



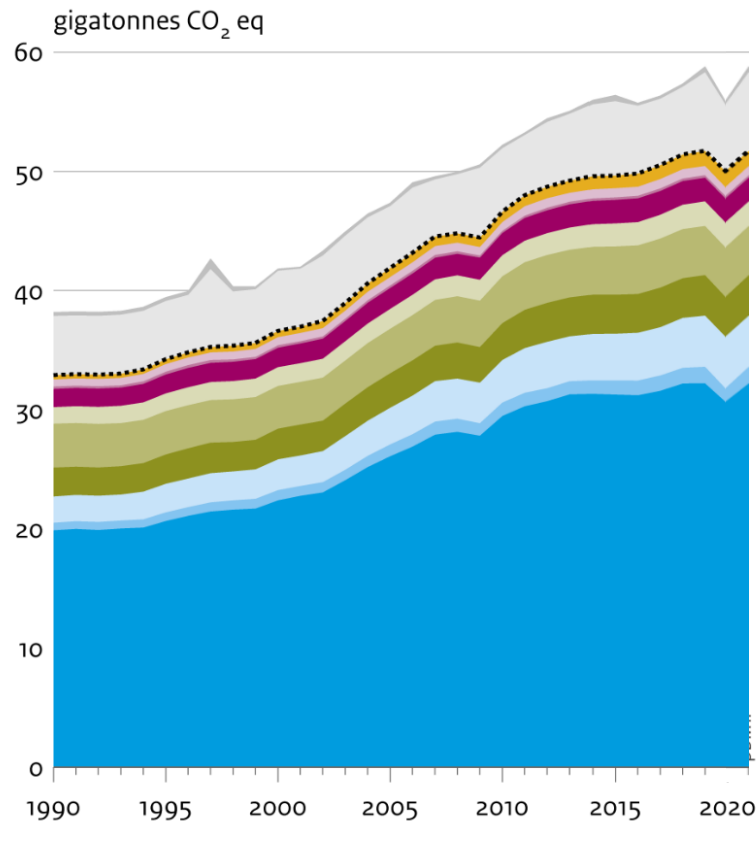
## CO<sub>2</sub> (equivalent) emissions and Global warming





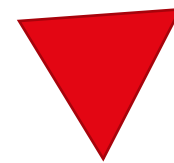
*Largest coal power plant in EU.  
5,030MW, Belchatow, Poland*

# I. CO<sub>2</sub> and equivalent emissions



- **Energy** (inc transport) and methane leaks → large Part of the CO<sub>2</sub> equivalent emissions
- **CO<sub>2</sub>** from cement and steel
- **Agriculture and land-use** also important

Strategic  
Dependancies



- Global warming
- Pollution and diseases
- Loss of biodiversity

<https://www.pbl.nl/>

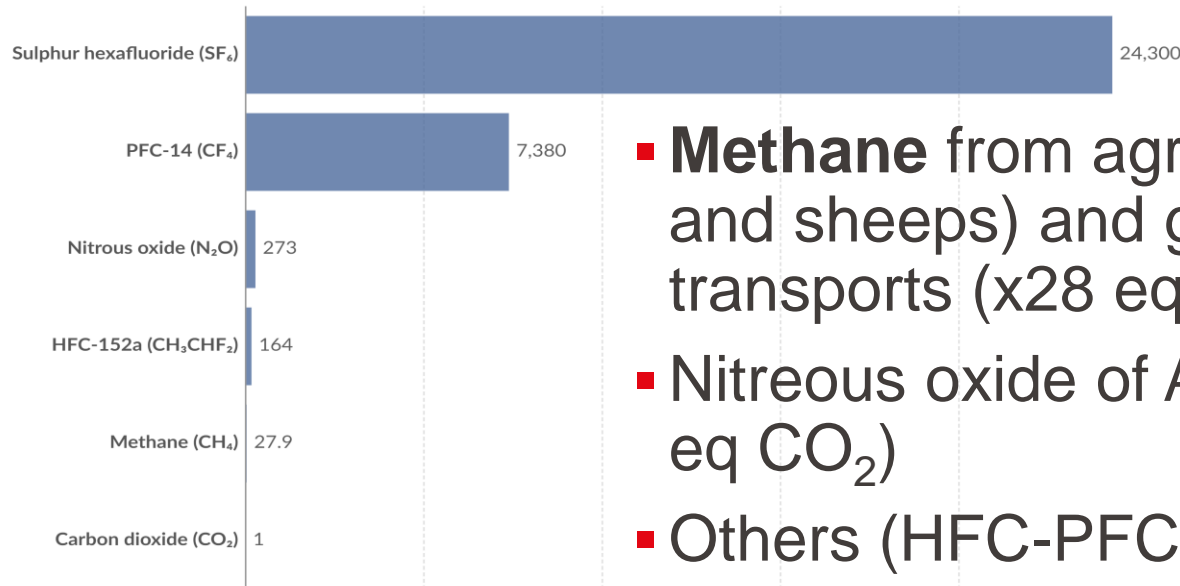
[EDGAR - The Emissions Database for Global Atmospheric Research \(europa.eu\)](https://edgar.jrc.ec.europa.eu/)

# Other green house gases play a role: CO<sub>2</sub> equivalent

## Global warming potential of greenhouse gases relative to CO<sub>2</sub>

Global warming potential<sup>1</sup> measures the relative warming impact of one unit mass of a greenhouse gas relative to carbon dioxide over a 100-year timescale.

Our World  
in Data



- **Methane** from agriculture (and cows and sheeps) and gas/oil fields and transports (x28 equiv CO<sub>2</sub>)
- Nitreous oxide of Agriculture (x273 eq CO<sub>2</sub>)
- Others (HFC-PFC-SF6...)

Data source: IPCC (2021)

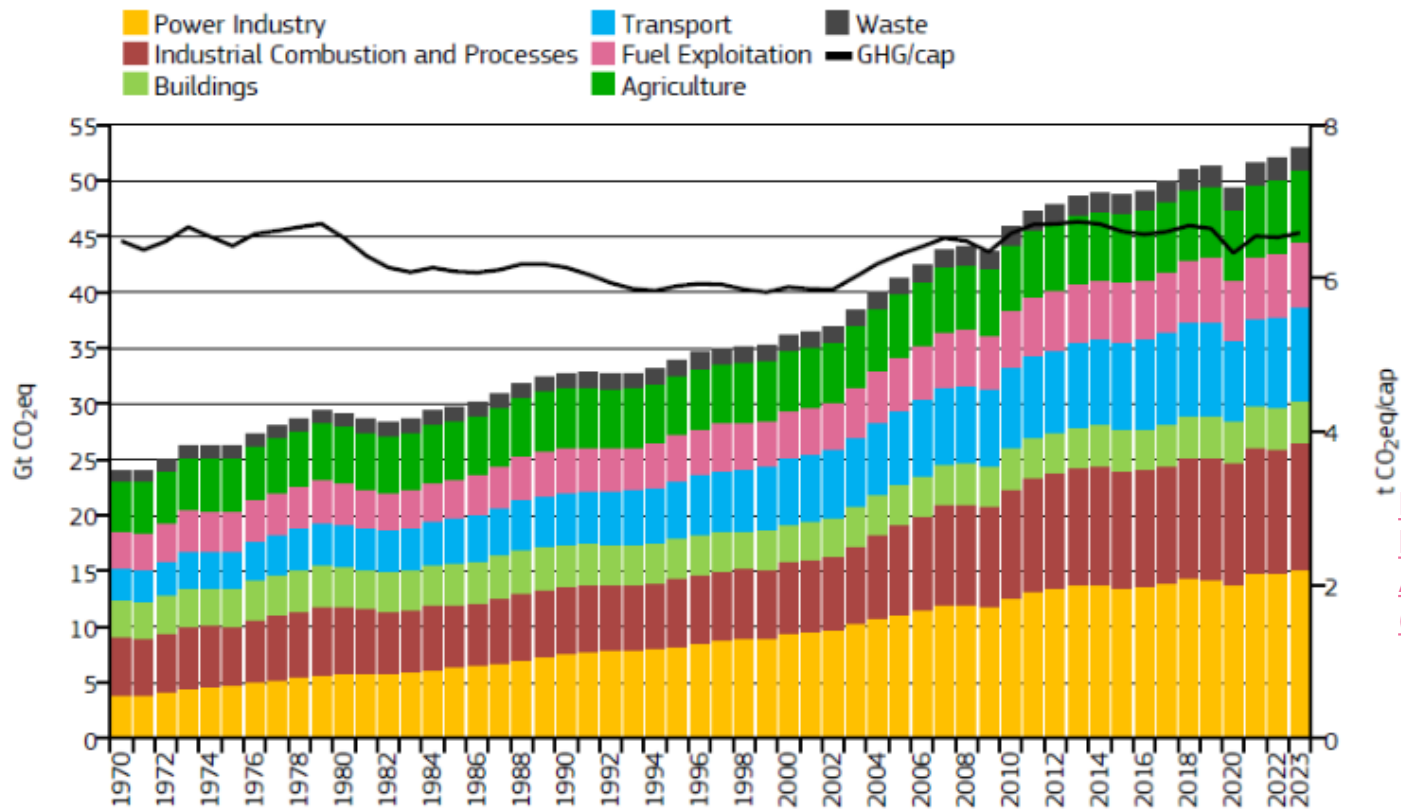
[OurWorldInData.org/co2-and-greenhouse-gas-emissions](https://ourworldindata.org/co2-and-greenhouse-gas-emissions) | CC BY

**1. Global warming potential:** Global warming potential (GWP) measures the amount of heat absorbed by a greenhouse gas relative to the same mass of carbon dioxide (CO<sub>2</sub>). It measures the amount of warming a gas creates compared to CO<sub>2</sub>. Carbon dioxide is given a GWP value of one. If a gas had a GWP of 10 then one kilogram of that gas would generate ten times the warming effect as one kilogram of CO<sub>2</sub>. Since greenhouse gases spend different amounts of time in the atmosphere, their global warming potential depends on the length of time that it's measured over. For example, GWP can be measured as the warming effect over 20 years, 50 years, or 100 years. Potent but short-lived greenhouse gases – like methane, for example – will have a higher GWP when measured over 20 years than over 100 years. The GWP value for methane over 100 years (GWP100) is 28. This means one kilogram of methane would cause 28 times the warming of one kilogram of CO<sub>2</sub>.

<https://ourworldindata.org/greenhouse-gas-emissions>

# Emission by sector (to 53 GT)

**Figure 2.** Global GHG emissions by sector (left axis, bars) and per capita (right axis, black line), 1970-2023

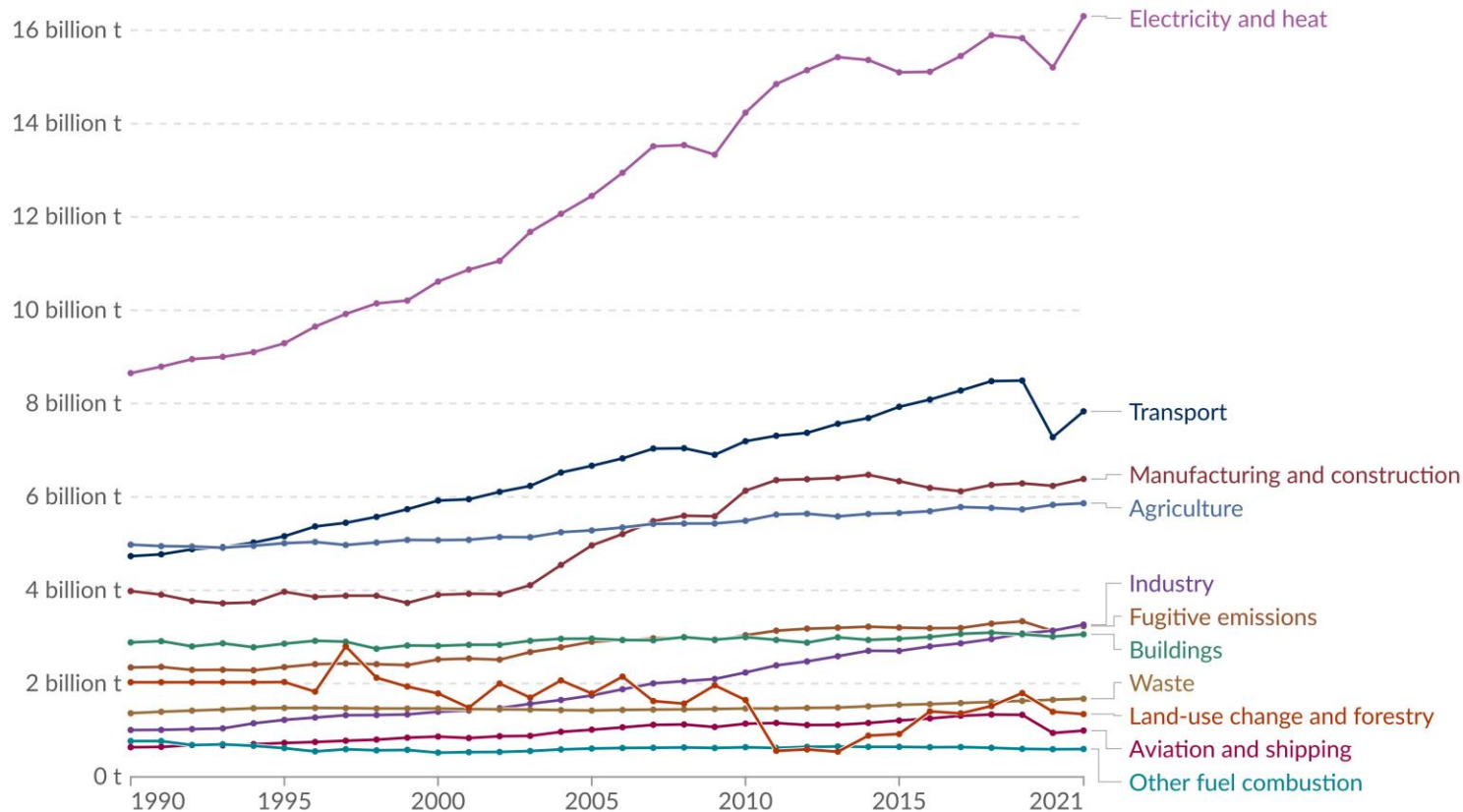


[EDGAR - The Emissions Database for Global Atmospheric Research \(europa.eu\)](https://edgar.jrc.ec.europa.eu/)

Source: JRC, 2024

# Greenhouse gas emissions by sector, World

Greenhouse gas emissions<sup>1</sup> are measured in tonnes of carbon dioxide-equivalents<sup>2</sup> over a 100-year timescale.



Data source: Climate Watch (2024)

OurWorldinData.org/co2-and-greenhouse-gas-emissions | CC BY

Note: Land-use change emissions can be negative.



A more complete way to look at the Emissions

(n.b. the best found... from 2016  
But no updated data)

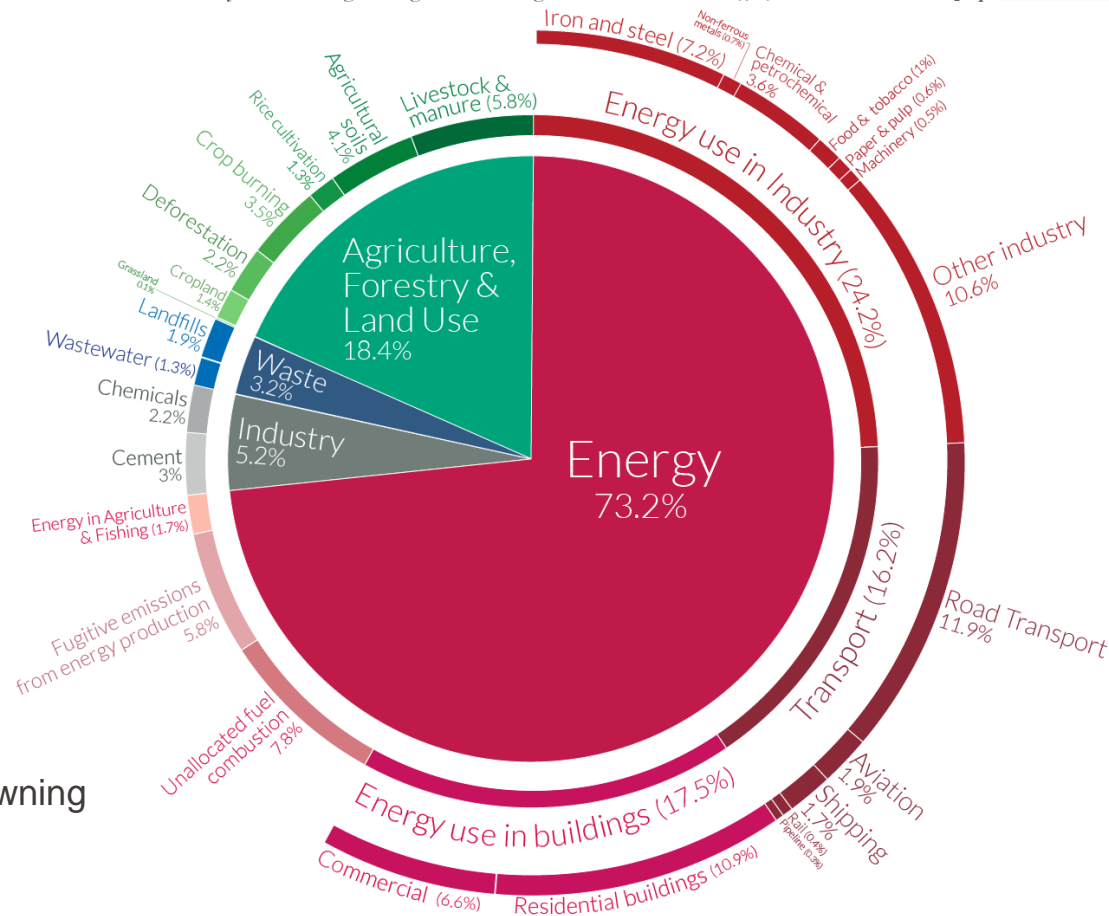
Industry 24 %  
Transport 16%  
Buildings 17%  
Agriculture 20%  
Chemicals 5.2%  
Fugitive emission 6%  
(likely more)

Direct CO2 emission  
of the electricity production  
~ 40% of CO2 emission  
30% of global CO2 eq emission  
IT ~ 2% of CO2 émission, fast growing

Source: <https://ourworldindata.org/emissions-by-sector>

# Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO<sub>2</sub>eq.



# Annual total CO<sub>2</sub> emission by world region\*

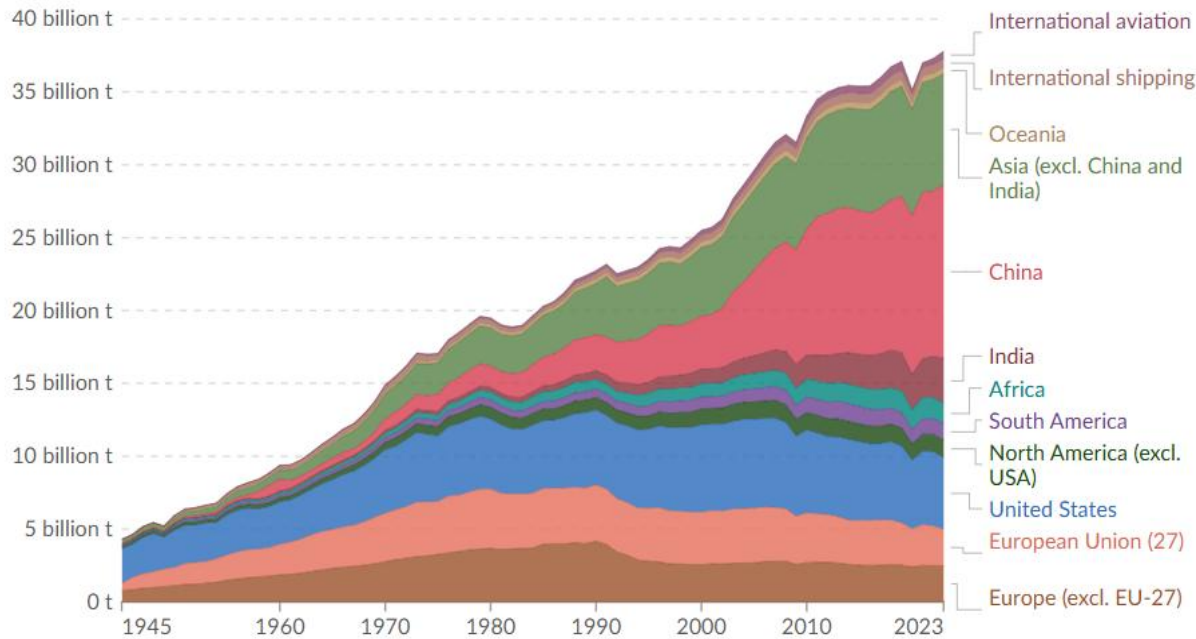
## Annual CO<sub>2</sub> emissions by world region

Emissions from fossil fuels and industry are included, but not land-use change emissions. International aviation and shipping are included as separate entities, as they are not included in any country's emissions.

Our World  
in Data

Table Chart

Settings



- Annually over 37 billion tonnes of CO<sub>2</sub>
- 50% increase since 2000
- According to IEA stabilisation in 2019, thanks to a switch to renewable
- Visible effect of Covid in 2020 (but resumes in 2021)
- China and Asia growing fast with still less cumulated emissions

1. Fossil emissions: Fossil emissions measure the quantity of carbon dioxide (CO<sub>2</sub>) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO<sub>2</sub> includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

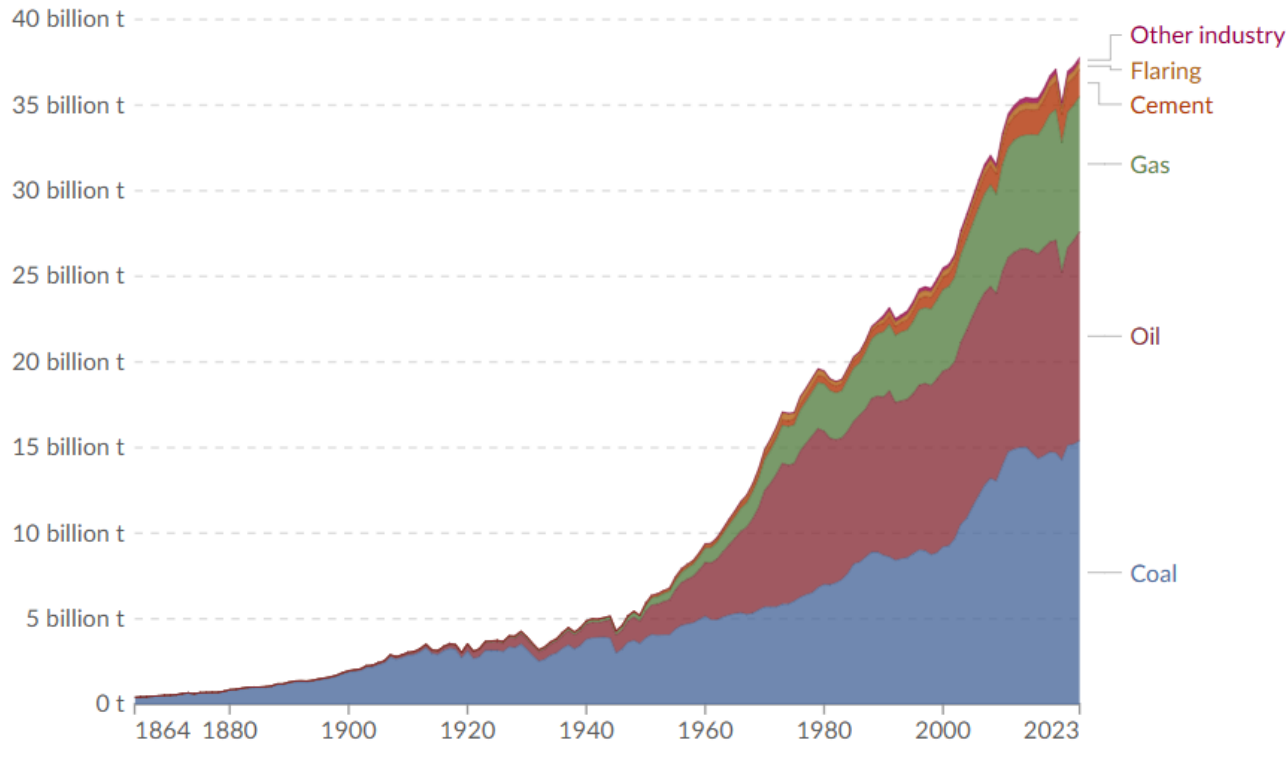
Source: <https://ourworldindata.org/co2-emissions#co2-emissions-by-region>



# (direct) CO<sub>2</sub> emissions by fuel type

## CO<sub>2</sub> emissions by fuel or industry type, World

Our World  
in Data



Most of CO<sub>2</sub> emissions  
Burning fossile fuel

- Electricity
- Transport
- Heating

Cement and Steel...

Data source: Global Carbon Budget (2024)

OurWorldinData.org/co2-and-greenhouse-gas-emissions | CC BY



Source: <https://ourworldindata.org/emissions-by-fuel>

# Cement and steel – nine steps to net zero

It is possible – and crucial – to green the building blocks of the modern world.

By [Paul Fennell](#) , [Justin Driver](#), [Christopher Bataille](#) & [Steven J. Davis](#)



Cement

→ 2.3 GT of CO<sub>2</sub>/per year,

Iron and steel releases

→ 2.6 GT CO<sub>2</sub>/per year

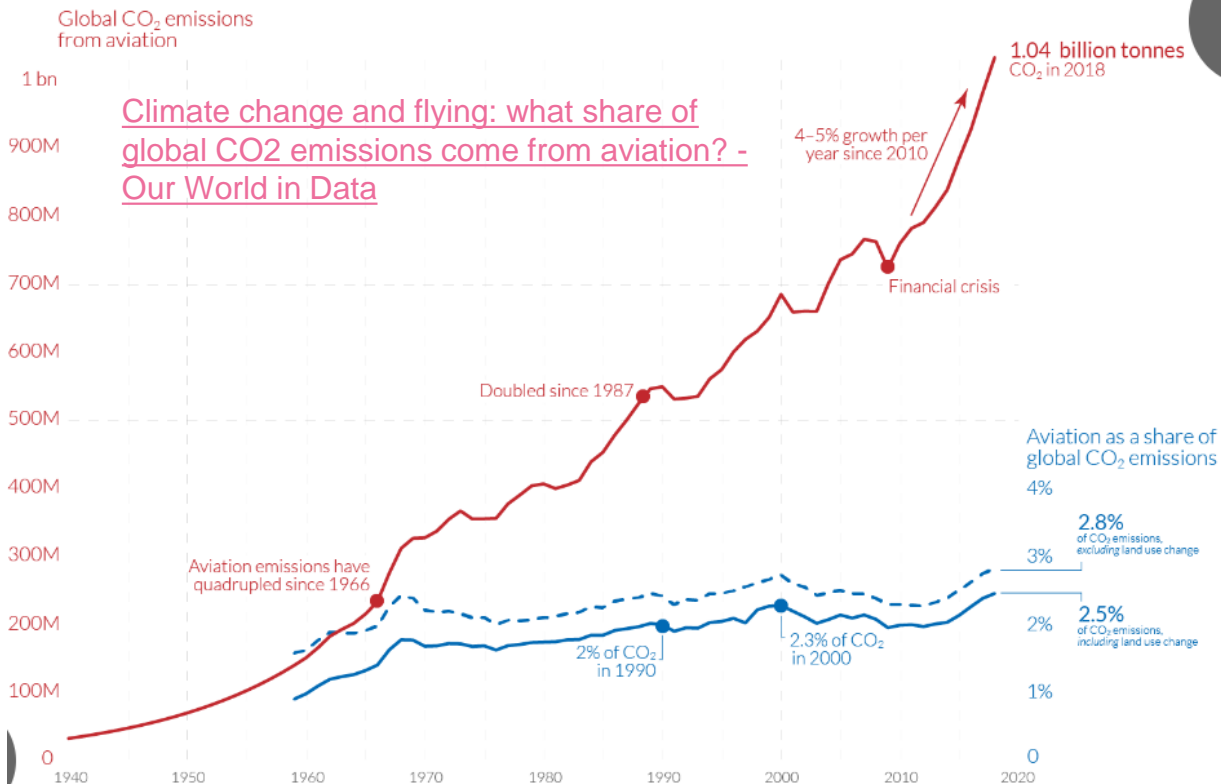
A mixture of input Energy and emission from chemical processes

- H<sub>2</sub> reduction for steel ?
- CO<sub>2</sub> capture for concrete ?

[Cement and steel — nine steps to net zero \(nature.com\)](#)

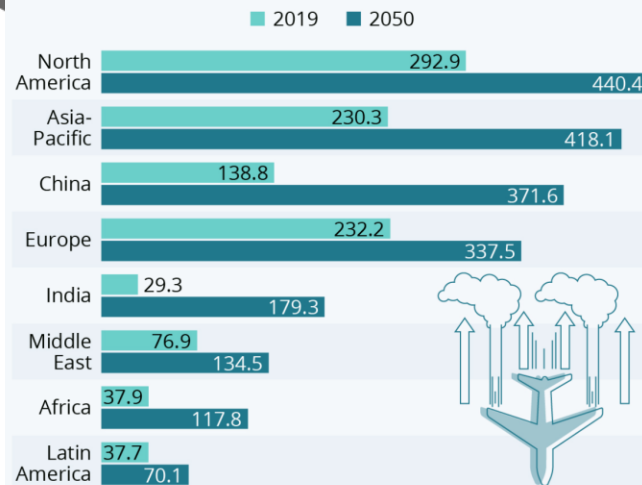
# CO<sub>2</sub> from aviation globally: 2.5% in 2020 + changes to atmosphere → 3.5%

Aviation emissions includes passenger air travel, freight and military operations. It does not include non-CO<sub>2</sub> climate forcings, or a multiplier for warming effects at altitude.



## Aviation Emissions to Skyrocket

Carbon emissions from aviation by world region (in million metric tons CO<sub>2</sub> equivalent)



Source: Bloomberg



statista

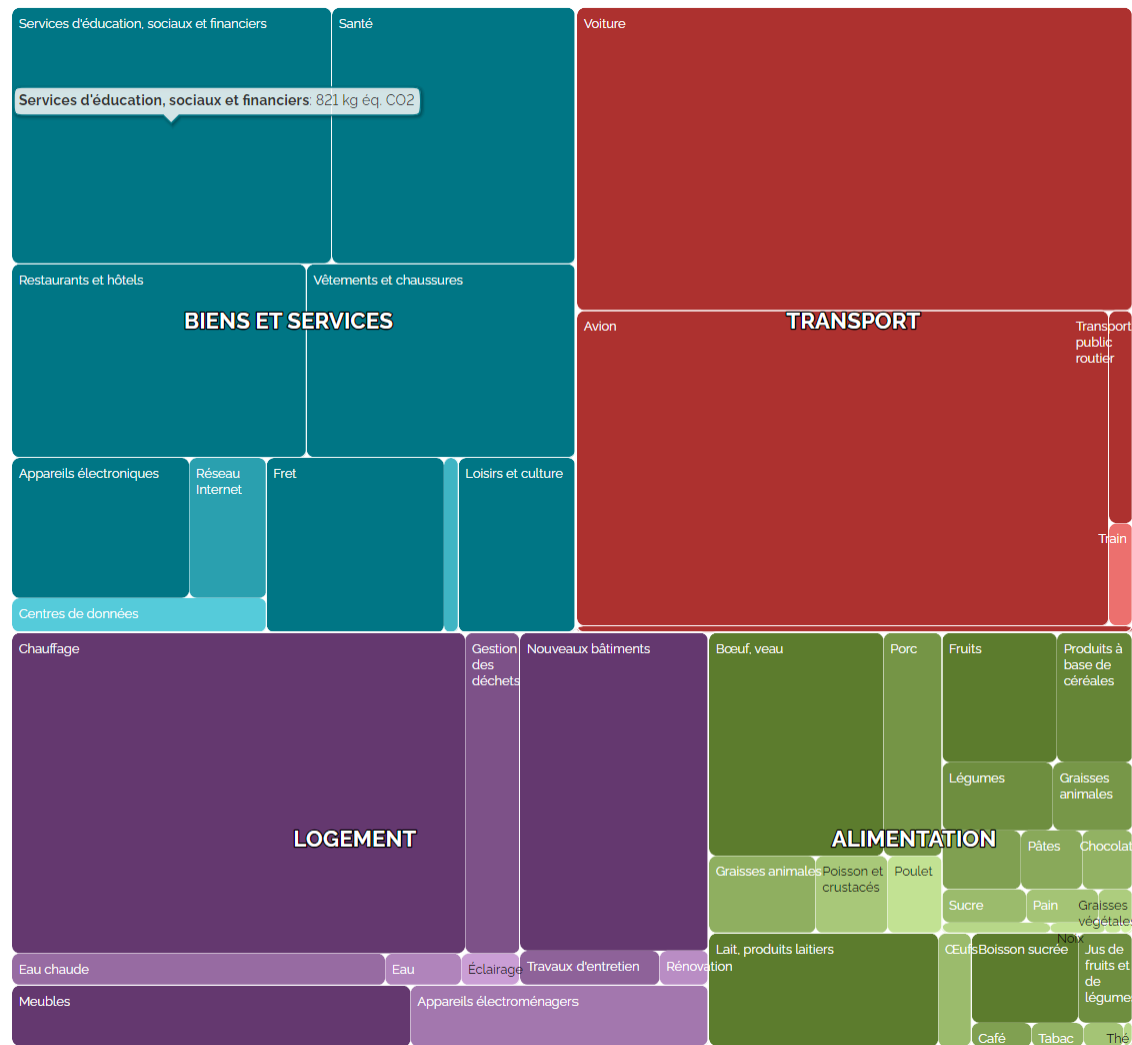
■ How to « limit » aviation emission ?

- Many ways to attribute emission
- Emissions are widespread over every aspect of our daily life.  
Work, transport, services, home, leisure, food, new cloths, smart phones, IT...
- Not one thing to improve, many things

Exemple: EPFL with 10'000 students. 80 GWh electricity → 8'000 kWh/year per student ...

- With swiss electricity mix ~ 800 kg CO<sub>2</sub>.... With EU mix 3200 kg...  
(if one wants to count per student !)

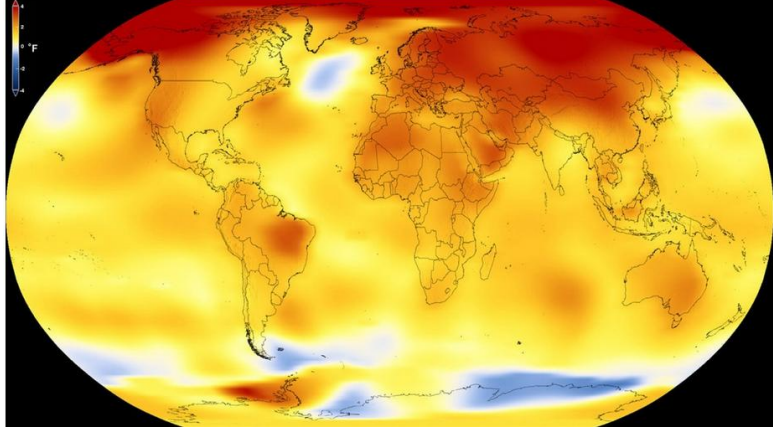




<https://clim pact.ch/about>

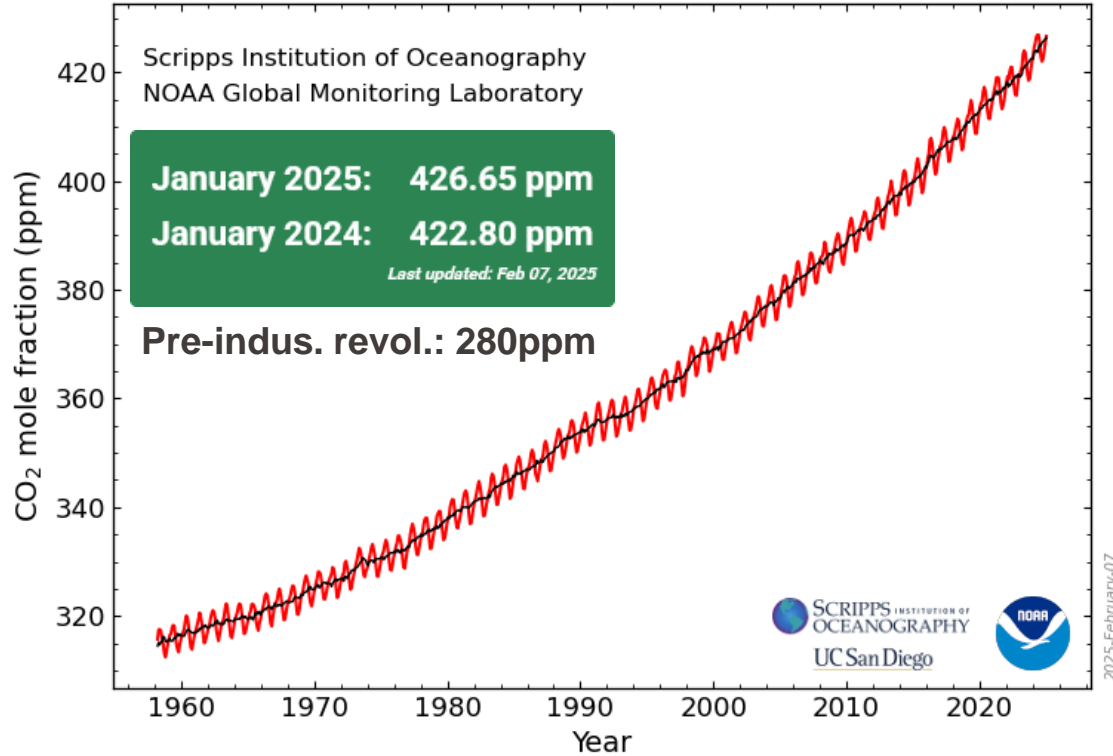
Empreinte  
carbone d'un.e  
citoyen.ne suisse  
| Clim pact

11.7 tons/year



## II. Impact of CO<sub>2</sub>-eq emissions



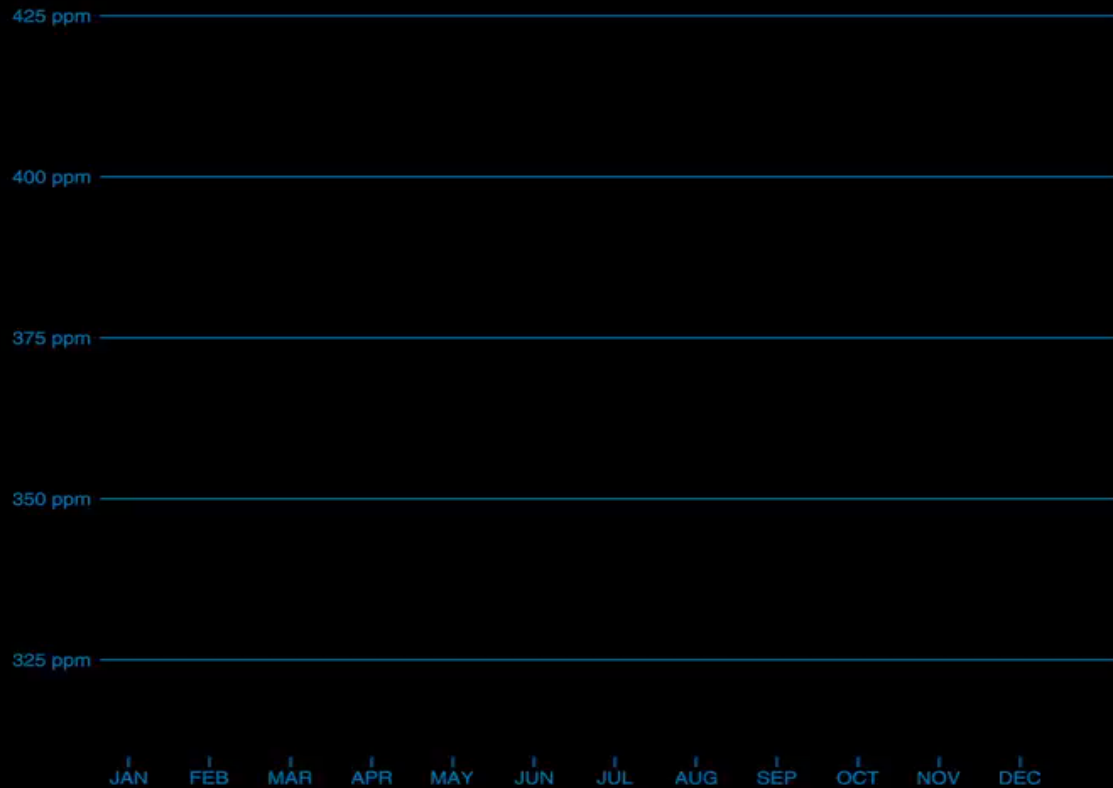
Atmospheric CO<sub>2</sub> at Mauna Loa Observatory

<https://gml.noaa.gov/ccgg/trends/>

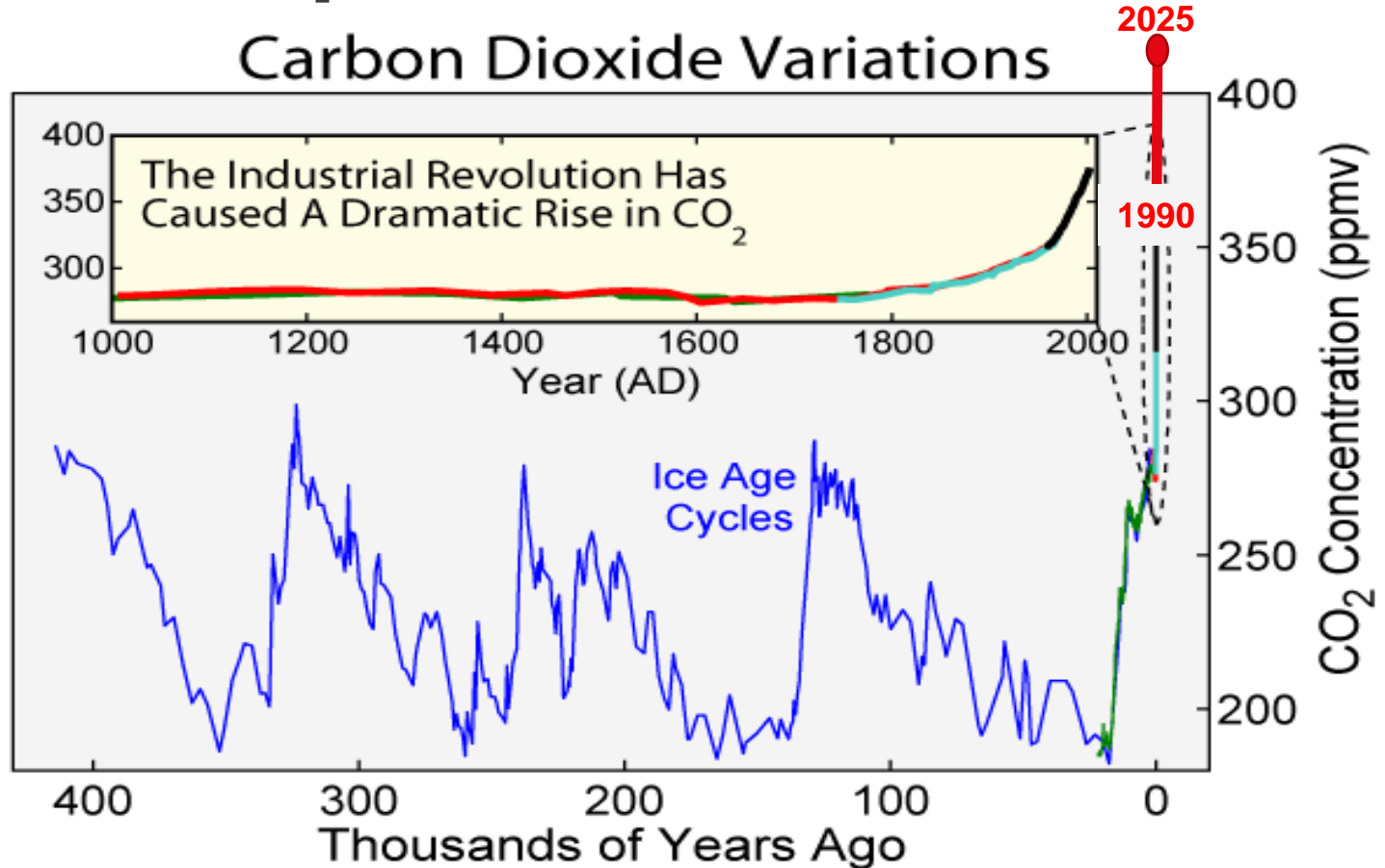


The Mauna Loa Atmospheric Baseline Observatory in Hawaii began measuring the amount of carbon in the atmosphere in 1958. Susan Cobb/NOAA

## Atmospheric Carbon Dioxide Concentration 1958



# CO<sub>2</sub> atmospheric concentration increase



Hasn't Earth warmed and cooled naturally throughout history? | [NOAA Climate.gov](https://www.noaa.gov/)

# International panel on climate change (IPCC)

<https://www.ipcc.ch/>

- In depth-synthesis of causes and (partially) actions required

In general, validated by states !



**The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.**

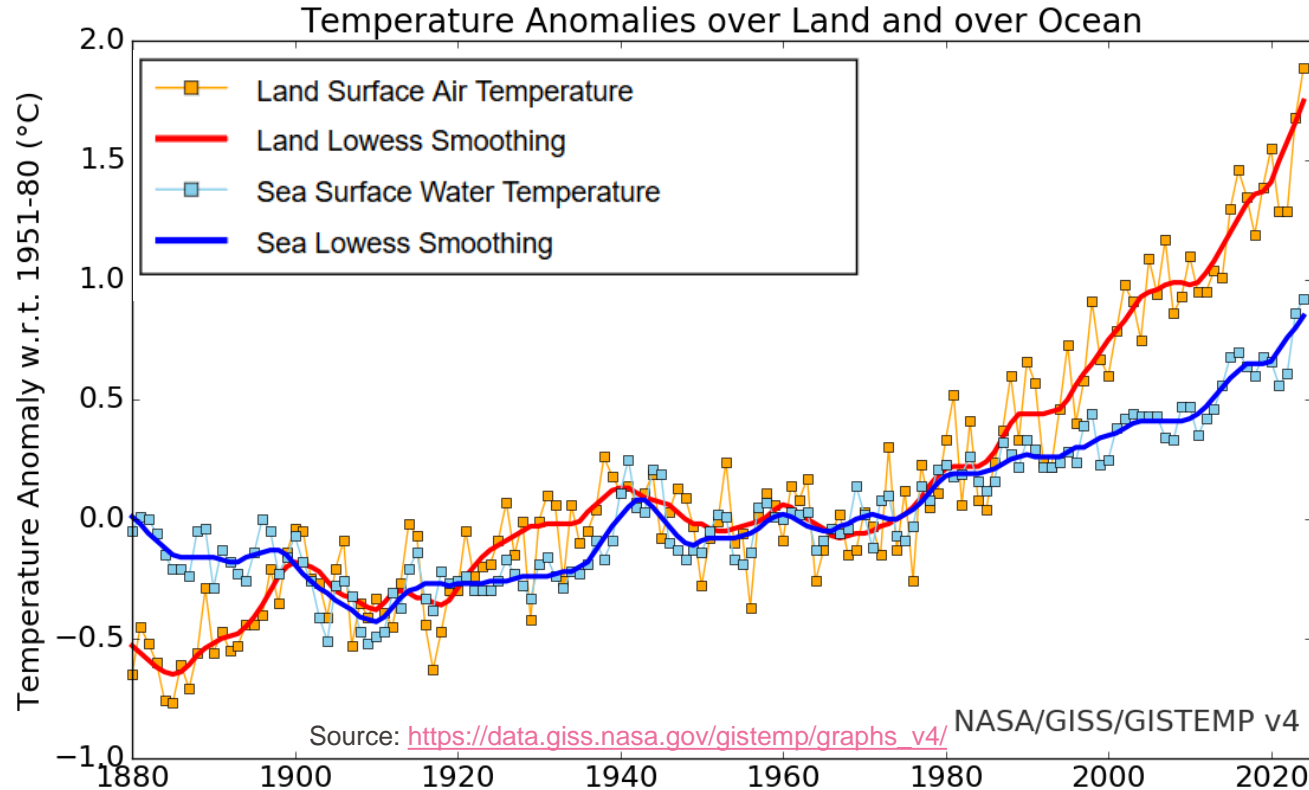


Find all latest report on

<https://www.ipcc.ch/reports/>

- Fossil fuel burnings has impact on health, relates to a huge mining/soil exploration and pollution, leads to conflicts, strategic dependances...
- Fossil fuel are the major reasons for global warming (~ 70-75 %)
- Unparallel CO<sub>2</sub> concentration increase in the atmosphere (413 ppm in 2020 → 426 in Jan 2025) linked to fossil fuel burning (and other CO<sub>2</sub> eq emissions)
- Major global temperature increase (now at > 0.2°C/decades, 1.1° more since beginning of industrialisation)
  - *Dec. 2023 = 1.65°C > 1880 - 1920*
  - *Dec. 2023 = warmest Dec. Since 1880*
  - *Average T Dec. For the last 10 years → 1.18°C > Dec. average 1880 - 1920*

# Average world temperature increase



Average  $> 1.5^{\circ}\text{C}$  from 1950 on land

Slope tends to accelerate

Curves can be modelled with complex models

- **Notes:** past cyclic (like cooler area) and non-cyclic events (e.g. little ice age) are associated to e.g. oscillation of earth orbits, or sun activity, meteorites and volcanic eruptions...



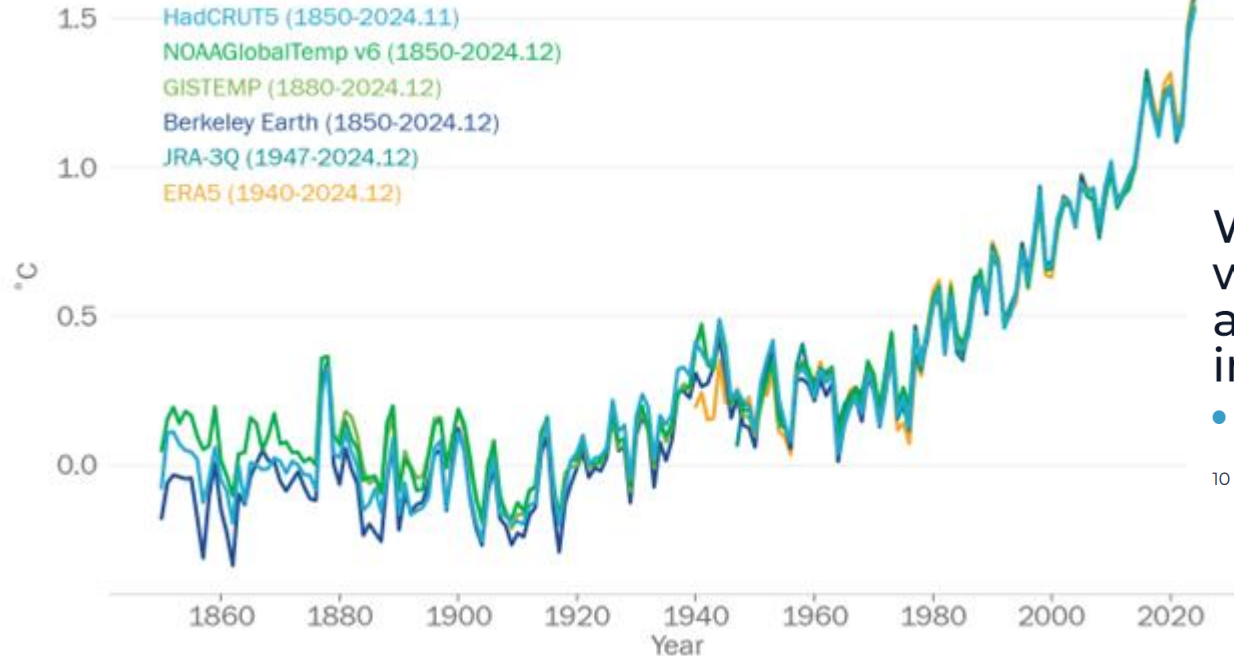
# 1.5°C already reached ?



WORLD  
METEOROLOGICAL  
ORGANIZATION

Weather Climate Water

Global mean temperature 1850-2024  
Difference from 1850-1900 average



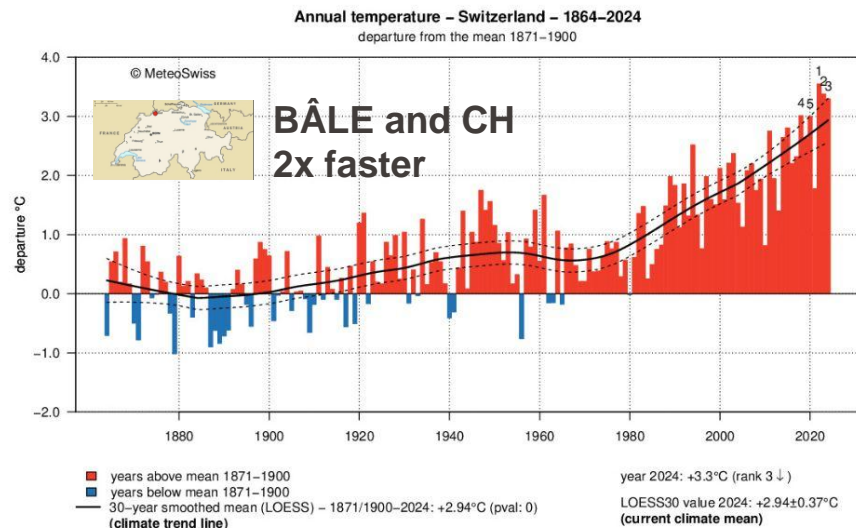
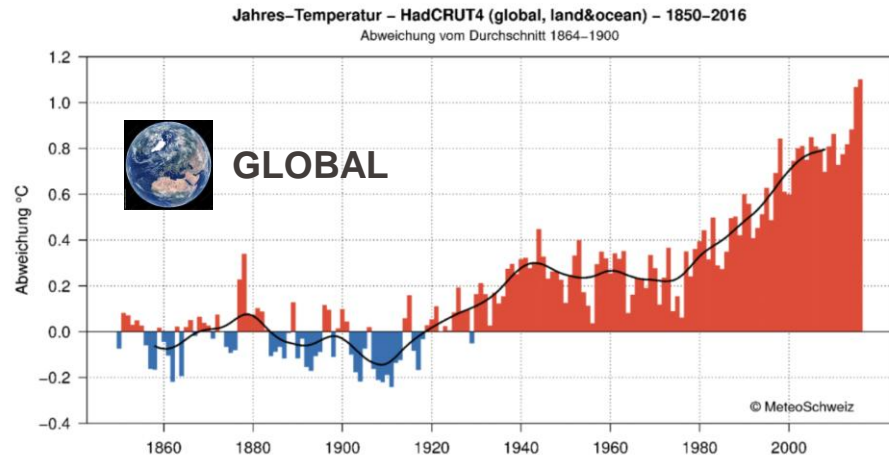
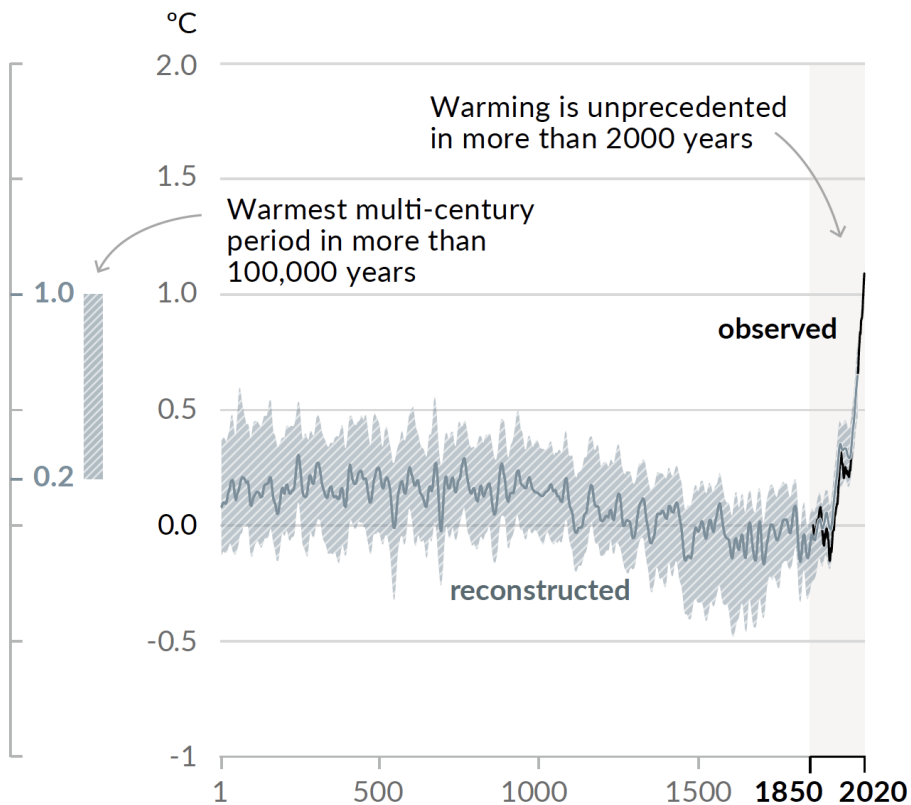
WMO confirms 2024 as  
warmest year on record at  
about 1.55°C above pre-  
industrial level

● PRESS RELEASE

10 January 2025

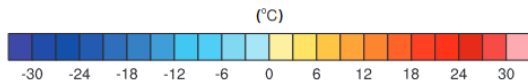
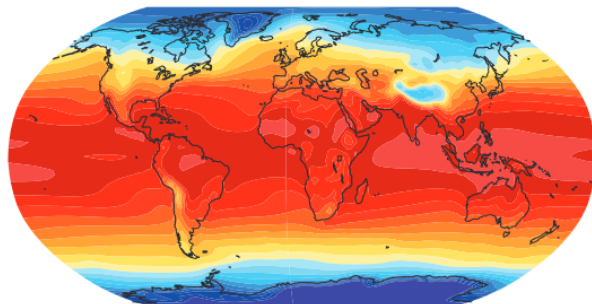
# Changes in global surface temperature relative to 1850-1900

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

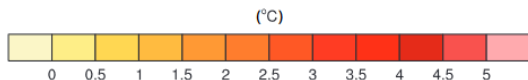
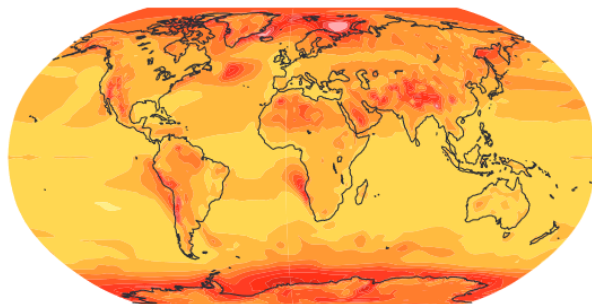


# Climate models

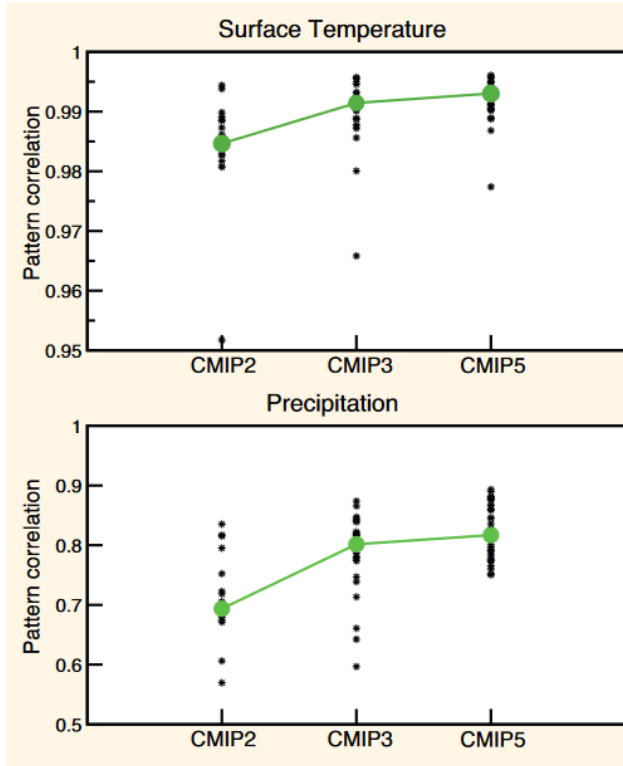
(a) Multi Model Mean Surface Temperature



(c) Multi Model Mean of Absolute Error



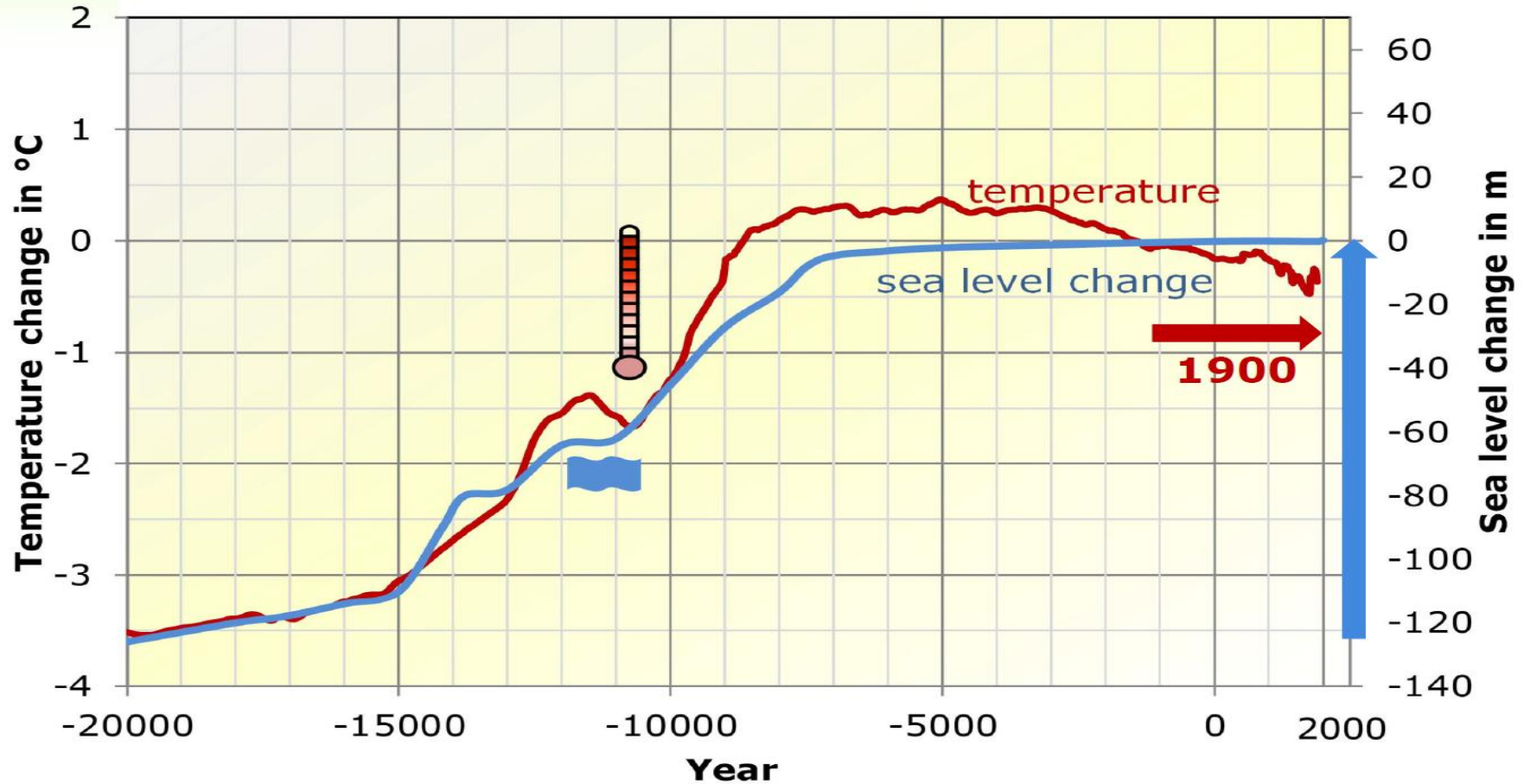
Are highly complex!  
Are constantly improving !



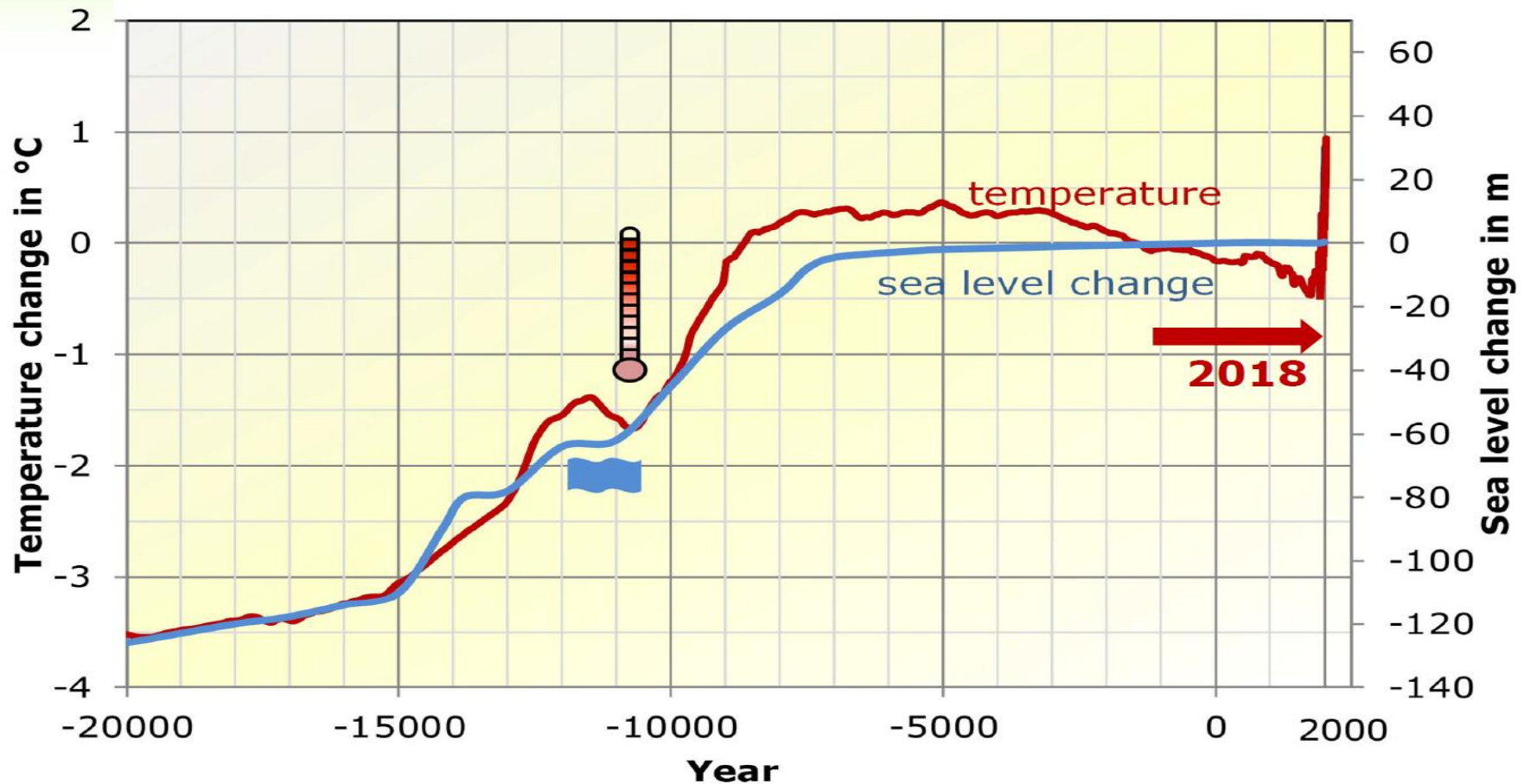
Model capability in simulating annual mean temperature and precipitation patterns as illustrated by results of three recent phases of the Coupled Model Intercomparison Project (**CMIP2**, models from about year 2000; **CMIP3**, models from about 2005; and **CMIP5**, the current generation of models)

[https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5\\_Chapter09\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf)

# Over 100 meters sea level rise since the ice age

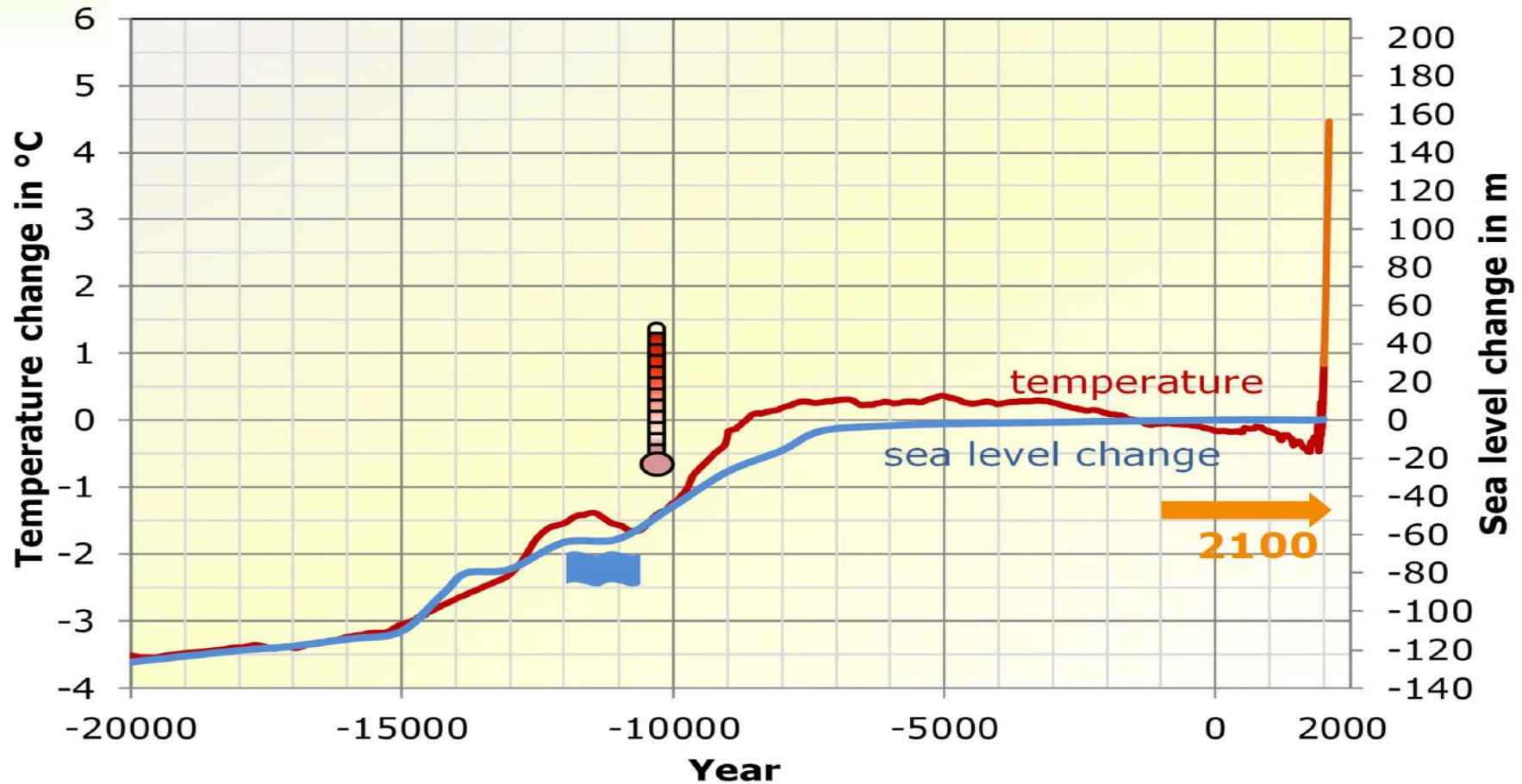


# 1°C further increase in temperature since 1900





# Up to 5°C further increase in temperature until 2100





# Global warming: human made

- All scientists agree that human activities and CO<sub>2</sub> (and eq CO<sub>2</sub>) emissions are responsible for the current temperature increased
- All the (complex) models made by climate scientists show the same effects and trends
- Hence there is a full consensus about global warming and its causes, to an unprecedented level
- There is no other model who could help explain the observed CO<sub>2</sub> and temperature increase, even less a model validated by a scientific community

The human cause of current global warming is part of the scientific knowledge



### III. Some words on climate science

# EPFL Why do you still have climato-sceptics and little actions



*R. Murdoch, one of the world most influential climato-sceptic*

- It is a mixture of
  - Not understanding how «science works»
  - Not perceiving the risks of climate change
  - Disinformation campaign to discredit climate science (e.g. Koch foundation in US, Rupert Murdoch media empire including Foxnews, Trump and Co\*, Hertiage foundation)
  - Lobbyism to support business as usual (from oil and oil related industry and countries \*\*) and profit opportunities
  - Some countries have a lot to loose (e.g. major oil/gas exporters) in the short term if strong actions are taken

• \*See an in-depth at NY times magazine <https://www.nytimes.com/interactive/2019/04/03/magazine/ruport-murdoch-fox-news-trump.html>

\*\*e.g <https://www.theguardian.com/business/2019/oct/24/fossil-fuel-big-five-spent-251m-lobbying-european-union-2010-climate-crisis>



RÉCHAUFFEMENT CLIMATIQUE ? ou DÉRÈGLEMENT CLIMATIQUE ?

Le 3 janvier 2024, la Suède a enregistré les températures les plus basses depuis 25 ans, avec -43 degrés ❄️ 🤖  
À cette heure, nous n'avons pas encore de commentaires du GIEC. Ils ne se sont toujours pas manifestés 🧑



French RN (n.b. maybe some understand the difference between climate and local weather)



## INTERVIEW

### «Für die Bauern ist die Klimaerwärmung nicht schlecht», sagt der künftige SVP-Präsident Marcel Dettling

Dem Landwirt ist es lieber, wenn es wärmer wird statt kälter. Und er will sich beim Stromgesetz mit seinem Bundesrat Albert Rösti anlegen.

René Donzé und Ladina Triaca  
(Interview)



Hören



Merken



Drucken



Teilen

17.02.2024, 18.56 Uhr ⌚ 9 min



Ich bin ein gläubiger Mensch, und ich glaube auch, dass wir nicht über alles bestimmen können.

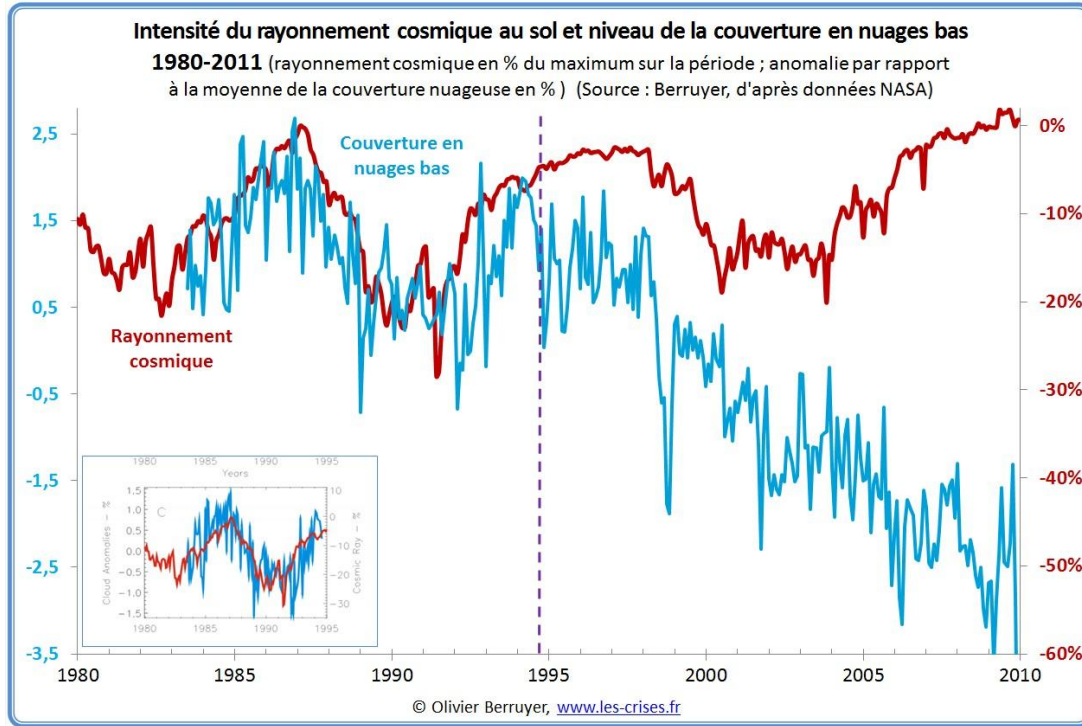
NEW HEAD of the largest Swiss Political party

## What science should be

- Hypothesis
- 1<sup>st</sup> publication
- Discussion/challenges by community
- Refutation or acception
- Integration into the scientific knowledge
- Public knowledge

Typical strategy of  
climate-sceptics (with  
or without awareness)

Keep only 1st  
publication as facts,  
even if they are  
demonstrated wrong  
later



Svensmark, H.

*Journal of Atmospheric and Solar-Terrestrial Physics*

59(1997) 1225-1232, Variation of cosmic ray flux and global cloud coverage - A missing link in solar-climate relationships

**Hypothesis and linked refuted since then by many studies.**

*Journal of Atmospheric and Solar-Terrestrial Physics*

Volume 62, Issue 1, January 2000, Pages 73-77

Torben Stockflet Jørgensena, Aksel Walløe Hansenb

Cited by more than 6000 climatosceptics websites !!!!  
 And no more valid at all !!!

The same for virtually all papers trying to challenge the human impact



# Climate pledge: try to keep 1.5°, if not 2°C global warming (average) before industrialisation

COP 21 in Paris  
COP 27 in Sharm El  
Sheikh, Egypt

UN Climate Change Conference (COP21) in Paris reached a breakthrough on 12 December 2015: the historic Paris Agreement.

The Agreement sets **long-term goals** to **guide** all nations:

- substantially reduce global greenhouse gas emissions to limit the global temperature increase in this century to **2 degrees Celsius** while pursuing efforts to limit the increase even further to 1.5 degrees;
- review countries' **commitments** every five years;
- provide **financing** to developing countries to mitigate climate change, strengthen resilience and enhance abilities to adapt to climate impacts.

The Agreement is a **legally binding international treaty**. It entered into force on 4 November **2016**. Today, 192 Parties (191 countries plus the European Union) have joined the Paris Agreement.

# Issue with Paris Agreement

- Not constraining
  - Did it mention fossile fuels ?
- Answer:

# Global greenhouse gas emissions and warming scenarios

- Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
- Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.

Annual global greenhouse gas emissions  
in gigatonnes of carbon dioxide-equivalents

150 Gt

In 2019 ~  
36.9 GT CO<sub>2</sub>  
14.1 GT CO<sub>2</sub>e  
51.0 GT

**No climate policies**  
4.1 – 4.8 °C

→ expected emissions in a baseline scenario if countries had not implemented climate reduction policies.

**Current policies**  
2.5 – 2.9 °C

→ emissions with current climate policies in place result in warming of 2.5 to 2.9°C by 2100.

**Pledges & targets (2.1 °C)**  
→ emissions if all countries delivered on reduction pledges result in warming of 2.1°C by 2100.

**2°C pathways**  
**1.5°C pathways**

100 Gt

50 Gt

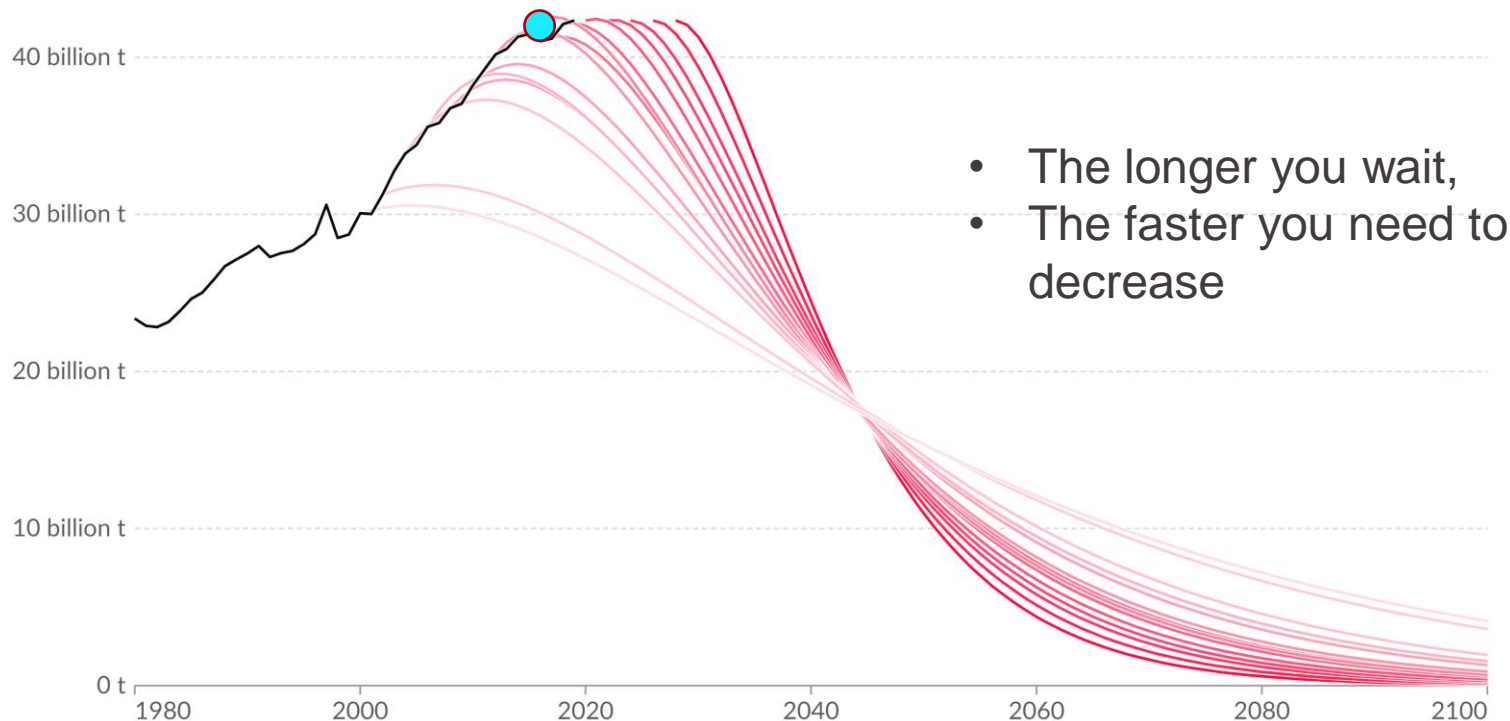
Greenhouse gas emissions  
up to the present

1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100

Complex modelling !

# CO<sub>2</sub> reductions needed to keep global temperature rise below 2°C

Annual emissions of carbon dioxide under various mitigation scenarios to keep global average temperature rise below 2°C. Scenarios are based on the CO<sub>2</sub> reductions necessary if mitigation had started – with global emissions peaking and quickly reducing – in the given year.

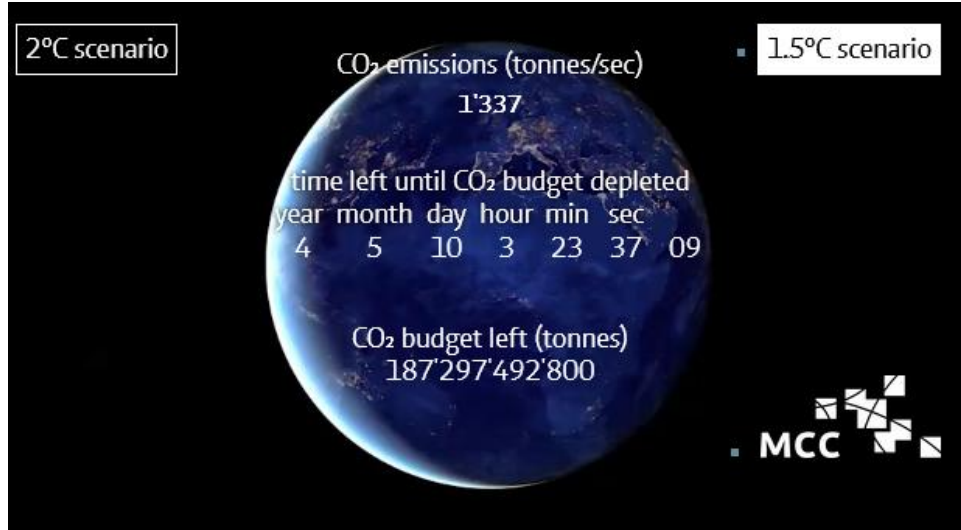


**Data source:** Robbie Andrews (2019); Global Carbon Project (2018); IPCC SR15 (2018)

**Note:** Carbon budgets are based on a >66% chance of staying below 2°C from the IPCC's SR15 Report.

[OurWorldInData.org/co2-and-greenhouse-gas-emissions](https://ourworldindata.org/co2-and-greenhouse-gas-emissions) | CC BY

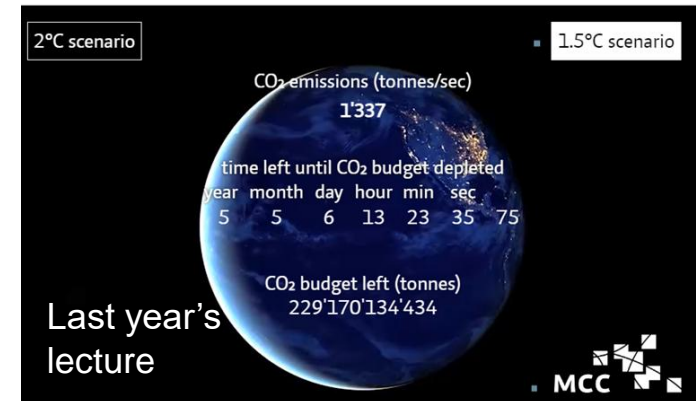
# Remaining carbon budget (at 42.2 Gt/year)



<https://www.mcc-berlin.net/en/research/co2-budget.html>

At current burning rate:  
5 years for 1.5°C scenario...  
22 years for 2°C scenario ~935 Gtonnes...

Is a **1.5° scenario** realistic ?  
(note there uncertainties in the simulation, but all points to negative feed-back loops)



# CO<sub>2</sub> and equivalent emissions: summary

<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>

- Global average temperatures have increased by more than 1.2-15°C since pre-industrial.
- CO<sub>2</sub> concentrations in the atmosphere are now well over 423 ppm – their highest levels in over 800,000 years.
- Globally we emit over 36 billion tonnes of CO<sub>2</sub> per year – this continues to increase, and another 12-17 billions tonnes CO<sub>2</sub>-eq, around 70-75% linked to energy
- Large differences – more than 100-fold – in per capita CO<sub>2</sub> emissions between countries.
- Today, China is the world's largest CO<sub>2</sub> emitter – accounting for more than one-quarter of emissions. This is followed by the USA (15%); EU-28 (10%); India (7%); and Russia (5%).
- The USA has contributed most to global CO<sub>2</sub> emissions to date, accounting for 24% of cumulative emissions. This is followed by the EU-28 (21%); China (15%); Russia (7%) and Japan (4%).
- Large amount of CO<sub>2</sub> embedded in traded goods → some countries' emissions increase while others decrease when we look at emissions based on consumption rather than production.
- There are large inequalities in CO<sub>2</sub> emissions: the world's poorest have contribute less than 1% of emissions, but will be the most vulnerable to climate change impacts.
- The world is not on-track to meet its agreed target of limiting warming to 2°C. Under current policies, expected warming will be in the range 2.7-3.3°C, **in the best case. Worst case 3-5°**



## IV. Impacts



2022/08/PR

28 February 2022

28th february press  
release and report  
of working group 2.**IPCC PRESS RELEASE****Climate change: a threat to human wellbeing and health of the planet.  
Taking action now can secure our future**

BERLIN, Feb 28 – Human-induced climate change is causing dangerous and widespread disruption in nature and affecting the lives of billions of people around the world, despite efforts to reduce the risks. People and ecosystems least able to cope are being hardest hit, said scientists in the latest Intergovernmental Panel on Climate Change (IPCC) report, released today.

“This report is a dire warning about the consequences of inaction,” said Hoesung Lee, Chair of the IPCC. “It shows that climate change is a grave and mounting threat to our wellbeing and a healthy planet. Our actions today will shape how people adapt and nature responds to increasing climate risks.”

[AR6 Synthesis Report:  
Climate Change 2023](#)

*3675 pages*

The Summary for Policymakers of the IPCC Working Group II report, Climate Change 2022: Impacts, Adaptation and Vulnerability was **approved** on **Sunday, February 27 2022**, by **195 member governments of the IPCC**, through a virtual approval session that was held over two weeks starting on February 14

- See level rise (melting ice on land, expanding water)
- Costal erosion (south of France, Spain, Florido all impacted)

Even more impactful with storms



Sur la côte atlantique, la destruction au début du mois de février de l'immeuble Signal, à Souillac-sur-Mer, est devenue le symbole de l'érosion côtière en France. [Stephane Mahe - REUTERS]

N.B: if Melting most snow of Antartica, Greenland, glaciers: 70 meters maximum water elevation

- Rise currently 3 mm per year
- Process-based models considered in the *IPCC special report on the ocean and cryosphere in a changing climate* project a rise in sea level over the 21st century in the range of **0.29-0.59 m** for a low-emissions scenario and **0.61-1.10 m** for a high-emissions scenario. News studies show for 2100 a global mean sea level rise in the range of **0.9-1.6 m\*** (low vs high emission scenarios)
- Global mean sea level in 2300 will likely be **2.5 m above current levels for a low-emissions scenario and 10 m** for a high-emissions scenario".
- These values will rise substantially if the largest estimates of sea level contributions from Antarctica over the coming centuries are included

[https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5\\_Chapter13\\_FINAL.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter13_FINAL.pdf)

[\\*A High-End Estimate of Sea Level Rise for Practitioners \(wiley.com\)](#)



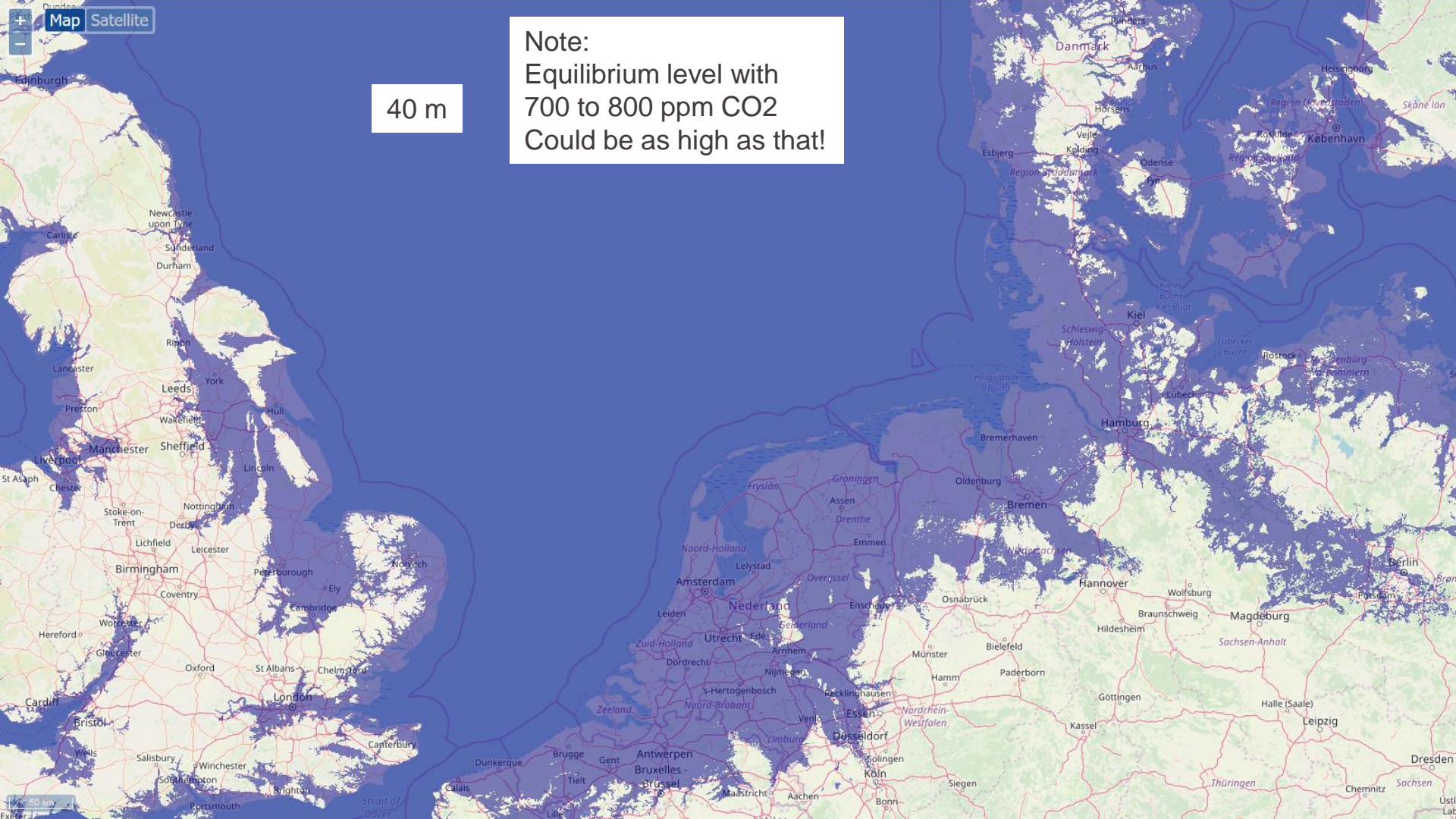












40 m

Note:  
Equilibrium level with  
700 to 800 ppm CO2  
Could be as high as that!

# EPFL Flooding, dykes and dams

- If rich enough build dykes/seawalls (but this will modify the environment)
- Leave or adapt !!!



Everglades under threat as Florida's mangroves face death by rising sea level

2 May 2018

434



Climate change was the engine that powered Hurricane Maria's ...

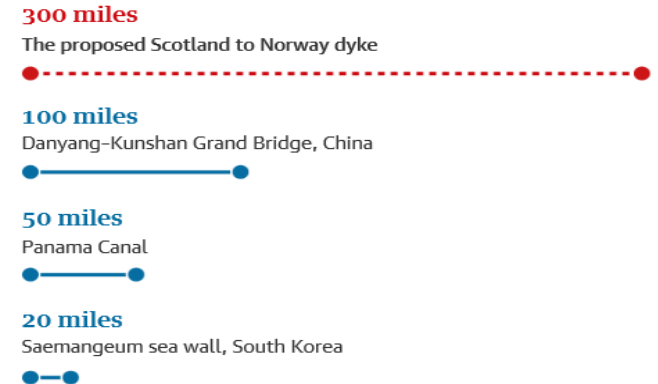


Several people have died and others are missing after record rains hit Australia's east coast, according to Reuters

Feb 28th. 2022



How the dyke compares to other projects



Guardian graphic. Source: Royal Netherlands Institute for Sea Research



# EPFL 2024 extreme events

2024's most costly climate disasters killed 2,000 people and caused \$229bn in damages, data shows

Analysis of insurance payouts by Christian Aid reveals three-quarters of financial destruction occurred in US



The aftermath of Hurricane Milton in Manasota Key, Florida, in the US in October 2024.  
Photograph: Rebecca Blackwell/AP

<https://www.theguardian.com/>

<https://www.cnn.com/>



## At least 87 dead and dozens missing in Vietnam after Typhoon Yagi

World Sep 15, 2024 1:00 PM EDT

<https://www.pbs.org/>

5:47 p.m. CET, January 16, 2025

## Properties in fire-stricken areas "damaged beyond belief," LA County official says

From CNN's Chris Boyette



An aerial view of beachfront homes that burned in the Palisades Fire in Malibu, California, on Wednesday. Mario Tama/Getty Images

## What to Know About Spain's Devastating Floods

At least 205 people were killed after the downpour, which some residents said was the worst they had ever witnessed.



Destroyed and submerged cars in Alcala, Spain, on Thursday, after flash floods swept through the region. Jon Jonen/Agence France Presse — Getty Images

<https://www.nytimes.com/2024>

# Major impacts of global warming

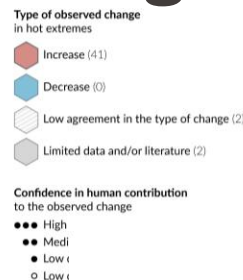
In addition to sea level rise

→ **More extreme climatic events,**

- storms, rains, floods
- Heat, fires, Droughts
- Loss of biodiversity

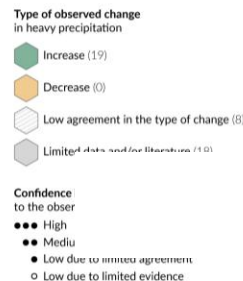
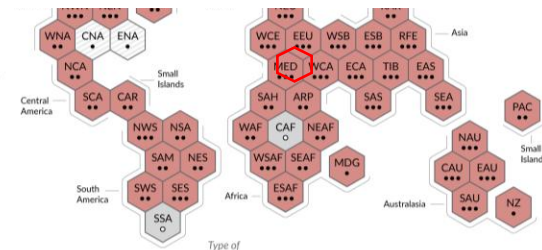
The frequency and strength of all events is increasing. This is validated by simulations.

As at the end of glacial age, **several feed-back loops start:** reduced reflection from snow and glaciers, liberation of methane from permafrost, change in marine current (e.g. AMOC, Gulf Stream)

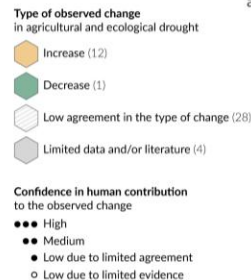
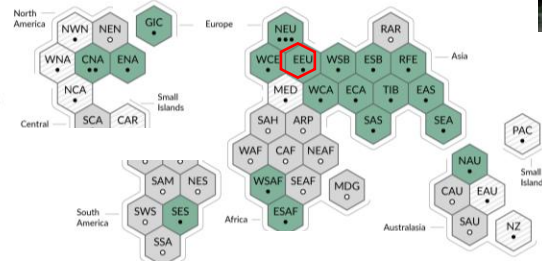


a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions

## Extreme heats

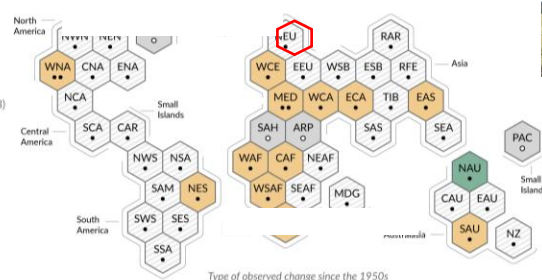


## Extreme rains

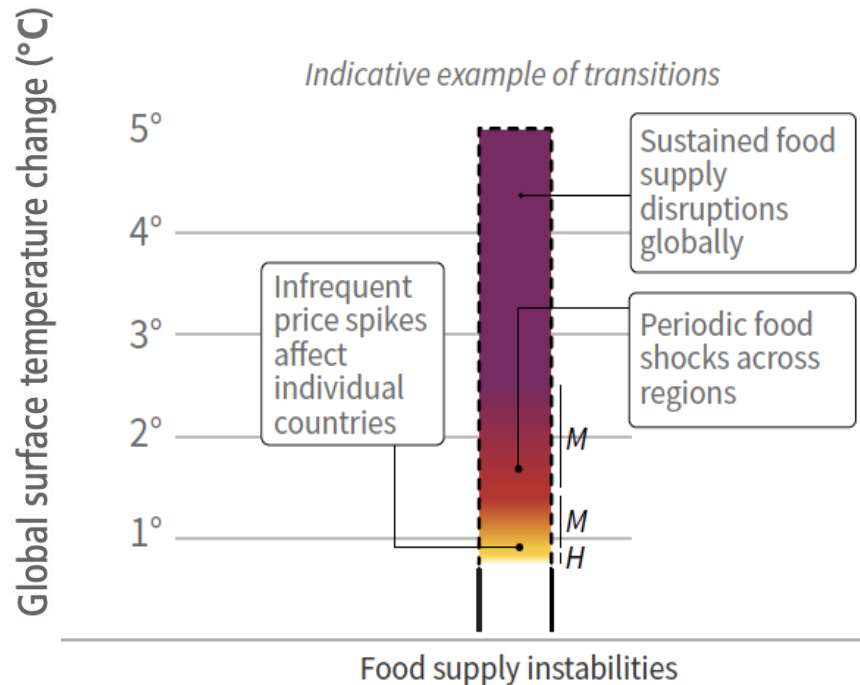


## Drought

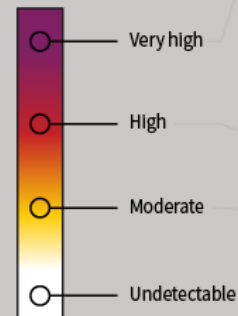
and confi he observed changes in the world's regions



# A major risk: food supply instabilities



(Rapport du GIEC sur les terres émergées: <https://www.ipcc.ch/srcc1>)



**Purple** indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

**Red** indicates severe and widespread impacts/risks. **Yellow** indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

**White** indicates that no impacts are detectable and attributable to climate change.

**Food risks will become one of the major issues in the 21st century.**  
**Every tons of CO2 not emitted counts !**

- Population migration (cf World bank report)
- Agriculture conditions changing, soil becomes unusable, **food security risks**

Many effects of global warming are accelerated/reinforced by local behaviour: endangering water supply, underground water, deforestation, attack on biodiversity through pesticides, mono-culture, overfishing, ....



Forecast from international thinktank the IEP predicting that 1.2 billion people could be displaced globally by 2050 due to climate change and natural disasters.



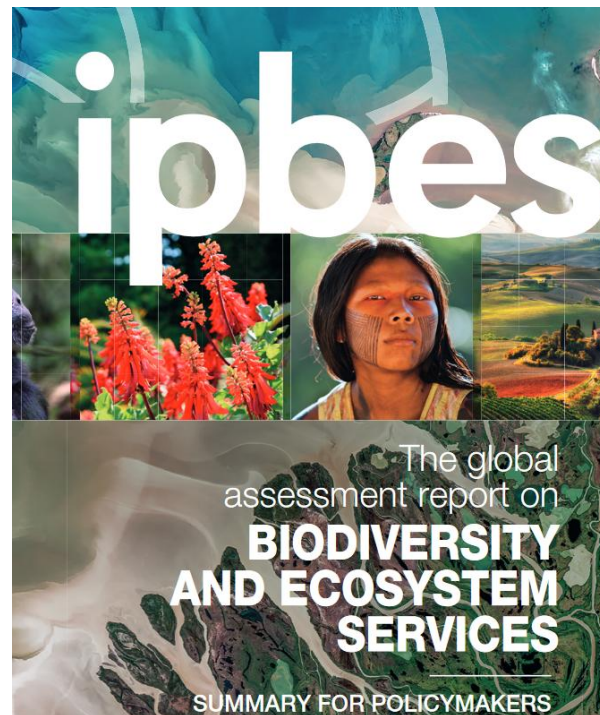
Grieceland 2021



Intergovernmental Science-Policy Platform on  
Biodiversity and Ecosystem Services (IPBES)

## *Main conclusions*

- A.** Nature and its vital contributions to people, which together embody biodiversity and ecosystem functions and services, are deteriorating worldwide.
- B.** Direct and indirect drivers of change have accelerated during the past 50 years
- C.** Goals for conserving and sustainably using nature and achieving sustainability cannot be met by current trajectories, and goals for 2030 and beyond may only be achieved through transformative changes<sup>4</sup> across economic, social, political and technological factors.
- D.** Nature can be conserved, restored and used sustainably while other global societal goals are simultaneously met through urgent and concerted efforts fostering transformative change

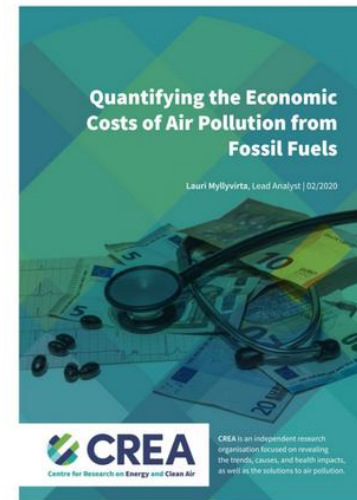


# Other effects of heavy fossil fuel burnings

- Pollution from fossil fuels cost trillions to the world economy, annually

“Quantifying the Economic Costs of Air Pollution from Fossil Fuels” is the first study to assess the global economic burden caused by air pollution from fossil fuels, estimating the costs at US\$2.9 trillion in 2018, or 3.3% of global GDP, far exceeding the likely costs of rapid reductions in fossil fuel use. 5 billions per day

- Fossil fuels are further subsidised (mostly reduction of local sale price): up to 5 trillions in subsidies to fossil fuels annually  
<https://www.imf.org/en/Publications/WP/Issues/2019/05/02/Global-Fossil-Fuel-Subsidies-Remain-Large-An-Update-Based-on-Country-Level-Estimates-46509>



- <https://energyandcleanair.org/about-us>

# EPFL Conclusion

## Scientifically

- Yes our world is burning
- Men are responsible for that
- Climato-sceptics are wrong, and likely criminals
- Action is highly needed and is already taking place punctually





# Climate crisis: the obvious answers to mitigate

## Reduce CO2 and Eq direct emission

- Produce useful energy with CO2 neutral sources
- Reduce sources of other CO2 equivalent sources (Methane and agriculture)
- Produce steel- cement and other material CO2 neutral

## Energy efficiency and substitution of CO2 and eq intensive solutions

- Look for improved efficiency everywhere (same service but less energy usage)
- Buy/build less what is CO2 intensive (e.g. a concrete vs a wood house)
- Consume less what is CO2 intensive (train rather than plane, small car)
- Eat less (red) meat and CO2 eq intensive products

## Recapture CO2

- Start to think of capturing some or a lot of CO2, needed for the long term

## Rethink our ways of living

- Promote SUFFICENCY (sobriété) :travel less, consume less, rethink our full way of consuming

***Introducing  
sufficiency***

Why energy  
sufficiency?

Understanding  
sufficiency

Project & contact



## Progress within boundaries

Energy sufficiency goes beyond energy efficiency: it's about having enough but not using too much. It's about doing things differently; about living well, within the limits.

# The big challenges of consumption

- **Many developing countries have a growing economy** and they don't want to stop their growth (for the reasons above, and cause they want to access some wealth).
- **No countries wants to limit energy access or impone sufficiency**  
n.b. 800 billions subsidies for fossile fuel after Ukraine invasion. Switzerland paid 400 millions for 250 MW generators rented for 4 years to avoid possible cuts. Manifestations and protests as soon as energy taxed.
- Individuals can make a difference by changing habits (less plane/car, smaller appartement/houses, less (red meat), less services...  
**In practice few really do, even in the most aware countries.** It is hard to impone smaller appartments. Some people care, but most don't want change much.



It is not likely that mankind will reduce it's energy consumption in the coming two decades (in the BP accounting technique). Assuming a reduced growth (1.5% vs 2%) is conservative.

- Demands defined the requested amount of energy
- **CO2 free energy source do not come in addition to fossile, and create more demand.**

But when ....

- When there is more demand, if it is not covered by CO2 free sources, it is covered with fossile



Documentaires et reportages

Info

"La transition énergétique est plus un slogan qu'une notion scientifique", interview de Jean-Baptiste Fressoz

II Mettre en pause

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Historian: Fressoz says: we add energy sources on top of each other. We never renounce to what was before.

Wrong !!!!! Beware of intellectual and historians speaking about energy

# A summary

- As seen hard/impossible to limit energy
- People risks to dig for energy and the last drop of fossil if enough
- Many populistics movements, industries and groups will propagate wrong theories, and will continue to push for fossils (for commercial or ideological reasons).
- Many well intended environmentalists or nature preservation people tend see more the impact (mining, landscape, CO2, rare materials) than the profit of clean energy sources, and **indirectly support the continuation of fossile fuel**

**The safest option (and mandatory) is to**

Make low CO2 energy sources and systems so cheap and so convenient, that even the most reluctant governments/people will have no other option than to switch to clean options, to enforce energy efficiency (e.g. insulation) everywhere where possible

- The fresks are fun, collaborative and creative workshops meant to raise awareness about environmental issues, and based on collective intelligence.
- The Climate Fresk uses data from the International Panel on Climate Change (**IPCC**) report.

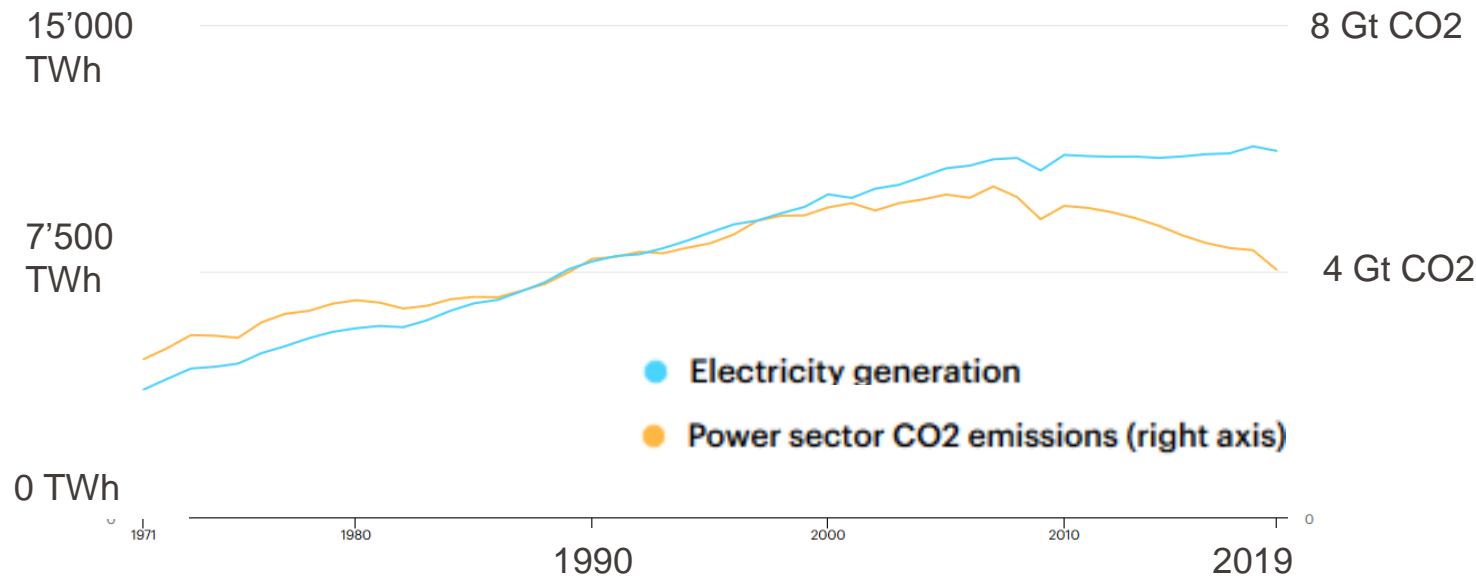


<https://www.epfl.ch/about/sustainability/community-and-awareness-building/fresks/>

# And you are here !



# Emission of power sector (electricity) in advanced economies: a ray of hope



- A reason for hope: a decoupling of CO2 emission and electricity generation in advanced economies... it is accelerating since 2019