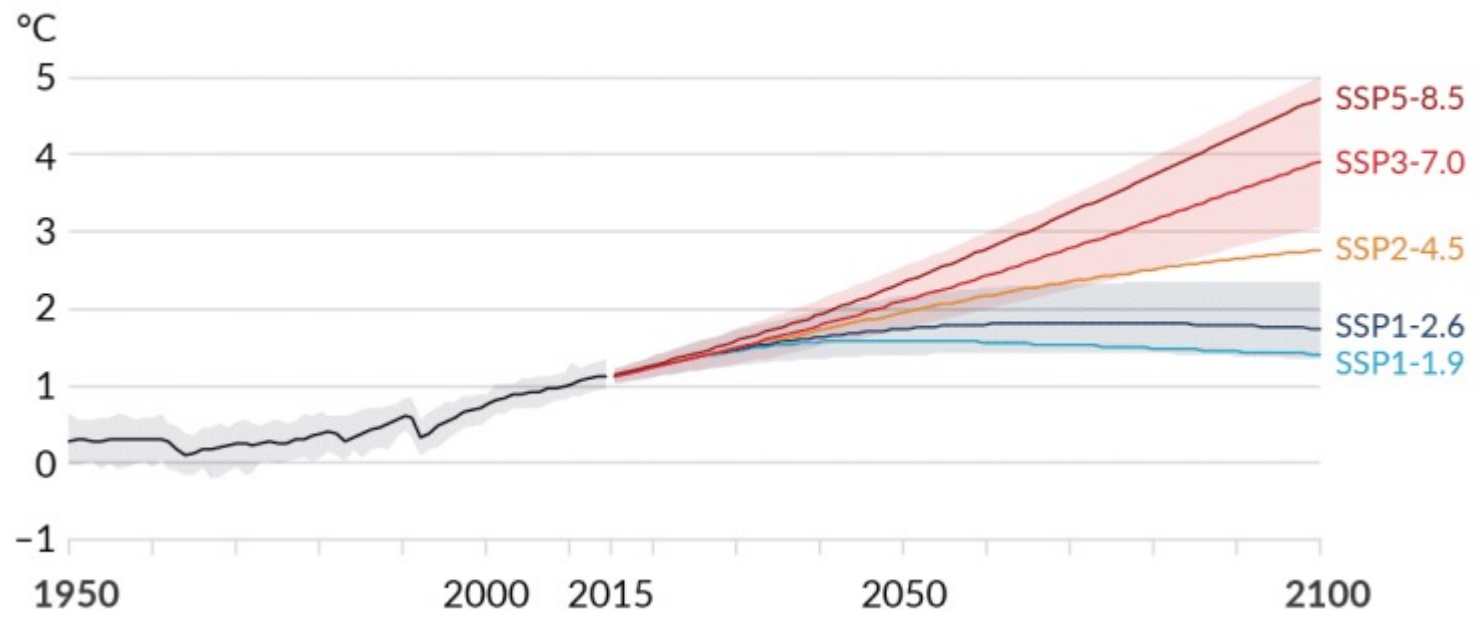
(a) Future annual emissions of CO₂ (left) and of a subset of key non-CO₂ drivers (right), across five illustrative scenarios



Source: IPCC AR6 WGI SPM Figure 4
© Intergovernmental Panel on Climate Change, 2021



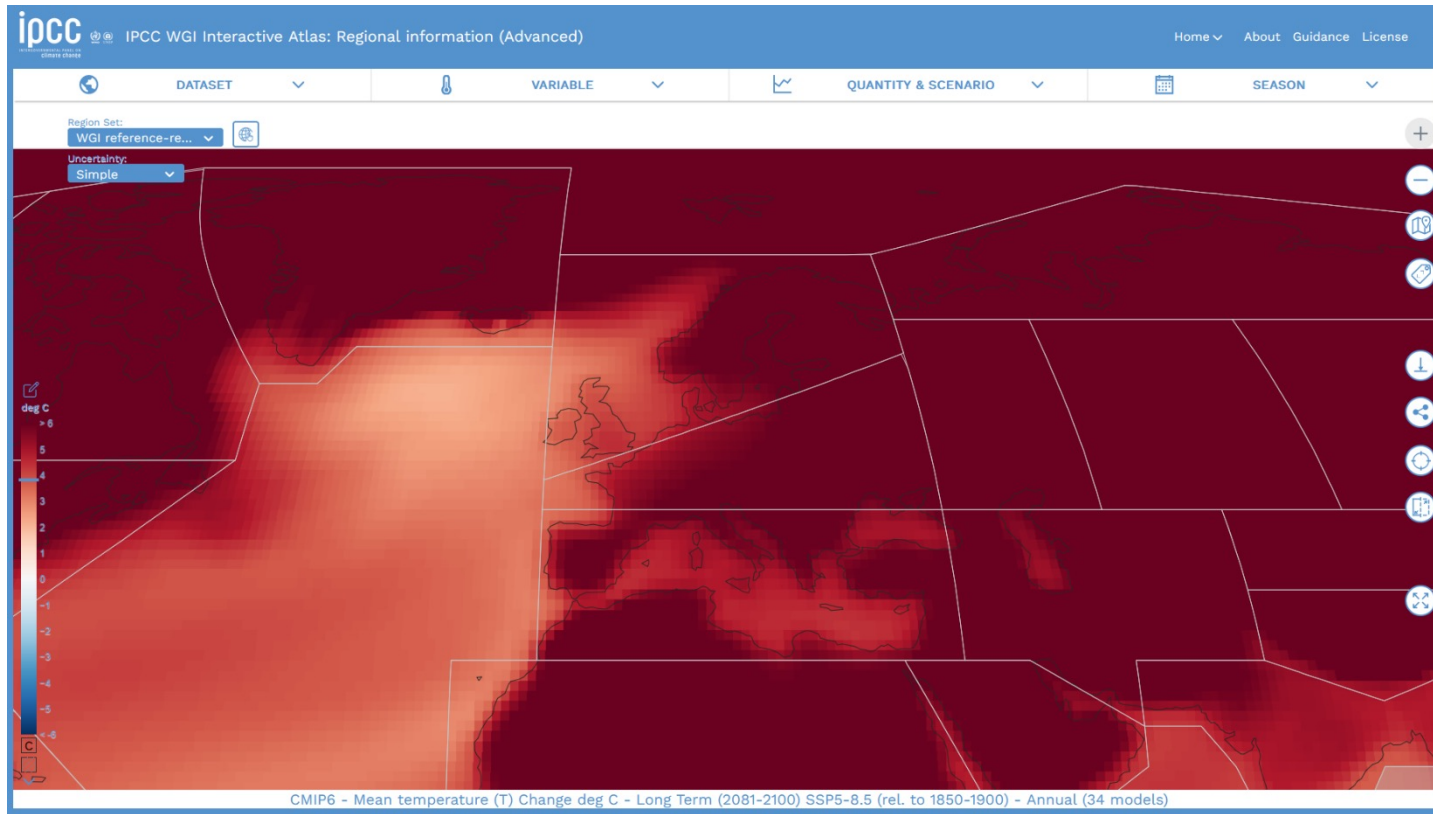
(a) Global surface temperature change relative to 1850–1900



Source: IPCC AR6 WGI SPM Figure 8
© Intergovernmental Panel on Climate Change, 2021



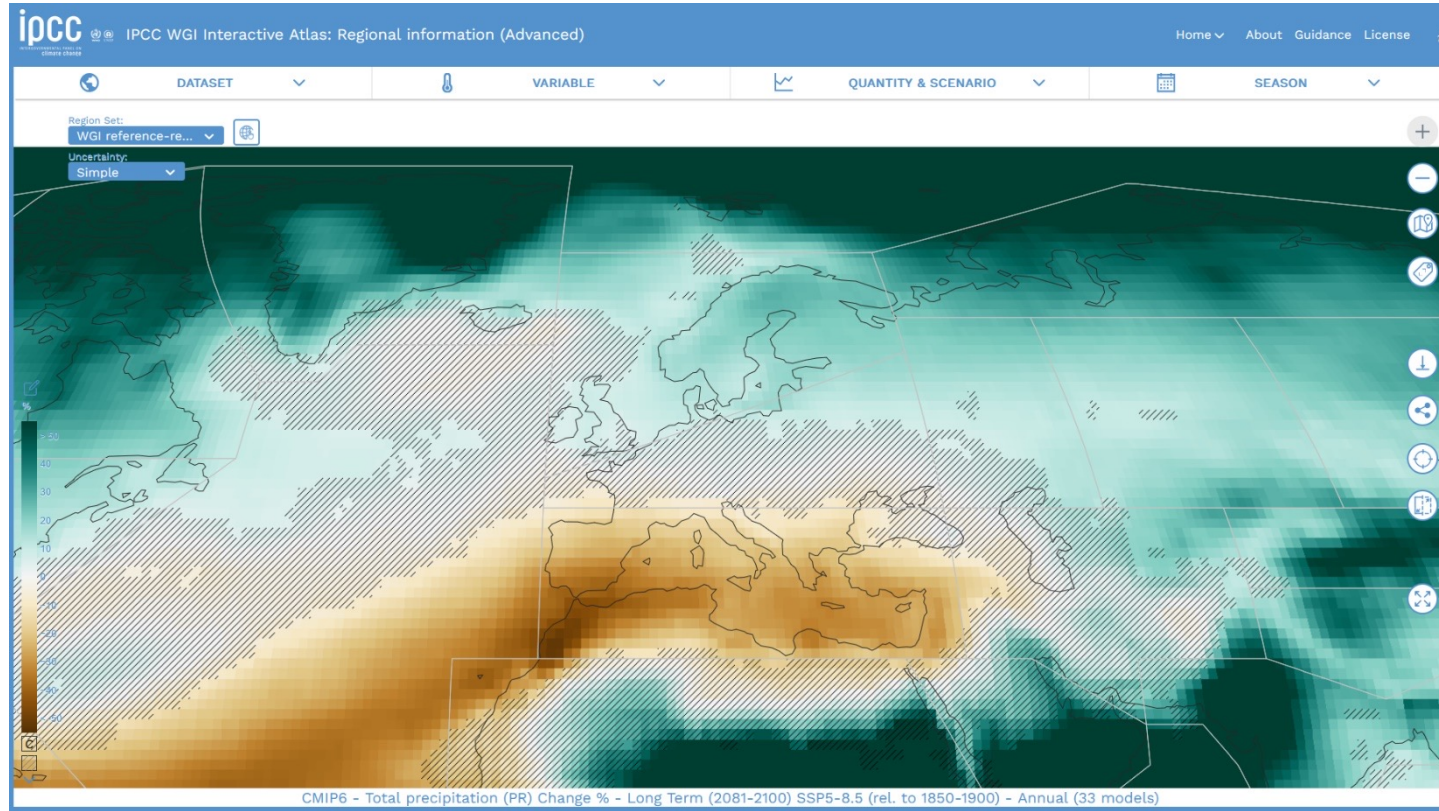
CMIP6 - Mean temperature (T) Change deg C - Long Term (2081-2100) SSP5-8.5 (rel. to 1850-1900) - Annual (34 models)



Source: interactive-atlas.ipcc.ch



CMIP6 - Total precipitation (PR) Change % - Long Term (2081-2100) SSP5-8.5 (rel. to 1850-1900) - Annual (33 models)

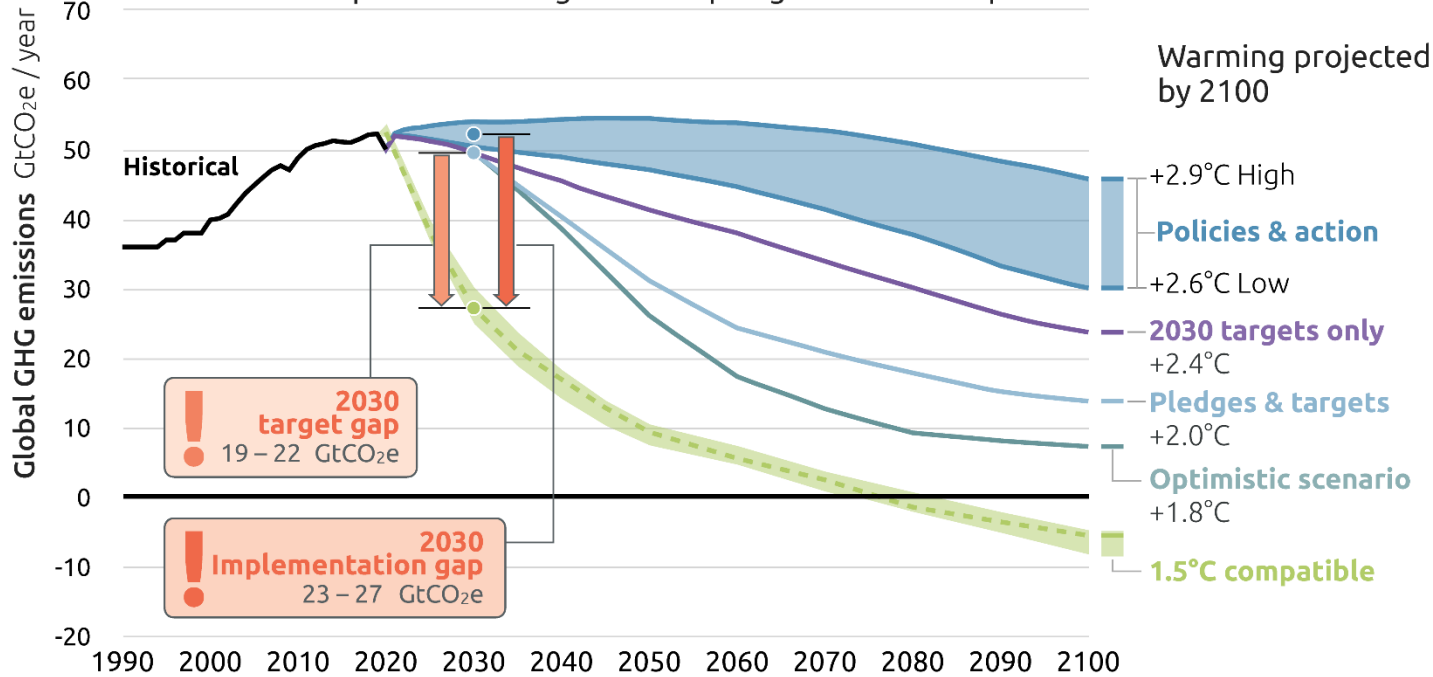


Source: interactive-atlas.ipcc.ch

2100 WARMING PROJECTIONS

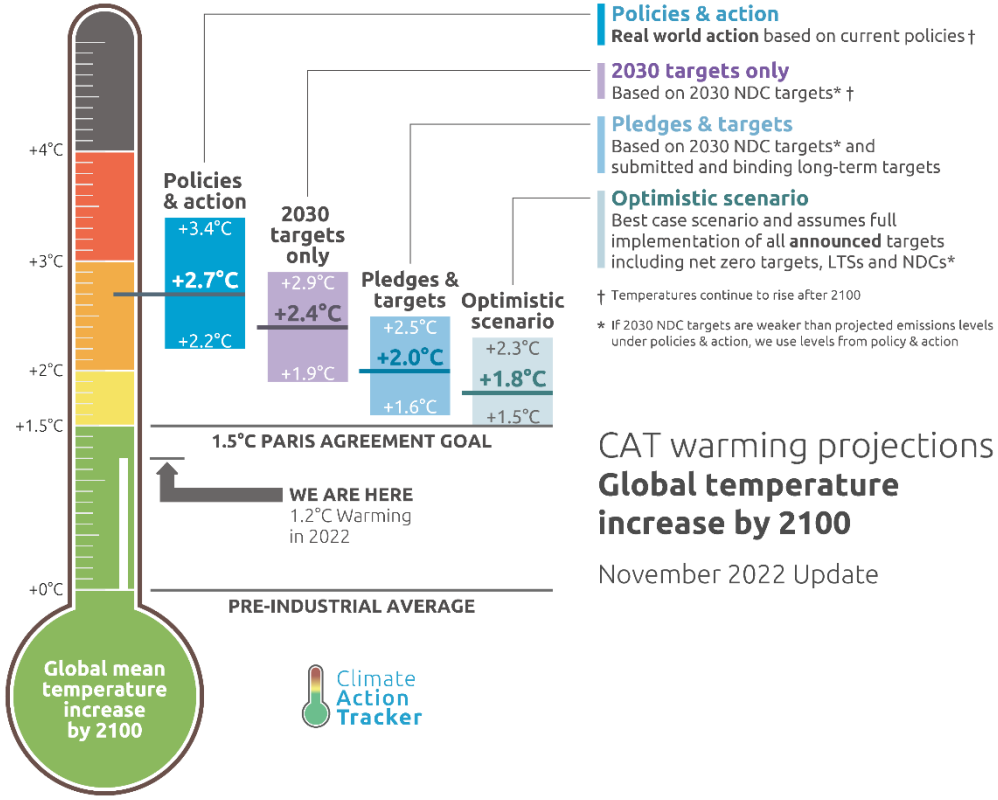
Emissions and expected warming based on pledges and current policies

Climate Action Tracker
Nov 2022 Update



Climate Action Tracker (2022). 2100 Warming Projections: Emissions and expected warming based on pledges and current policies. November 2022. Available at: <https://climateactiontracker.org/global/temperatures/>. Copyright ©2022 by Climate Analytics and NewClimate Institute. All rights reserved.





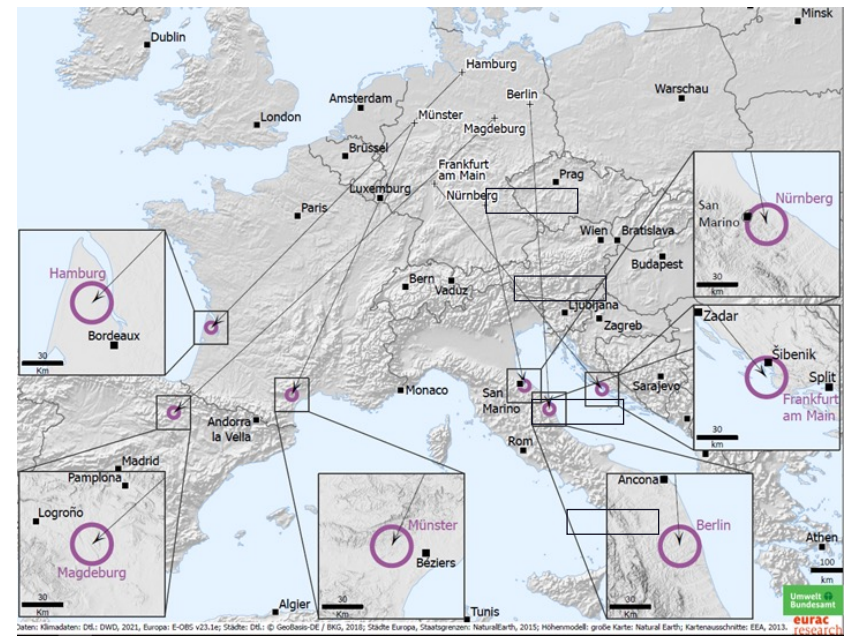
CAT warming projections
Global temperature increase by 2100
November 2022 Update

Climate Action Tracker (2022). The CAT Thermometer. November 2022. Available at: <https://climateactiontracker.org/global/catt-thermometer/> Copyright © 2022 by Climate Analytics and NewClimate Institute. All rights reserved



Which place has a similar climate today as we expect in the future (RCP8.5)?

Source: Analysing spatial patterns of climate change: climate clusters, hotspots and analogues to support climate risk assessment and communication in Germany
A. Crespi, K. Renner, M. Zebisch, I. Schauser, N. Leps, A. Walter
Climate Services, 2023.
<https://doi.org/10.1016/j.cliser.2023.100373>



Berlin with a climate like central Italy

- The infrastructure, the flora and much more are very different
 - A tremendous amount of change needs to take place in Berlin
- A city like Berlin very likely has the capacity to adapt
- The same is not true for many cities / states in the world.

Take home message about climate change

1. Experts agree.
2. It's real.
3. It's us.
4. It's bad.
5. There's hope.

Source: <https://climatecommunication.yale.edu/for-educators/climate-change-basics-five-facts-ten-words/>





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