ETH zürich

ipcc INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

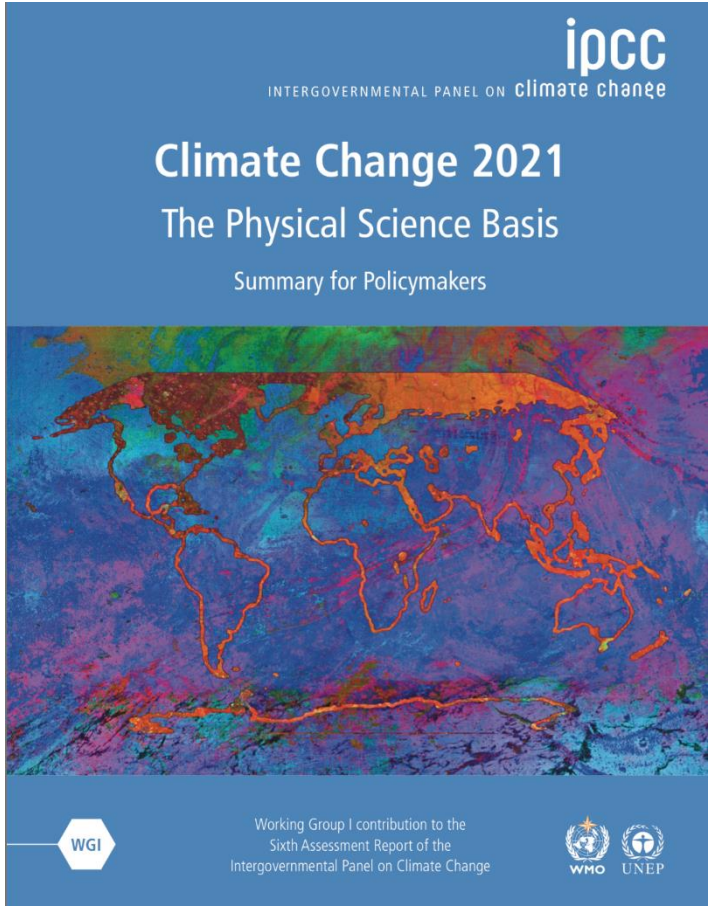
# 6th World Climate Report: Let's set out on our journey with practicable steps

Prof. Sonia I. Seneviratne, ETH Zurich
Coordinating lead author, IPCC AR6 "Physical climate basis" Chapter 11
sonia.seneviratne@ethz.ch
@SISeneviratne

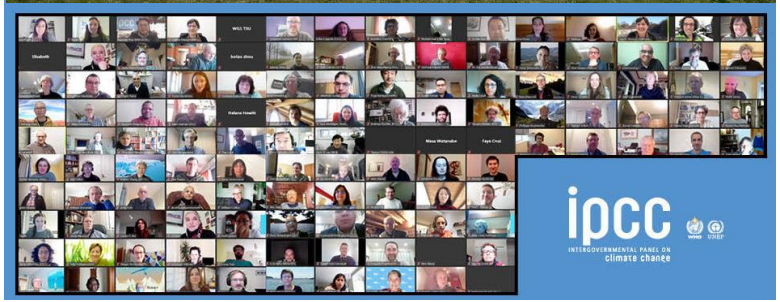
Grid Forum 2022, swissgrid, 30.08.2022

#ClimateReport #IPCC

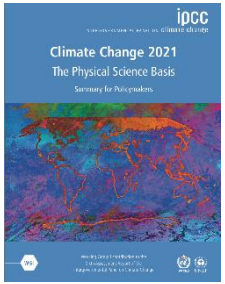
# IPCC AR6 Working Group I report
https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

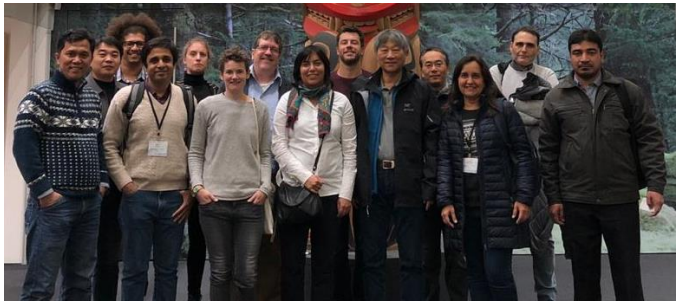




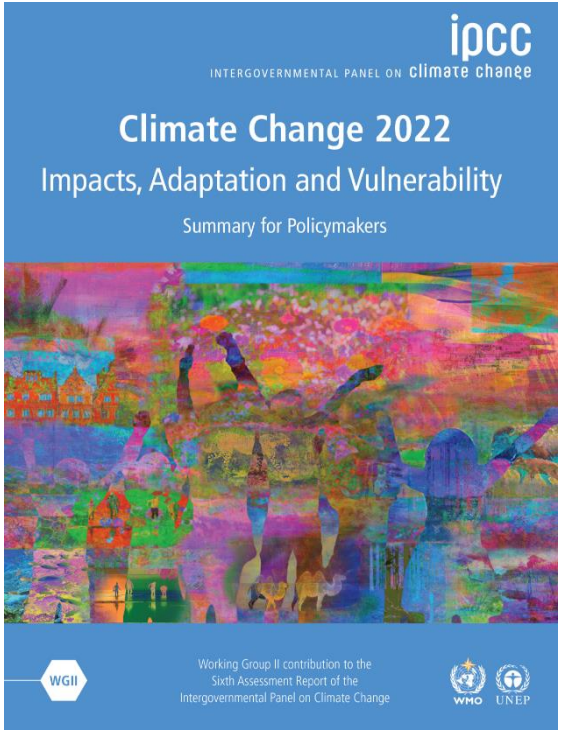

Released,
August 2021



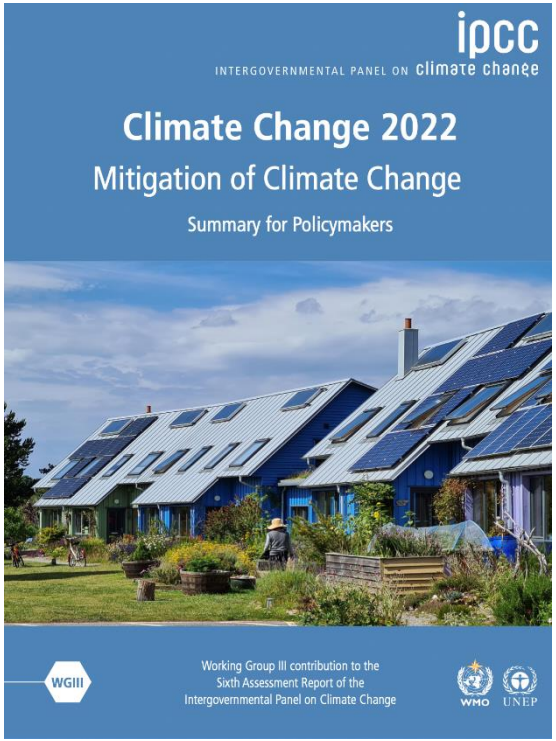



Chapter 11 team:
Sonia I. Seneviratne, Xuebin Zhang
Muhammad Adnan, Wafae Badi, Claudine Dereczynski, Alejandro Di Luca, Subimal Ghosh, Iskhaq Iskandar, James Kossin, Sophie Lewis, Friederike Otto, Izidine Pinto, Masaki Satoh, Sergio M. Vicente-Serrano, Michael Wehner, Botao Zhou

# IPCC AR6 Working Group II and III reports




Released, February 28, 2022




Released, April 4, 2022

**IPCC AR6 Working Group II report**
**https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/**

**IPCC AR6 Working Group III report**
**https://www.ipcc.ch/report/ar6/wg3/**

# Swiss parliament, May 2, 2022

https://naturwissenschaften.ch/uuid/i/49b95bc5-b302-5a70-852d-fa491abdf817-Trendwende_Klima_und_Biodiversität_Parlament_trifft_Wissenschaft

https://sciencesnaturelles.ch/uuid/i/49b95bc5-b302-5a70-852d-fa491abdf817-Inverser_la_tendance_dans_les_domaines_du_climat_et_de_la_biodiversité_le_Parlement_rencontre_les_milieux_scientifiques

# When do we see signs that the climate crisis is really serious?

We see these signs **now**

Canada, 2021

Germany, 2021

ENERGY

India's Heatwaves Are Testing the Limits of Human Survival

Analysis by Kush Poland and David Gelling | Bloomberg

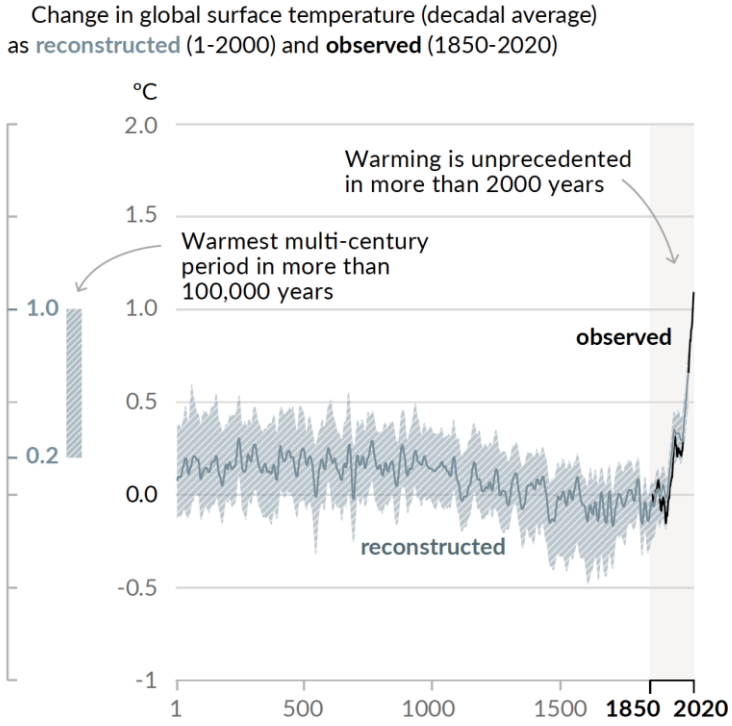
Today at 8:24 p.m. EDT

India, 2022

Europe, 2022

# Observed global warming

## Changes in global surface temperature relative to 1850-1900




*(IPCC AR6, Fig. SPM.1)*

- We already had 1.1°C (1.09°C) of global warming in 2011-2020 compared to 1850-1900
- This warming level is unprecedented in the history of human civilisation, in more than 100’000 years
- It is unequivocal that human influence has warmed the atmosphere, ocean and land
- We are responsible for all of the warming, not only part of it

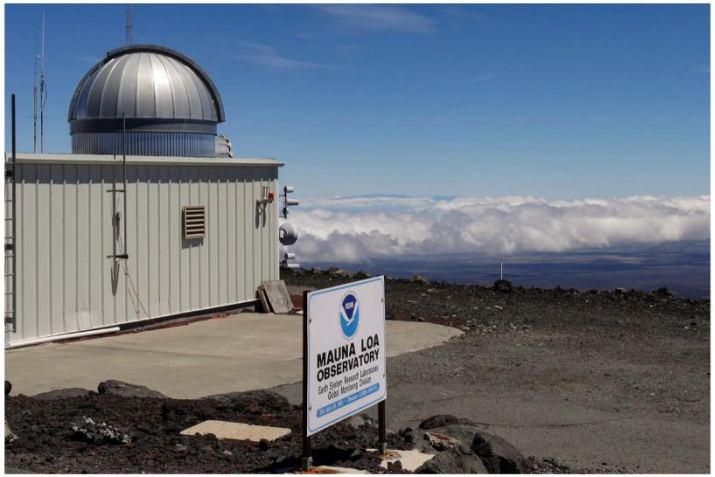
# $CO_2$ concentrations

May 2022: 420.99ppm

## *Carbon Dioxide Levels Are Highest in Human History*

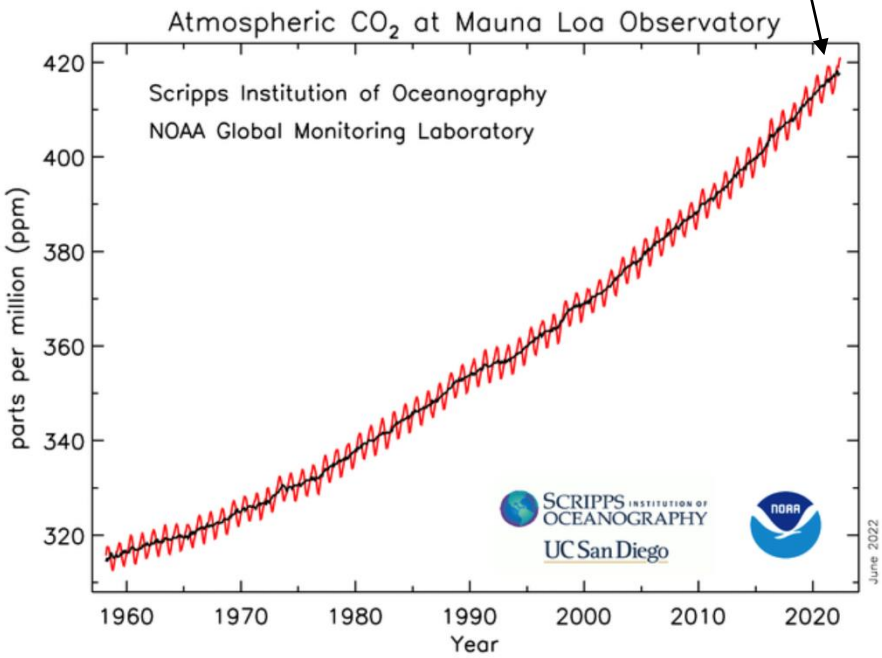
Humans pumped 36 billion tons of the planet-warming gas into the atmosphere in 2021, more than in any previous year. It comes from burning oil, gas and coal.

Give this article 230




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

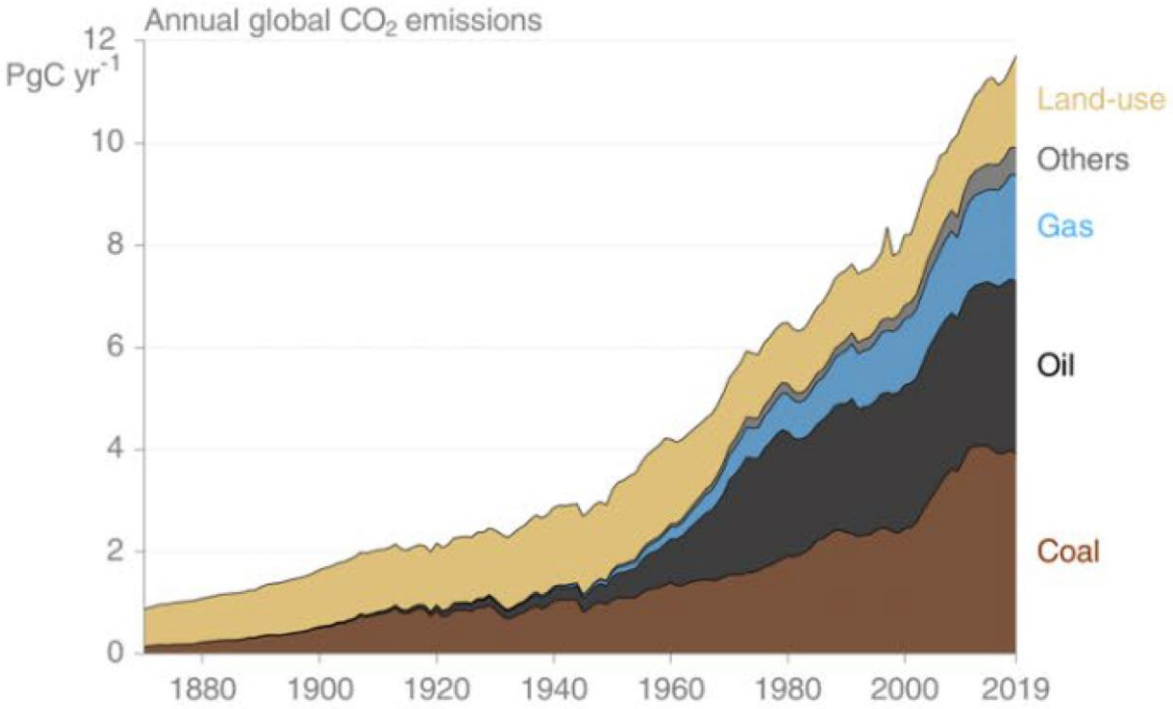
New York Times, June 3, 2022




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

# Atmospheric $CO_2$ concentrations and $CO_2$ emissions

The cause of human-induced global warming is clear

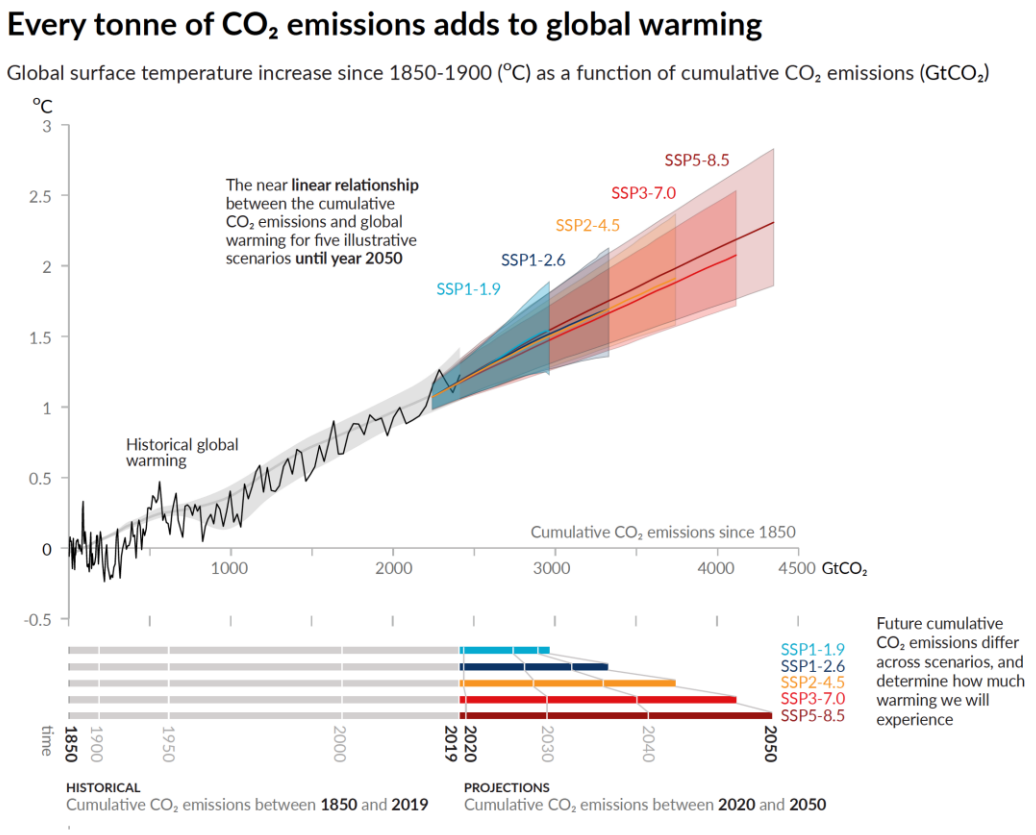



Sources of $CO_2$ emissions:

- Burning of fossil fuels
- Land use (deforestation)

*(IPCC AR6, Chapter 5: Figs. 5.6 and 5.5)*

# Cumulative $CO_2$ emissions vs global warming




Every additional emission of $CO_2$ leads to additional global warming

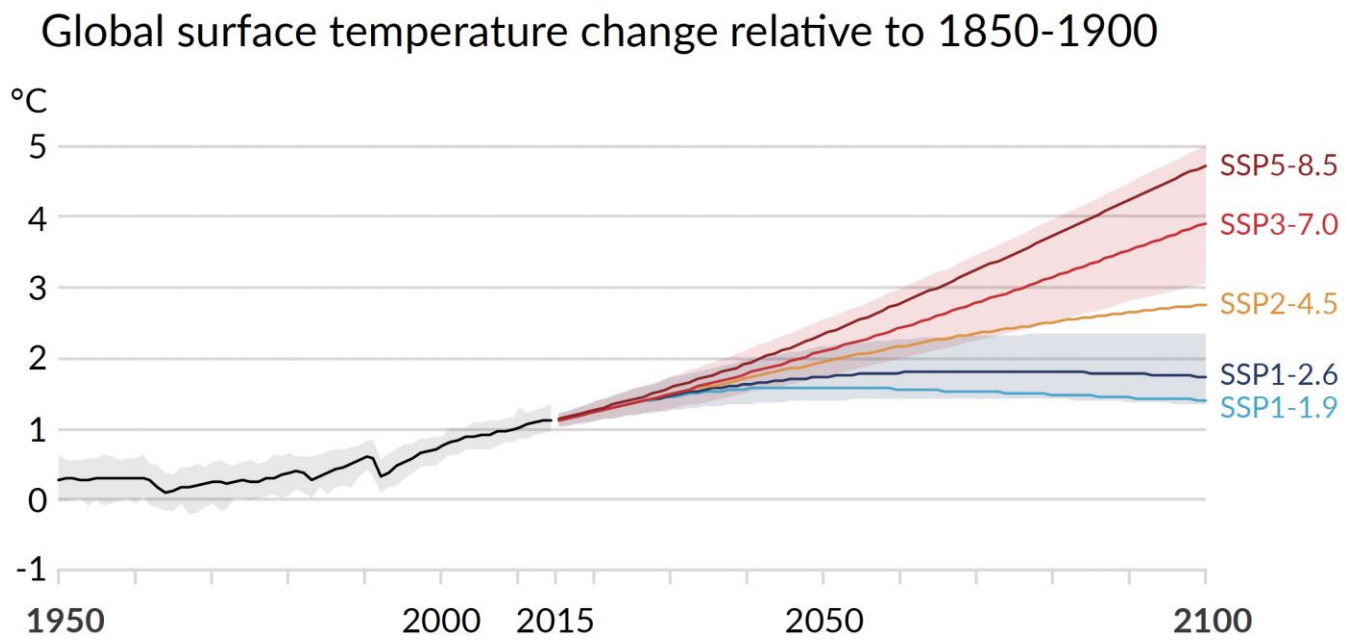
Every avoided emission leads to less global warming

*(IPCC AR6, Fig. SPM.10)*

Our $CO_2$ emissions have **consequences for hundreds to thousands of years**, as well as some **irreversible consequences**.

# Long-term commitments and irreversibility

After reaching net-zero $CO_2$ emissions, global warming will not decrease significantly!



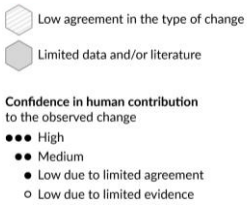

*(IPCC AR6)*

**No region is spared**: All regions show changes in some climate extremes, and Switzerland is also particularly affected

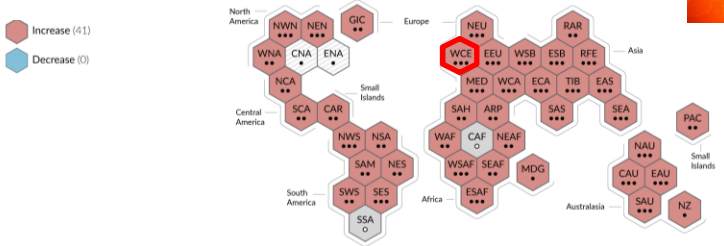
# Observed changes in extremes

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

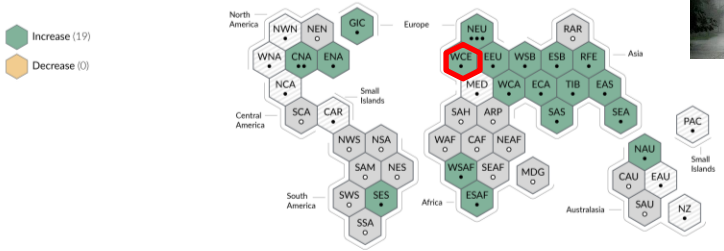
West-Central Europe, including Switzerland, is a hot spot of changes in climate extremes



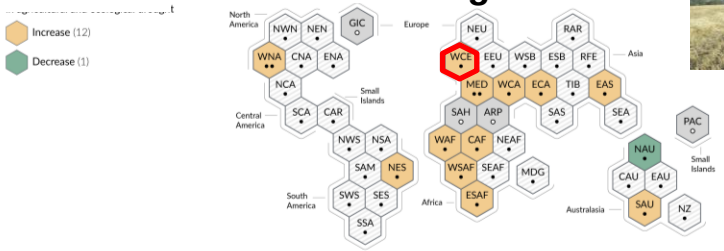

## Hot extremes




## Extreme rainfall

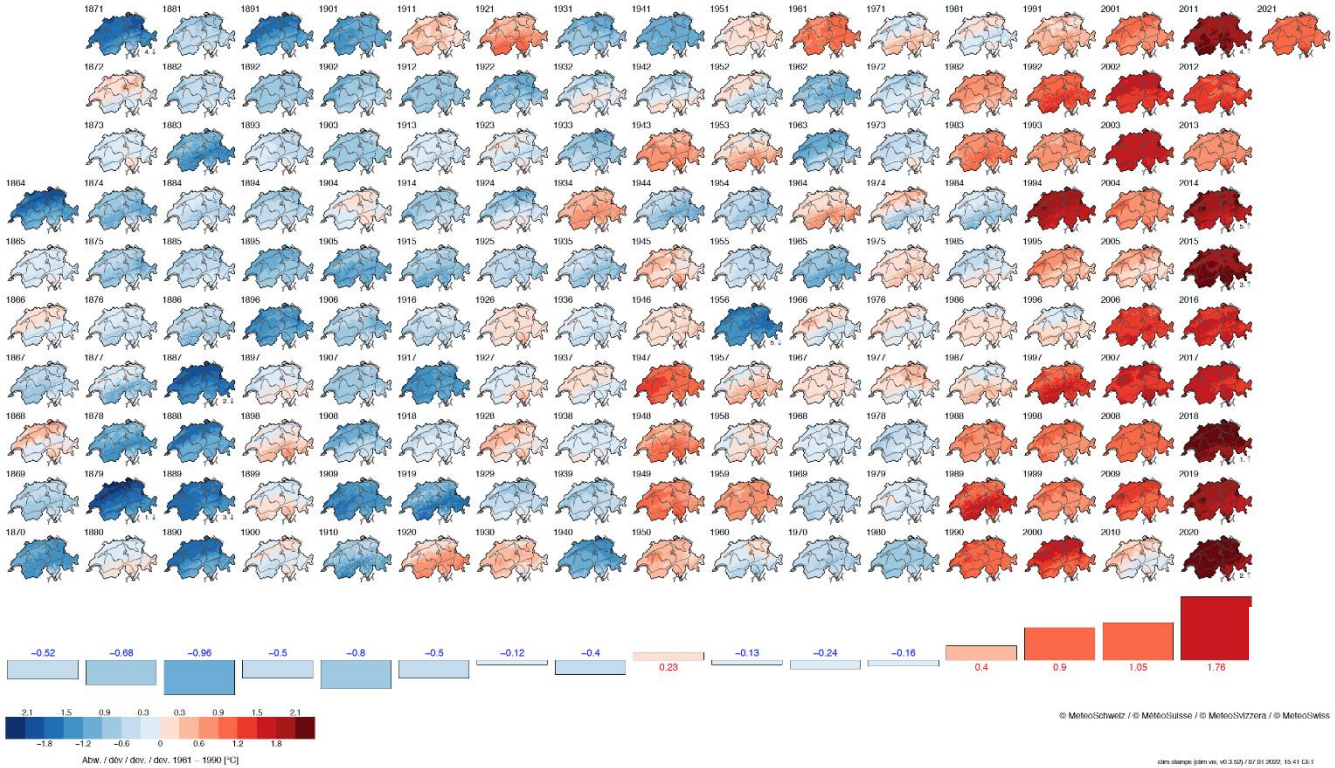



## Drought



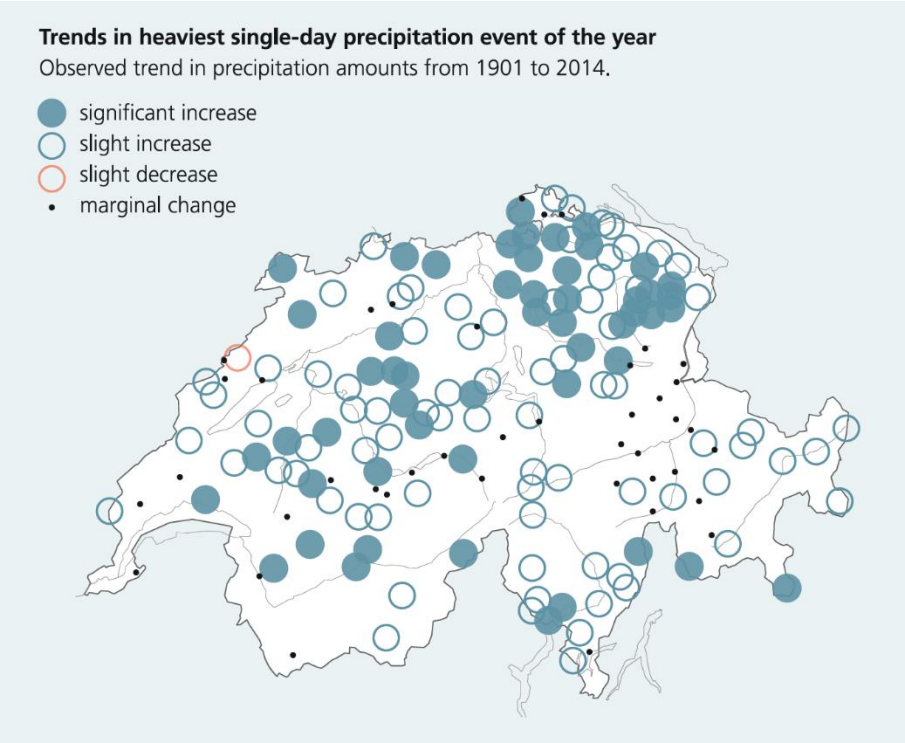
# Observed changes: Switzerland

**Warming in Switzerland is twice larger than the global average: >+2ºC since 1864;** meteoswiss.ch**)**



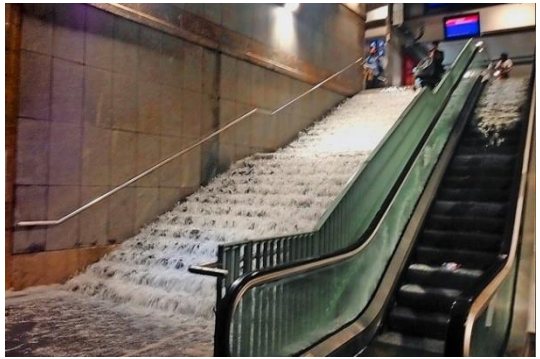

*(https://www.meteosuisse.admin.ch/home/climat/changement-climatique-suisse.html)*

# Heavy precipitation




*(CH2018 Scenarios 2018)*

https://www.nccs.admin.ch/nccs/en/home/climate-change-and-impacts/swiss-climate-change-scenarios/order-the-ch2018-brochure.html

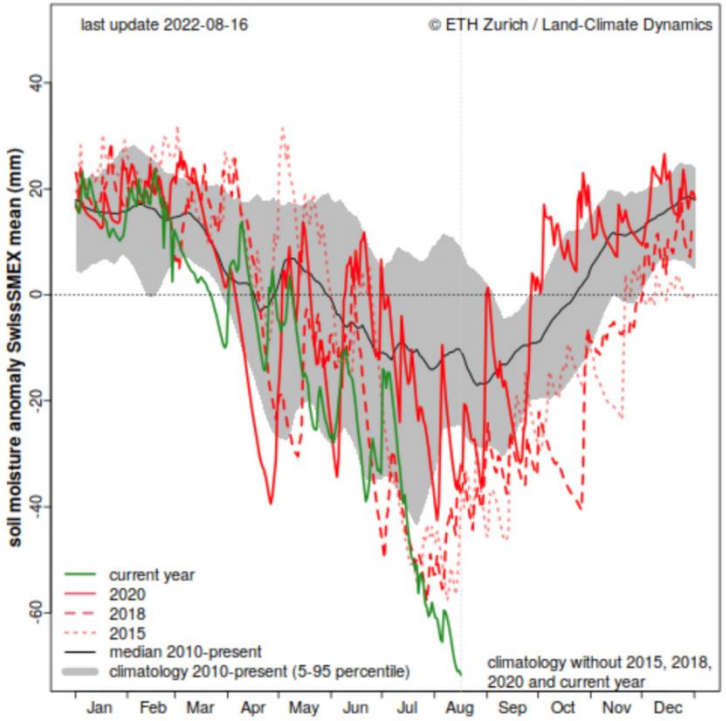


Lausanne, June 2018

Lucerne, July 2021

# Droughts: Current summer


Switzerland: Soil moisture measurements




"worst drought in 500 years" *(GLOFAS, Copernicus)*

Driest conditions since start of measurements (2010)

**Every additional increase in global warming**, even an increase of 0.1°C, **implies more frequent and more intense climate extreme** events

# Changes in extremes with increasing global warming



Changes in the **frequency and intensity of climate extremes become larger with increasing global warming:**

- hot extremes
- marine heatwaves
- heavy precipitation
- agricultural and ecological droughts in some regions
- proportion of intense tropical cyclones
- concurrent extremes at the same or different locations (compound events)

Temperature extremes

Heavy precipitation

Floods

Droughts

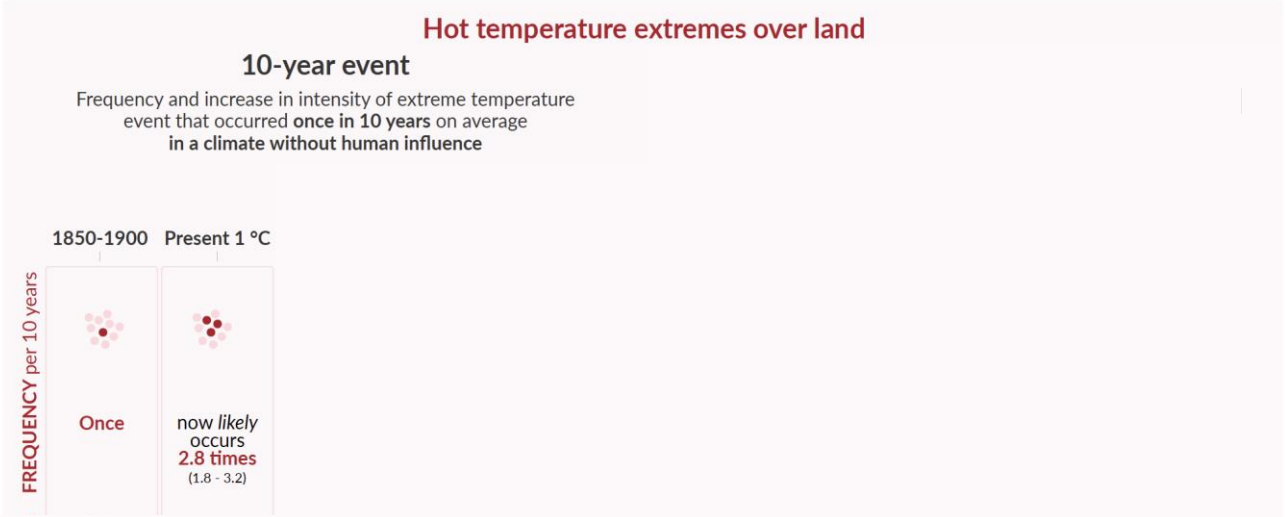
Storms

Compound events

# Changes in extremes as function of global warming



## Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

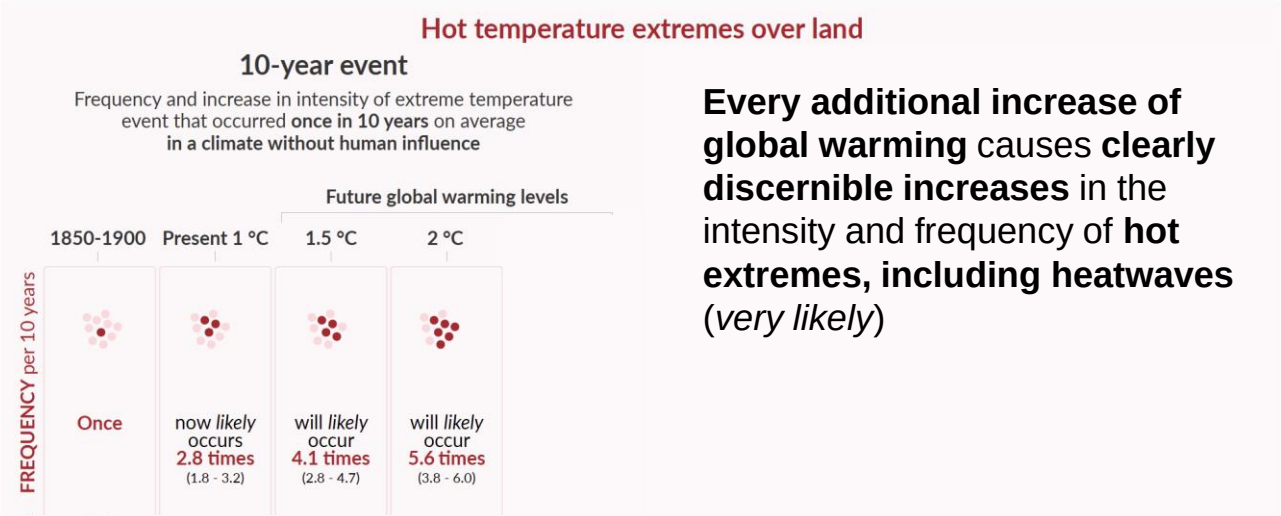



*(IPCC AR6, Fig. SPM.6)*

# Changes in extremes as function of global warming



## Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming



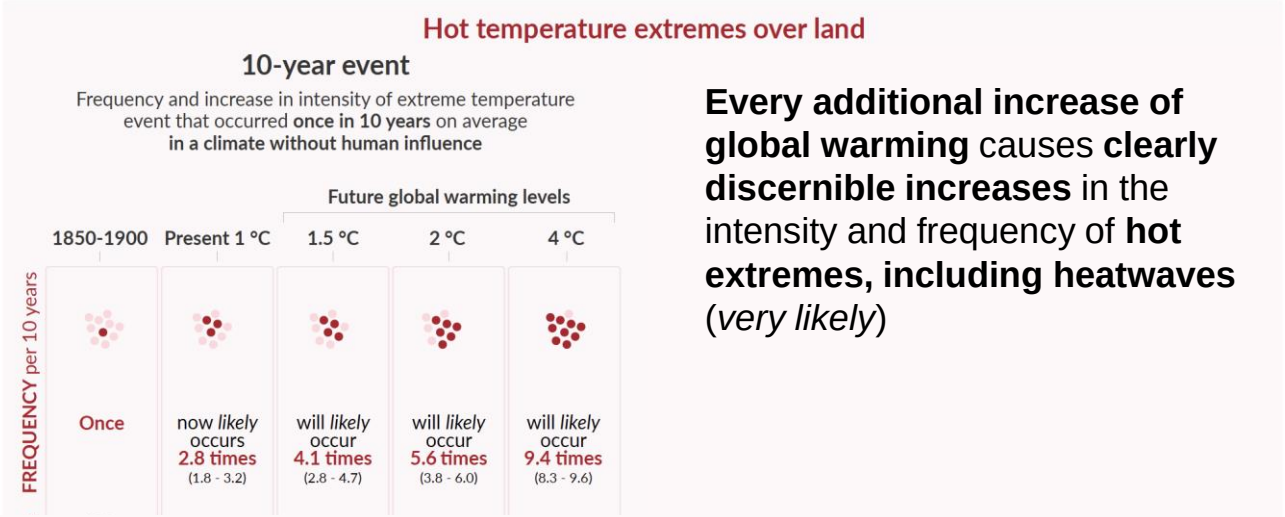

**Every additional increase of global warming** causes **clearly discernible increases** in the intensity and frequency of **hot extremes, including heatwaves** (*very likely*)

*(IPCC AR6, Fig. SPM.6)*

# Changes in extremes as function of global warming



## Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming




**Every additional increase of global warming** causes **clearly discernible increases** in the intensity and frequency of **hot extremes, including heatwaves** (*very likely*)

*(IPCC AR6, Fig. SPM.6)*

# Changes in extremes as function of global warming

## Compound events:

- **With further global warming, every region is projected to increasingly experience multiple changes in climatic impact-drivers, including extremes**

# Compound events:

- **With further global warming, every region is projected to increasingly experience multiple changes in climatic impact-drivers, including extremes**

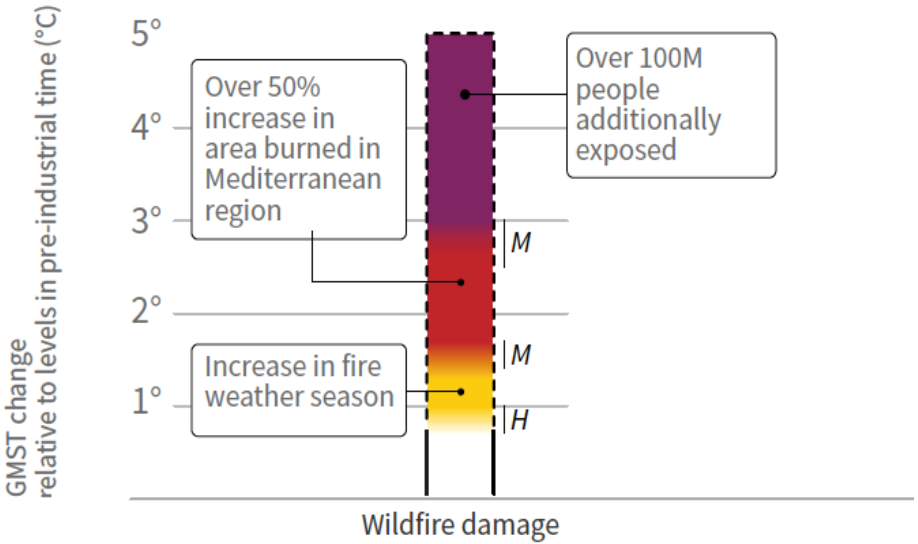
- Many regions are projected to experience an increase in the probability of **compound events** with higher global warming (*high confidence*):
  - **Concurrent heatwaves and droughts; fires**
  - **Compound flooding**

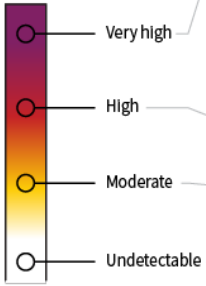
# Compound events:

- **With further global warming, every region is projected to increasingly experience multiple changes in climatic impact-drivers, including extremes**

- Many regions are projected to experience an increase in the probability of **compound events** with higher global warming (*high confidence*):
  - **Concurrent heatwaves and droughts; fires**
  - **Compound flooding**
  - **Concurrent extremes at multiple locations** become more frequent, including in **crop-producing areas**, at 2°C and above compared to 1.5°C global warming (*high confidence*)

# Evidence on risks at 2°C vs 1.5°C




**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.

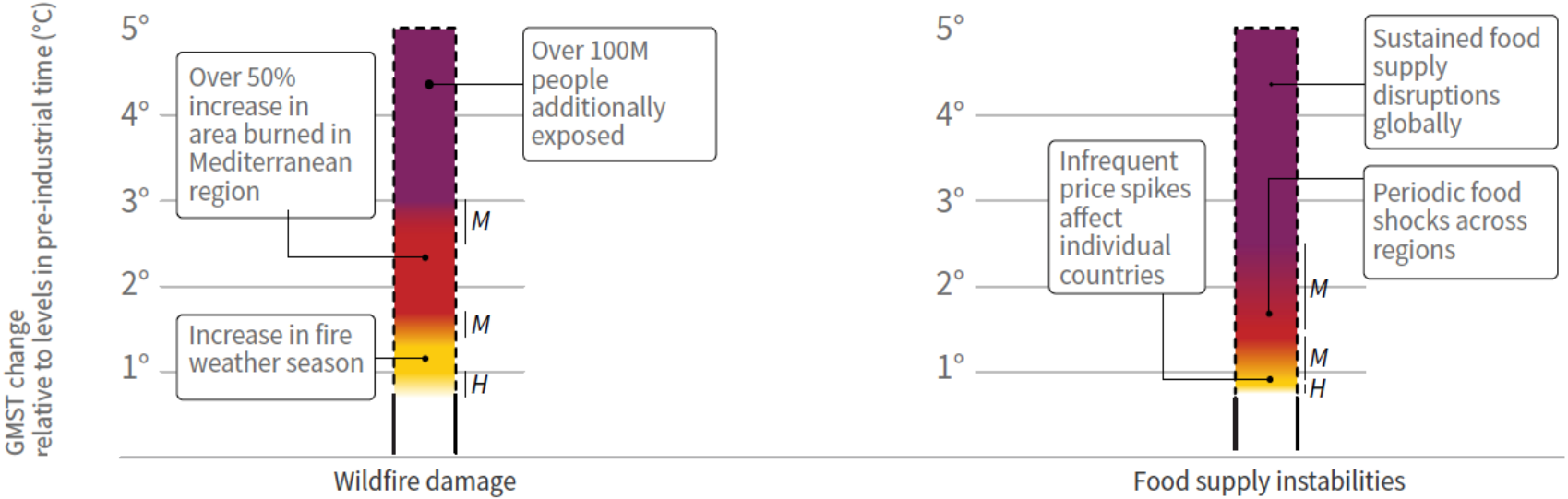
**Red** indicates severe and widespread impacts/risks.

**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.

*(IPCC Land report: https://www.ipcc.ch/srccl)*

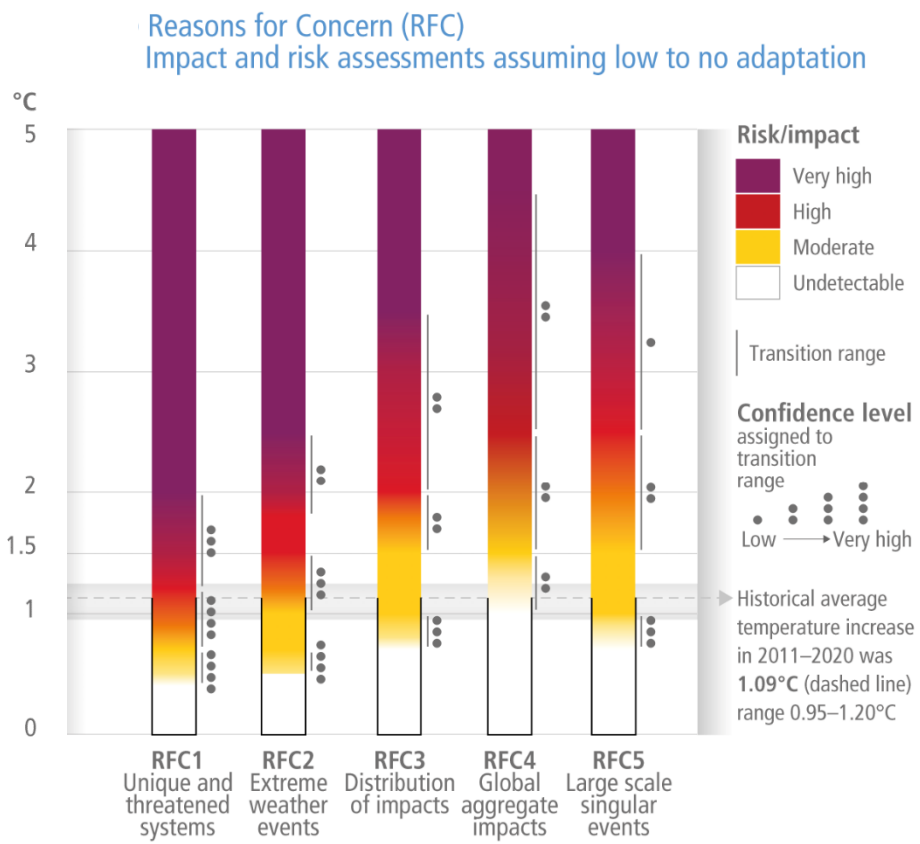
# Evidence on risks at 2°C vs 1.5°C



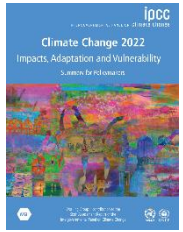

*(IPCC Land report: https://www.ipcc.ch/srccl)*

High risks for wildfire damages and food supply instabilities already above 1.5°C

# Evidence on risks at 2°C vs 1.5°C




*(IPCC AR6 WG2, 2022)*

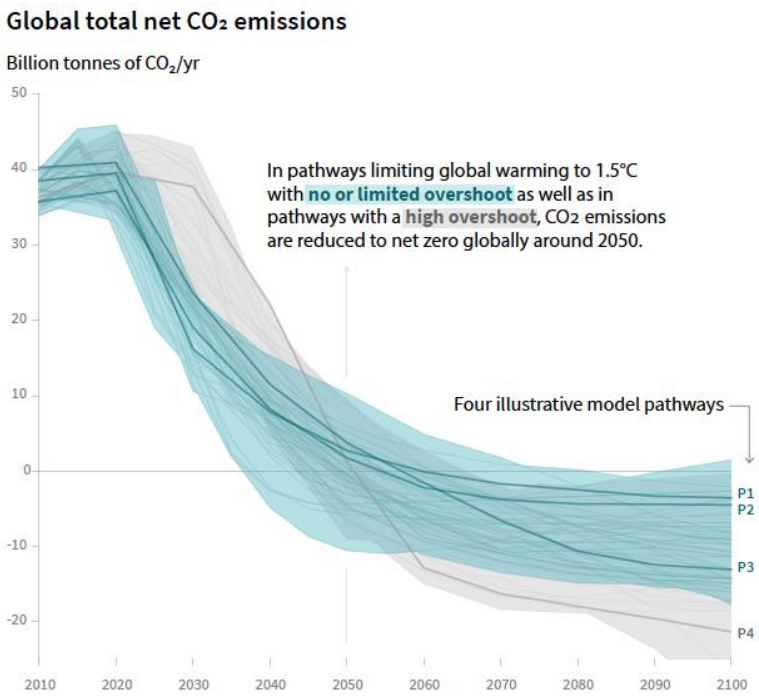



Above 1.1°C we are starting to get into high risks

"Near-term actions that limit global warming to close to 1.5°C would substantially reduce projected losses and damages related to climate change in human systems and ecosystems, compared to higher warming levels, but cannot eliminate them all (*very high confidence*)."

We have **only a few years** to act: We need to **halve $CO_2$ emissions until 2030** and reach net-zero $CO_2$ within less than 20-30 years to stabilise global warming at 1.5°C.

# Scenarios for stabilization at ~1.5°C

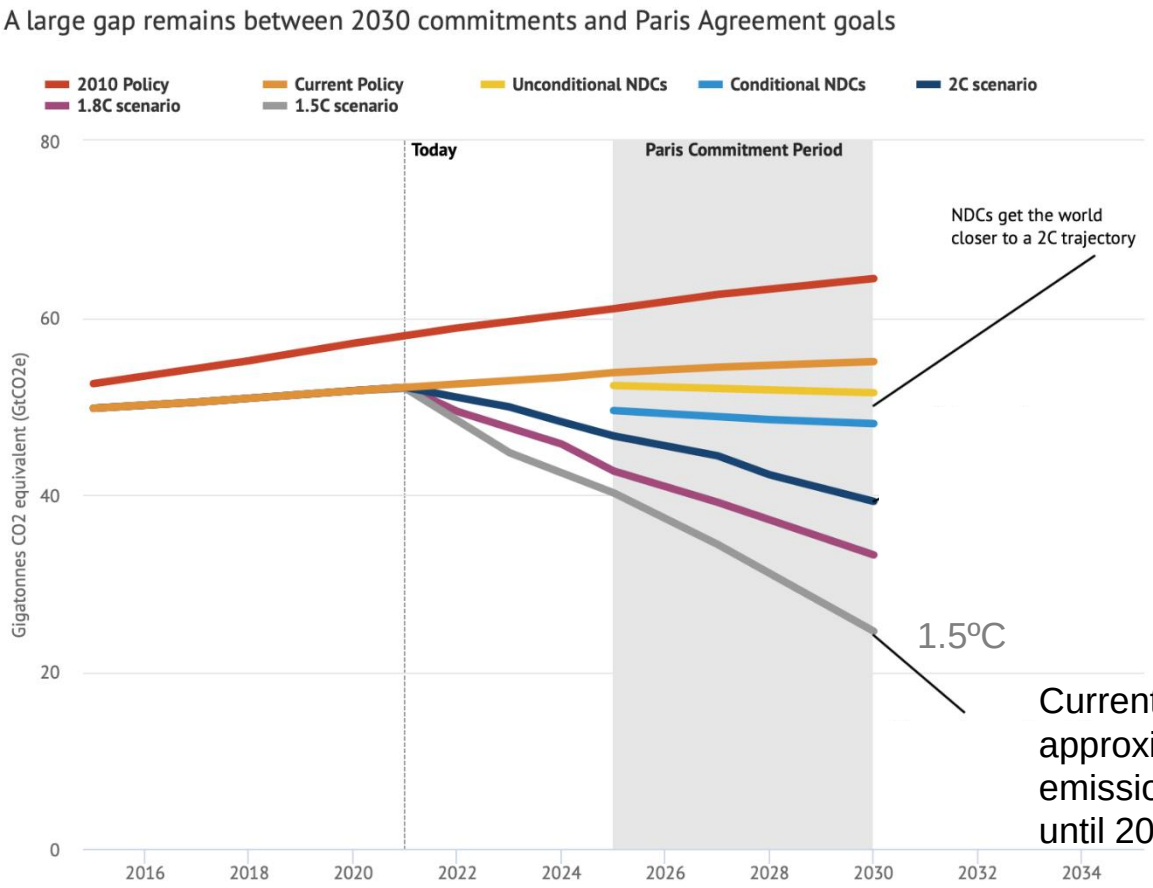



*(IPCC SR15)*

**Stabilization to ~1.5ºC requires changes which are unprecedented in terms of scale**:

- **Immediate reduction of $CO_2$ emissions on global scale** (until 2030: ~50% of 2010)
- **Net-zero $CO_2$ emissions at the latest in 2040** (66% probability) **– 2050** (50% probability)
- **"Negative emissions"** after reaching net-zero $CO_2$: **At most 10%** of present-day emissions

# Glasgow climate conference (COP26)




Based on 2030 targets: we are on a trajectory towards 2.4°C

We are not on track

Current targets would imply approximately a stabilisation of emissions, but we need to halve them until 2030 for a 1.5°C trajectory

Adapted from: https://www.carbonbrief.org/analysis-do-cop26-promises-keep-global-warming-below-2c

# How to reach net-zero $CO_2$?

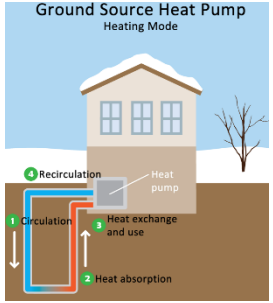
- **No more use of fossil fuels (coal, oil, gas)**
  - Renewable energy
  - Clean electricity
  - Electrification of energy use

**~90% reduction of current $CO_2$ emissions**

Solar panels

Wind energy

Electric mobility




Geothermal heating

# How to reach net-zero $CO_2$?

- **No more use of fossil fuels (coal, oil, gas)**
  - Renewable energy
  - Clean electricity
  - Electrification of energy use

**~90% reduction of current $CO_2$ emissions**

- **Carbon dioxide removal (waste combustion, cement), synthetic fuels (planes)**

**~10% compensation of $CO_2$ emissions;** very small scale at present (<<1%)

Several caveats (timing, scale, effectiveness, resilience)

Afforestation

Carbon capture and storage

Synthetic fuels

# How to reach net-zero $CO_2$?

- **No more use of fossil fuels (coal, oil, gas)**
  - Renewable energy
  - Clean electricity
  - Electrification of energy use

**~90% reduction of current $CO_2$ emissions**

- **Carbon dioxide removal (waste combustion, cement), synthetic fuels (planes)**

**~10% compensation of $CO_2$ emissions;** very small scale at present (<<1%)

Several caveats (timing, scale, effectiveness, resilience)

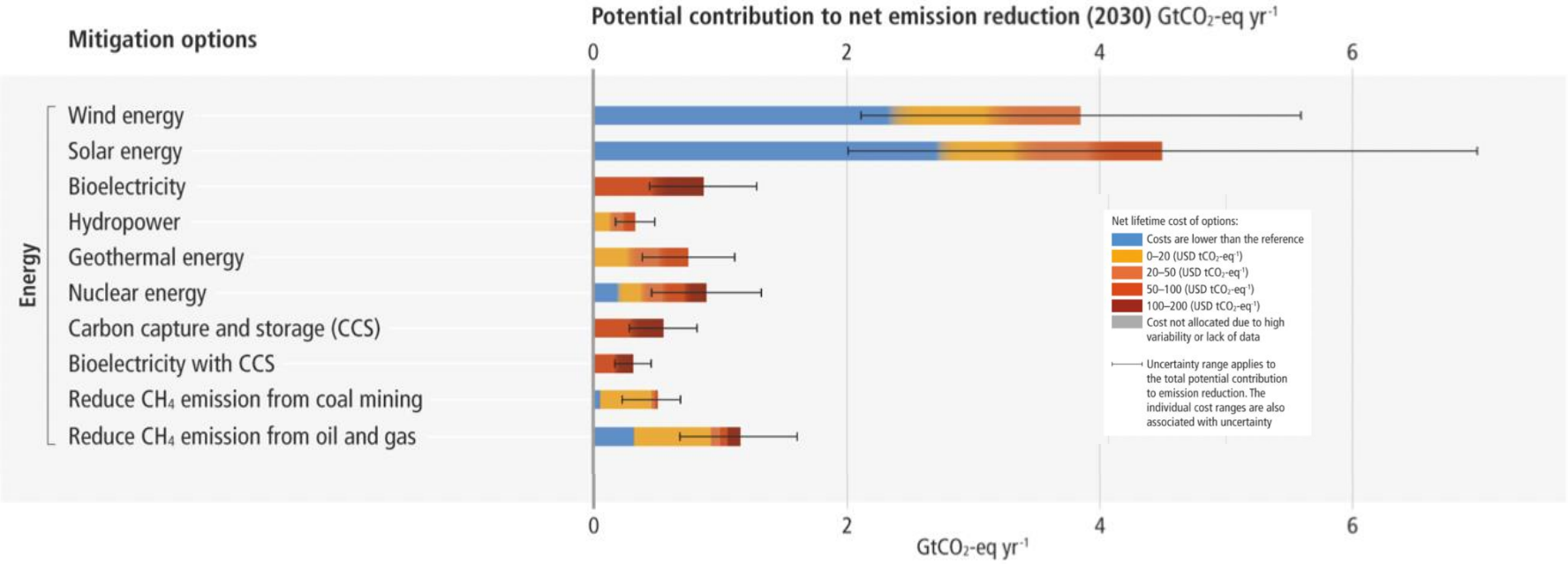
Afforestation

Carbon capture and storage

Synthetic fuels

# Good news: **Cheap renewables**, synergies of climate mitigation with **higher well-being**

# Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.




*(IPCC WG3, 2022)*

# A world without $CO_2$ emissions would be nice!

Numerous co-benefits:

1. Less climate impacts and costs for ecosystems and health
2. Several further co-benefits for health:
   - Less local air pollution (particles)
   - Less noise (no more petrol cars)
   - Healthy diets, more active mobility
3. More geopolitical security: Less dependency on autocratic fossil fuel-exporting regimes

*(Paris without cars)*

# Conclusions

- It is worth limiting global warming to 1.5°C: This aim is stated in the 2015 Paris agreement and confirmed in the 2021 Glasgow climate pact.
  **First essential step: Halve $CO_2$ emissions until 2030!**

- **Electricity networks play an essential role for decarbonization:**
  - Needed electrification of energy use to move away from fossil fuels
  - Needed $CO_2$-free electricity generation

- We need to urgently foster the energy transition, international cooperation is essential for stable electricity production

ipcc
INTERGOVERNMENTAL PANEL ON climate change

EVERY ACTION MATTERS
EVERY BIT OF WARMING MATTERS
EVERY YEAR MATTERS
EVERY CHOICE MATTERS

# Thank you!