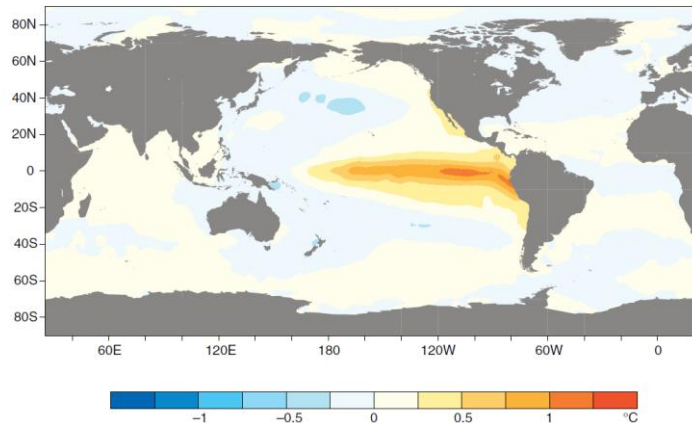
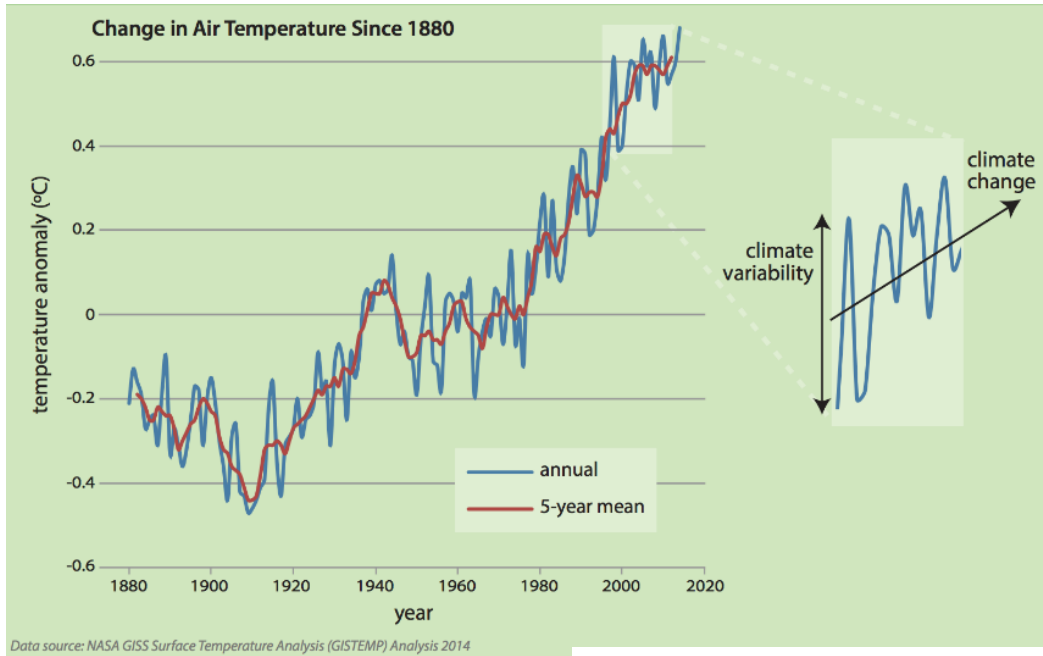
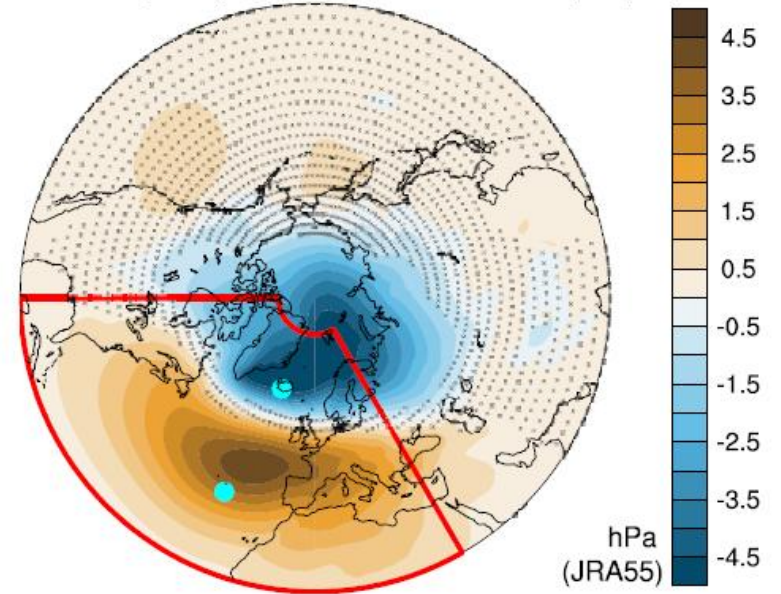


Climate variability



Modes of climate variability

a. MSLP spatial pattern for NAO in Dec-Feb (DJF)



NAO has a large influence on Europe's and North America's winters

ENSO is the largest source of variability to global interannual change of surface temperature

	No.	Date	Topics	Deadlines / tentative
Basics	1.	11.09.2025	Introduction to the climate system	Questionnaire (not graded)
	2.	18.09.2025	Climate System, Radiation	
	3.	25.09.2025	Radiation, Earth's Energy balance, Greenhouse effect	launch of first assignment
	4.	02.10.2025	Aerosols & clouds, Radiative Forcing	Launch of poster project
	5.	09.10.2025	Feedback mechanisms, Climate Sensitivity	
	6.	16.10.2025	Paleoclimate	submission of Poster proposal (graded)
Present and future Climate change	7.	30.10.2025	Climate variability, Introduction to IPCC	
	8.	06.11.2025	Current state of climate, IPCC – report, Paris Agreement, Climate scenarios (RCPs, SSPs)	
	9.	13.11.2025	Emissions Gap, 1.5 vs 2.0°C vs warmer, Tipping elements, Extreme Events	submission of Poster draft (graded)
	10.	20.11.2025	Extreme Events, Carbon budget	
	11.	27.11.2025	Carbon budget, Metrics	submission of assignment (graded)
Actions	12.	04.12.2025	Polar climate change	
	13.	11.12.2025	Mitigation measures	Poster Conference (graded)
	14.	18.12.2025	Climate engineering, questions and answers session	fill in Questionnaire in exercises (not graded)

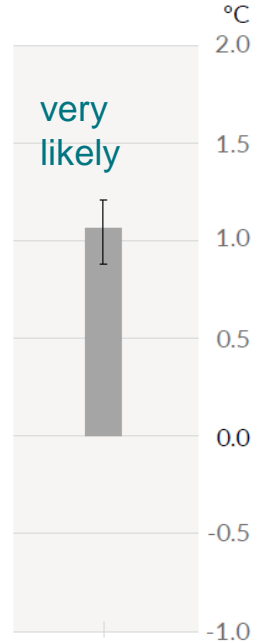
Current state of climate change and future scenarios

Results from the new IPCC assessment report 6 (AR6)

Attribution of today's global warming

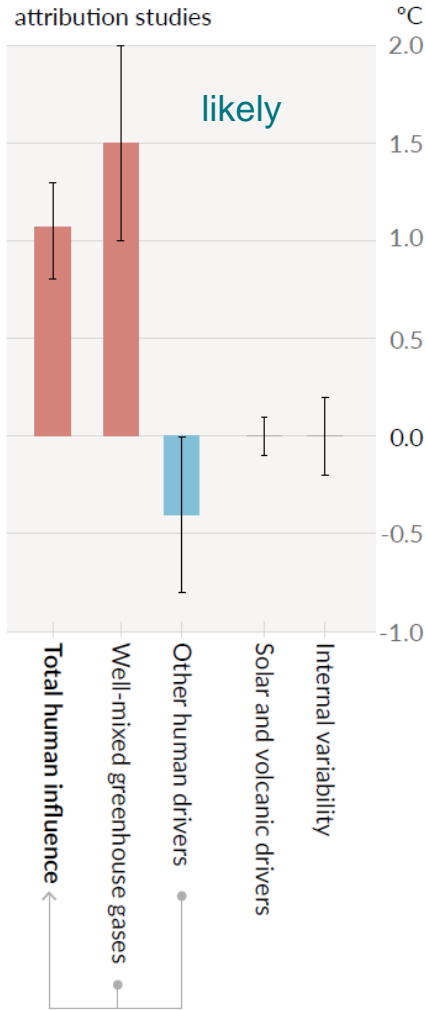
Observed warming

a) Observed warming 2010-2019 relative to 1850-1900



Contributions to warming based on two complementary approaches

b) Aggregated contributions to 2010-2019 warming relative to 1850-1900, assessed from attribution studies



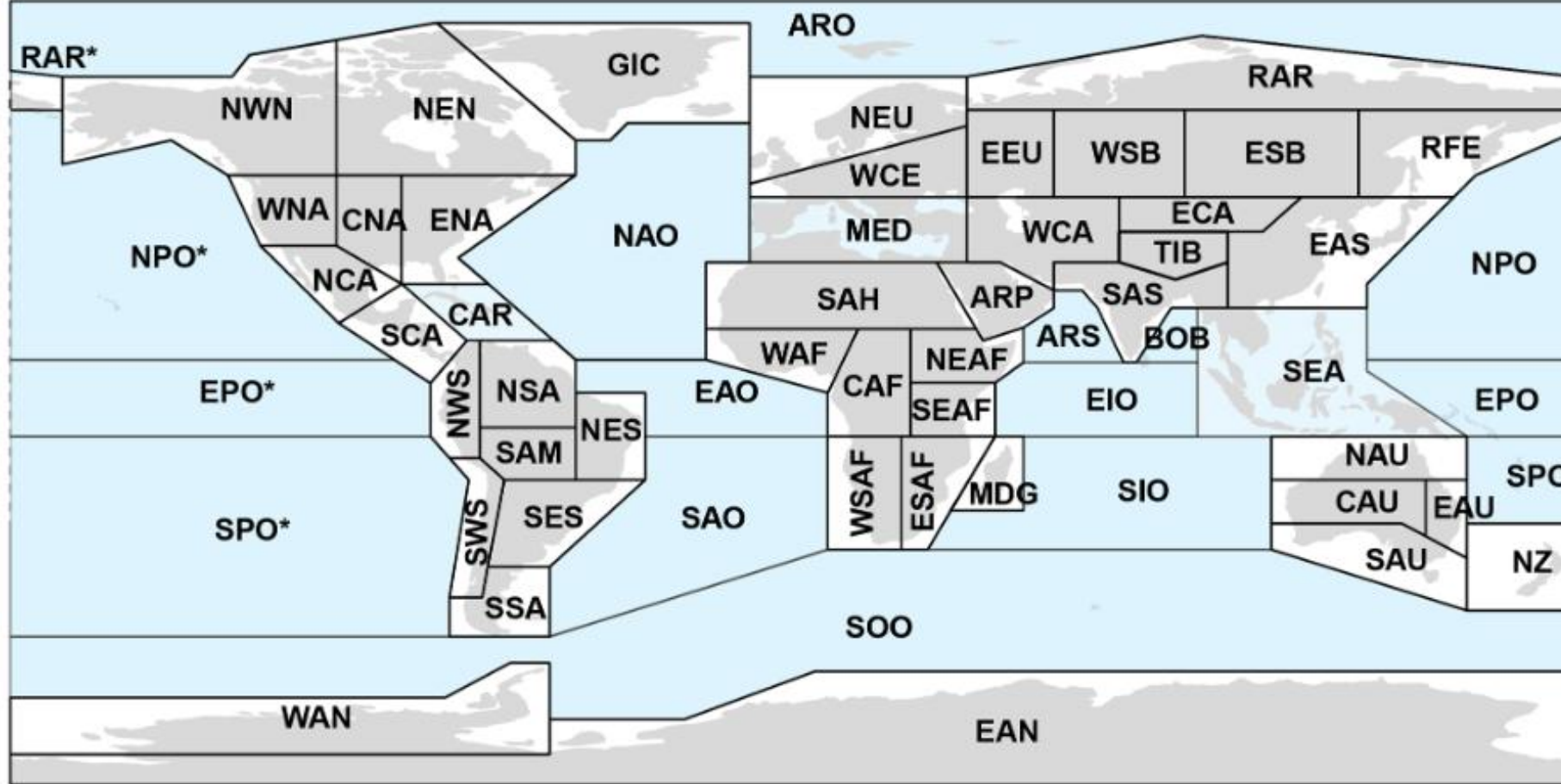
c) Contributions to 2010-2019 warming relative to 1850-1900, assessed from radiative forcing studies



Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling.

■ Figure SPM2

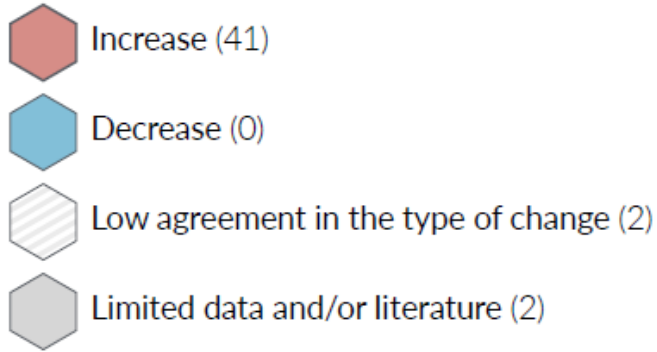
It's not only temperature and not only global



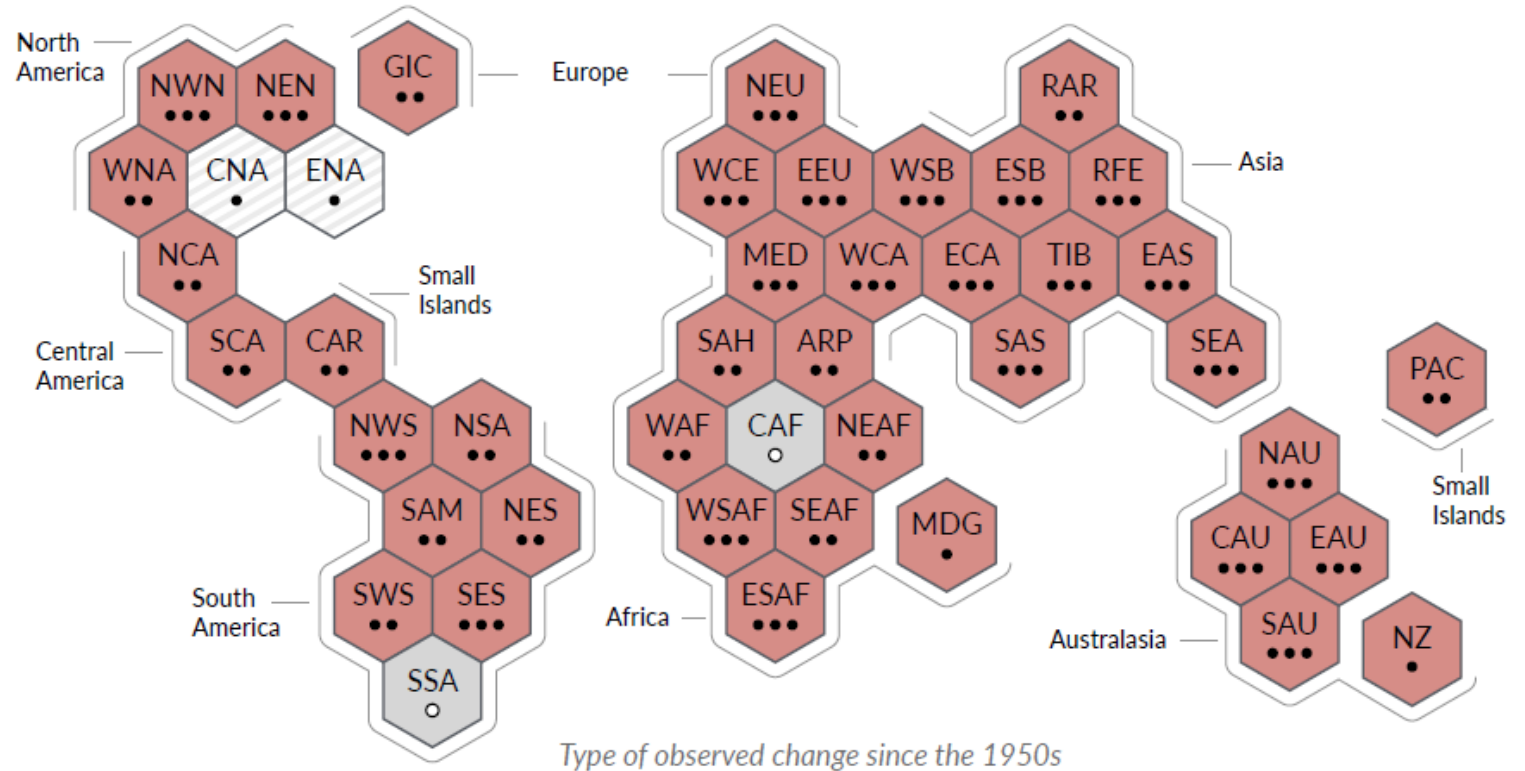
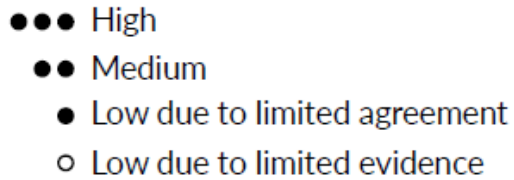
IPCC AR6 WGI reference regions: **North America:** NWN (North-Western North America), NEN (North-Eastern North America), WNA (Western North America), CNA (Central North America), ENA (Eastern North America), **Central America:** NCA (Northern Central America), SCA (Southern Central America), CAR (Caribbean), **South America:** NWS (North-Western South America), NSA (Northern South America), NES (North-Eastern South America), SAM (South American Monsoon), SWS (South-Western South America), SES (South-Eastern South America), SSA (Southern South America), **Europe:** GIC (Greenland/Iceland), NEU (Northern Europe), WCE (Western and Central Europe), EEU (Eastern Europe), MED (Mediterranean), **Africa:** MED (Mediterranean), SAH (Sahara), WAF (Western Africa), CAF (Central Africa), NEAF (North Eastern Africa), SEAF (South Eastern Africa), WSAF (West Southern Africa), ESAF (East Southern Africa), MDG (Madagascar), **Asia:** RAR (Russian Arctic), WSB (West Siberia), ESB (East Siberia), RFE (Russian Far East), WCA (West Central Asia), ECA (East Central Asia), TIB (Tibetan Plateau), EAS (East Asia), ARP (Arabian Peninsula), SAS (South Asia), SEA (South East Asia), **Australasia:** NAU (Northern Australia), CAU (Central Australia), EAU (Eastern Australia), SAU (Southern Australia), NZ (New Zealand), **Small Islands:** CAR (Caribbean), PAC (Pacific Small Islands)

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

Type of observed change in hot extremes



Confidence in human contribution to the observed change

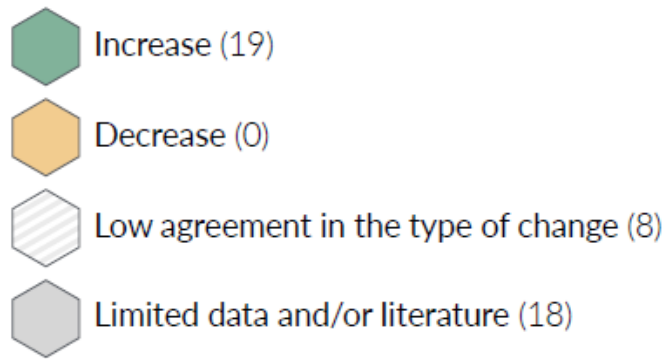


Type of observed change since the 1950s

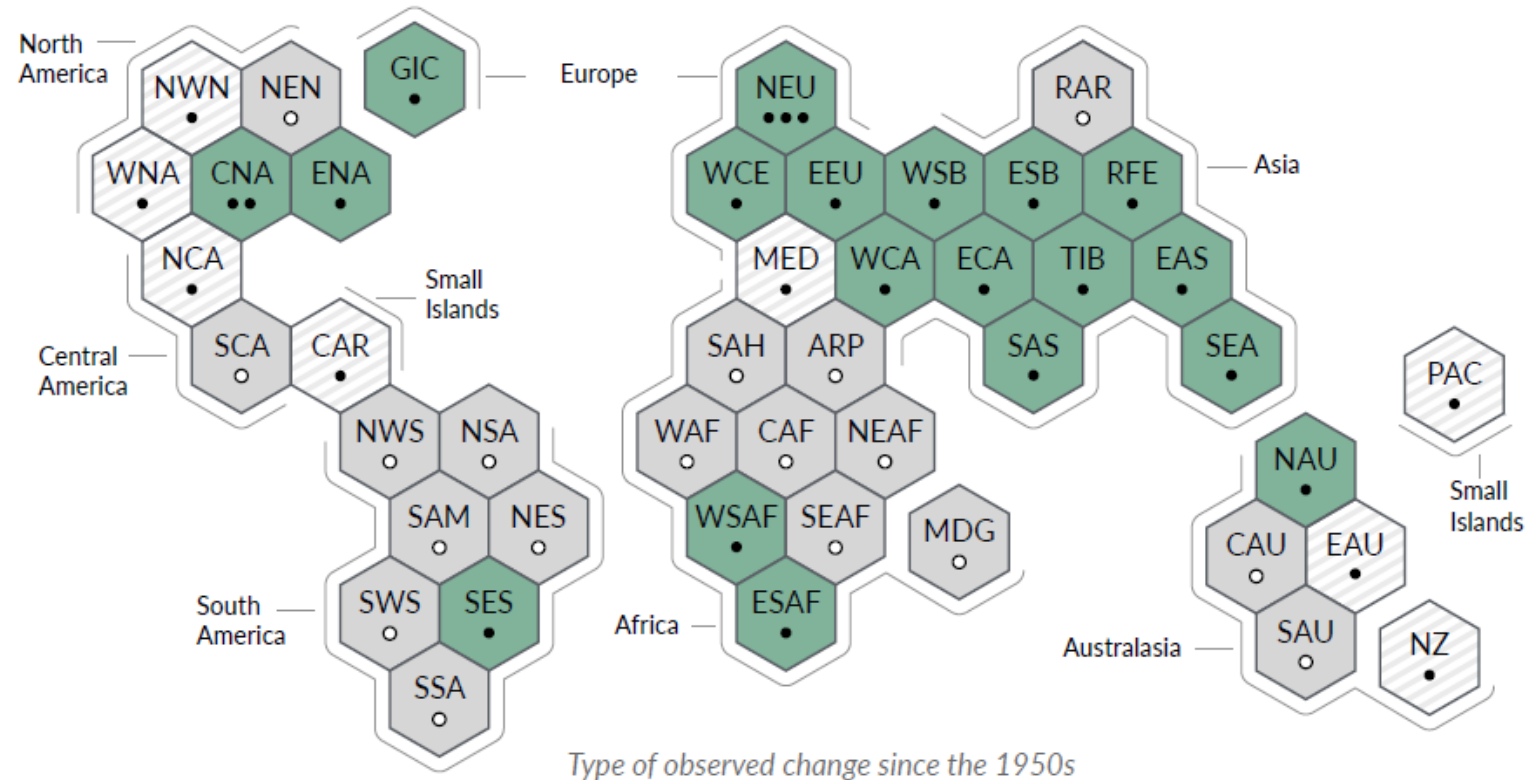
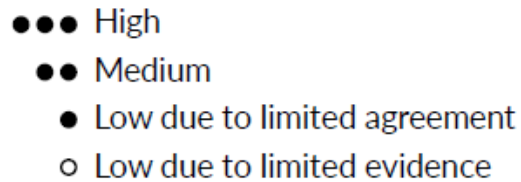
For hot extremes, the evidence is mostly drawn from changes in metrics based on daily maximum temperatures; regional studies using other indices (heatwave duration, frequency and intensity) are used in addition. Red hexagons indicate regions where there is at least *medium confidence* in an observed increase in hot extremes.

b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change in heavy precipitation



Confidence in human contribution to the observed change

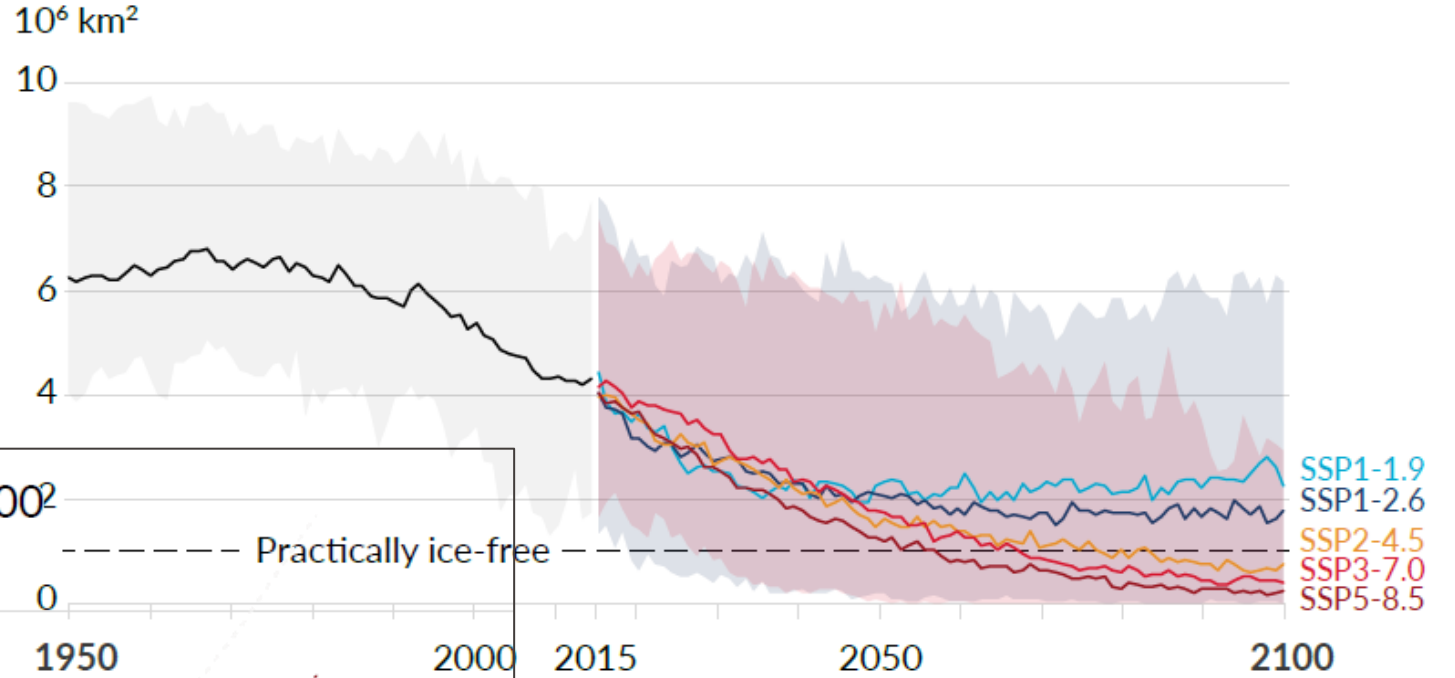


For heavy precipitation, the evidence is mostly drawn from changes in indices based on one-day or five-day precipitation amounts using global and regional studies. Green hexagons indicate regions where there is at least *medium confidence* in an observed increase in heavy precipitation.

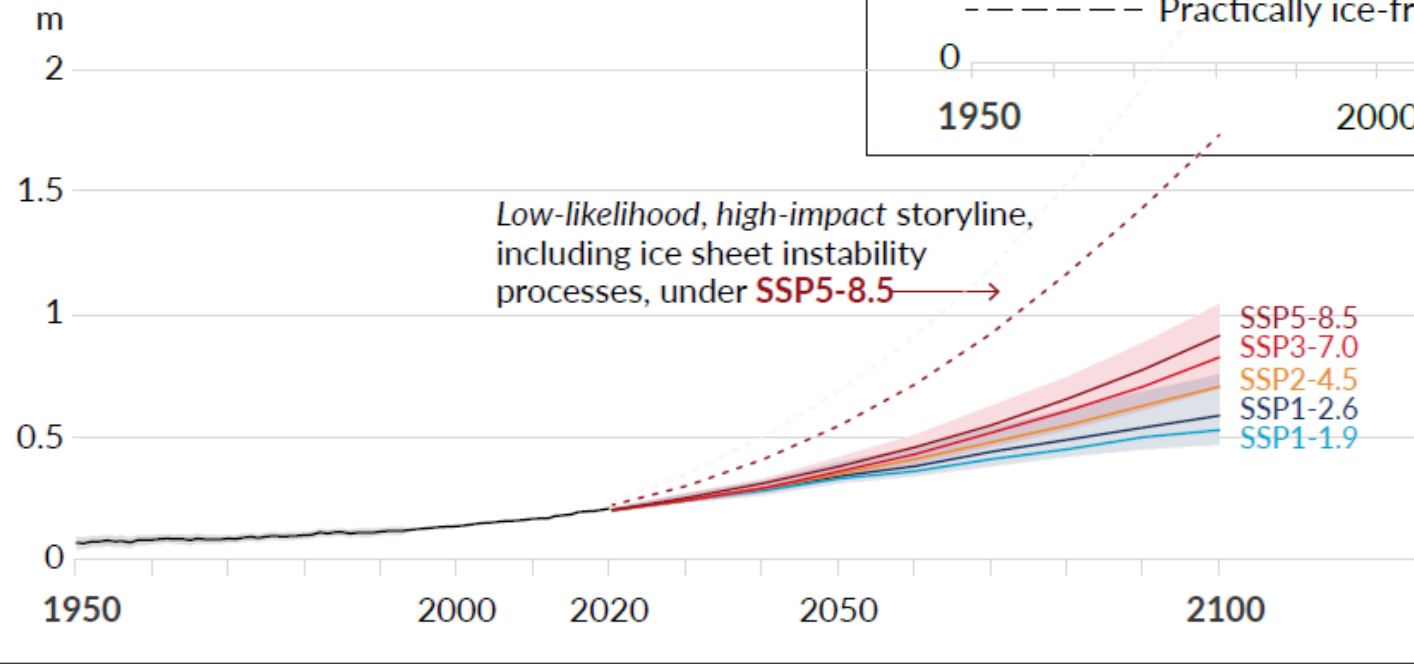
More indicators

To be discussed in the exercises
(Climate Impact Drivers, CIDs)

b) September Arctic sea ice area



d) Global mean sea level change relative to 1900





- IPCC reports are issued every 5-8 years. WMO provides yearly updates.
- There is less peer-reviewed literature contribution, the report is more based on monitoring activities.
- Key messages are structured around 7 key indicators.
- Each key indicator is linked to the sustainable development goals (SDGs).

<https://wmo.int/publication-series/state-of-global-climate-2024>

Atmospheric carbon dioxide

KEY MESSAGES

- In 2023, the atmospheric concentration of carbon dioxide, as well as those of methane and nitrous oxide, reached the highest levels in the last 800 000 years.
- Real-time data from specific locations show that levels of these three main greenhouse gases continued to increase in 2024.

Global mean near-surface temperature

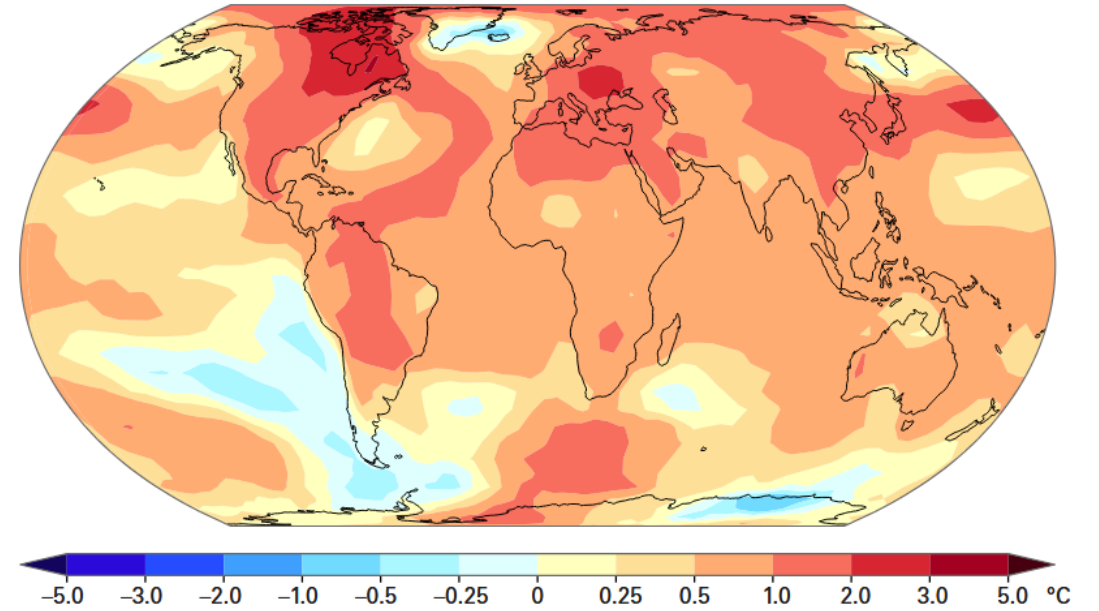


Figure 9. Annual average temperature anomalies relative to the 1991–2020 average. The values shown are the median of six global temperature datasets.

Source: Data from six global temperature datasets. For details see [Datasets and methods](#).

KEY MESSAGES

- The annually averaged global mean near-surface temperature in 2024 was $1.55\text{ °C} \pm 0.13\text{ °C}$ above the 1850–1900 average used to represent pre-industrial conditions.
- The year 2024 was the warmest year in the 175-year observational record, clearly surpassing the previous warmest year, 2023 at $1.45\text{ °C} \pm 0.12\text{ °C}$ above the 1850–1900 average.
- For global mean temperature, each of the past ten years, 2015–2024, were individually the ten warmest years on record.

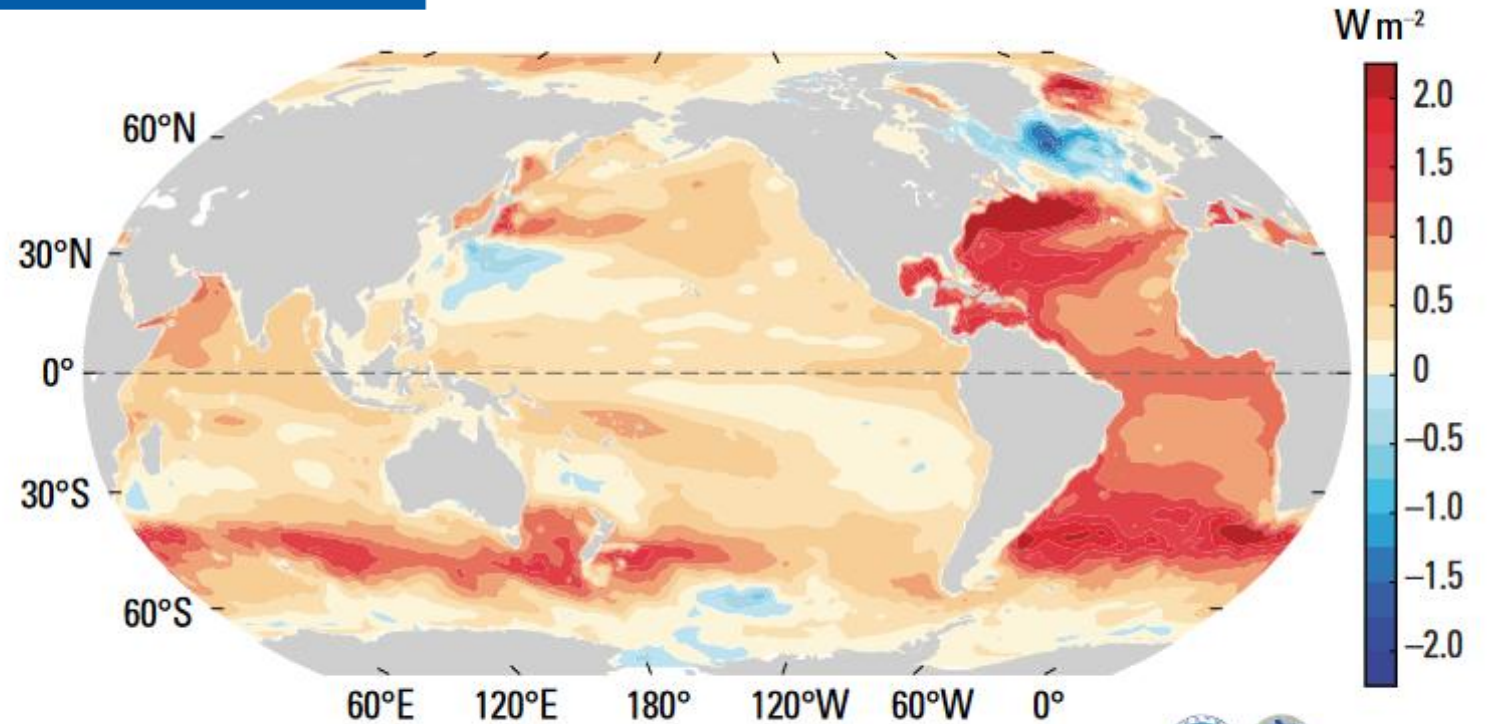
Ocean heat content

KEY MESSAGES

- In 2024, ocean heat content reached the highest level in the 65-year observational record, exceeding the previous record high set in 2023.
- Over the past eight years, each year has set a new record for ocean heat content.
- The rate of ocean warming over the past two decades, 2005–2024, is more than twice that observed over the period 1960–2005.

Figure 5. Observed upper 2000 m OHC trend from 1958 to 2023.

Source: Data updated from Cheng et al.²⁵



Global mean sea level

KEY MESSAGES

- In 2024, global mean sea level reached a record high in the satellite record (from 1993 to present).
- The rate of global mean sea-level rise in the past 10 years (2015–2024) was more than twice the rate of sea-level rise in the first decade of the satellite record (1993–2002).

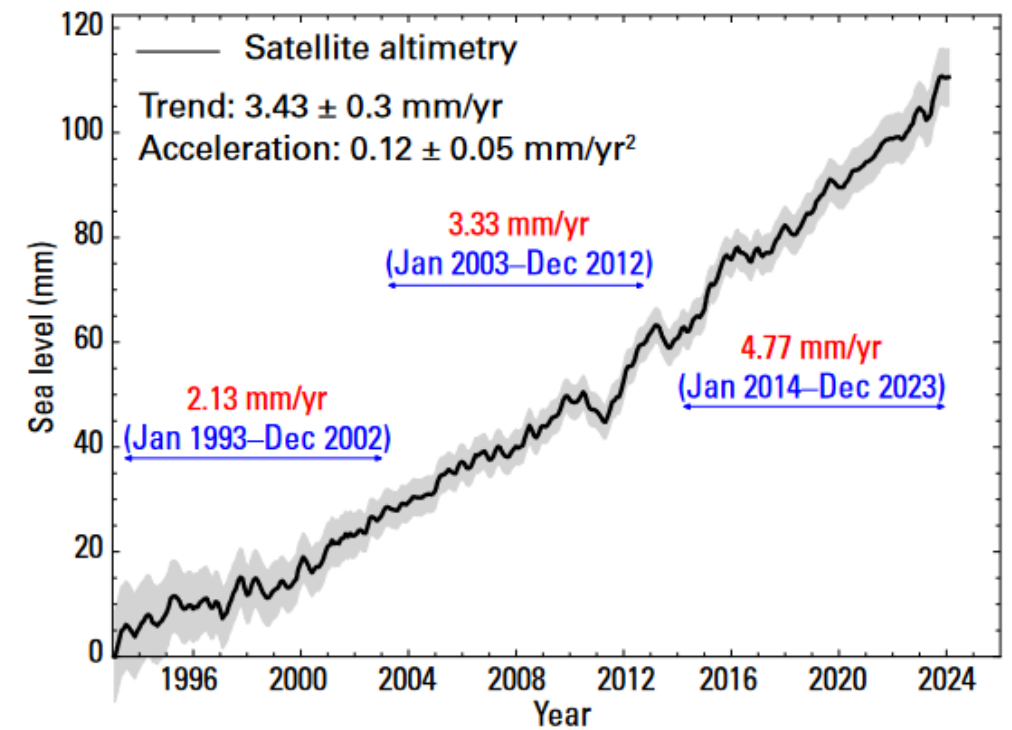


Figure 6. GMSL evolution between January 1993 and December 2023 based on satellite altimetry. The black line is the best estimate, and the grey shaded area indicates uncertainty. Red and blue annotations indicate the average rate of sea-level rise during three decades of the record as indicated.

Source: AVISO altimetry

Ocean pH

KEY MESSAGES

- Acidification of the ocean surface has continued over the past 39 years as shown by the steady decrease of global average ocean surface pH.
- Regionally, ocean acidification is not increasing uniformly.

El Niño–Southern Oscillation

KEY MESSAGES

- The strong 2023/2024 El Niño followed three consecutive years of La Niña from late 2020 to early 2023.
- El Niño conditions were established by mid-2023, became strong by the end of 2023 and dissipated by the second quarter of 2024.

Glacier mass balance

KEY MESSAGES

- Glacier mass loss from 2021/2022 to 2023/2024 represents the most negative three-year glacier mass balance on record, and seven of the ten most negative annual glacier mass balances since 1950 have occurred since 2016.
- Exceptionally negative mass balances were experienced in Norway, Sweden, Svalbard and the tropical Andes.

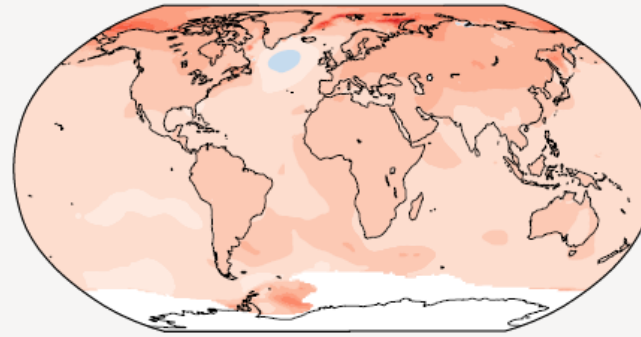
Sea-ice extent

- The minimum daily extent of Arctic sea-ice in 2024 was the seventh lowest in the observed record (1979 to present).
- The 18 lowest Arctic sea-ice extent minima in the satellite record all occurred in the past 18 years.
- The annual minimum and maximum of Antarctic sea-ice extent were each the second lowest in the observed record (1979 to present).

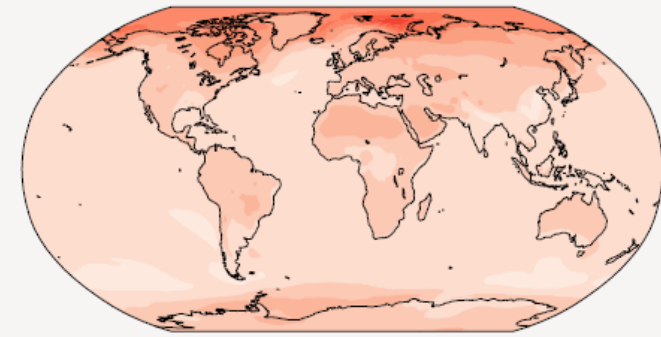
a) Annual mean temperature change (°C) at 1 °C global warming

Warming at 1 °C affects all continents and is generally larger over land than over the oceans in both observations and models. Across most regions, observed and simulated patterns are consistent.

Observed change per 1 °C global warming



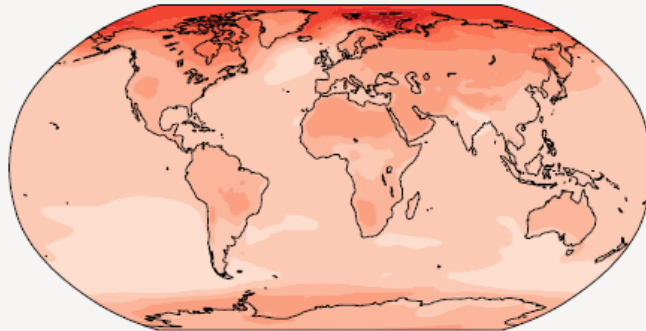
Simulated change at 1 °C global warming



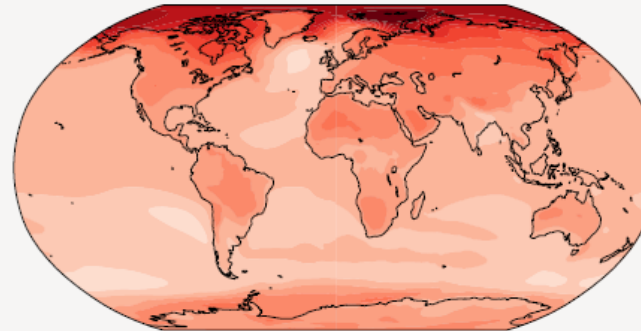
b) Annual mean temperature change (°C) relative to 1850-1900

Across warming levels, land areas warm more than oceans, and the Arctic and Antarctica warm more than the tropics.

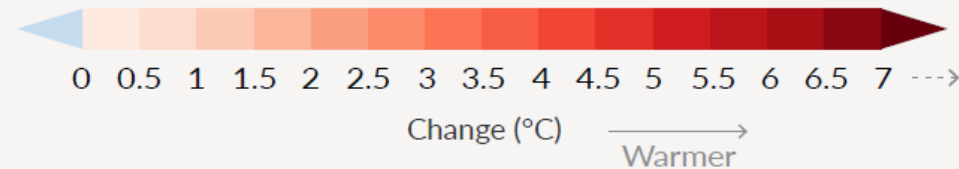
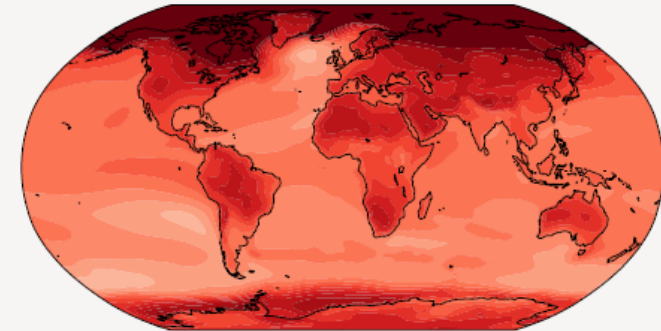
Simulated change at 1.5 °C global warming



Simulated change at 2 °C global warming



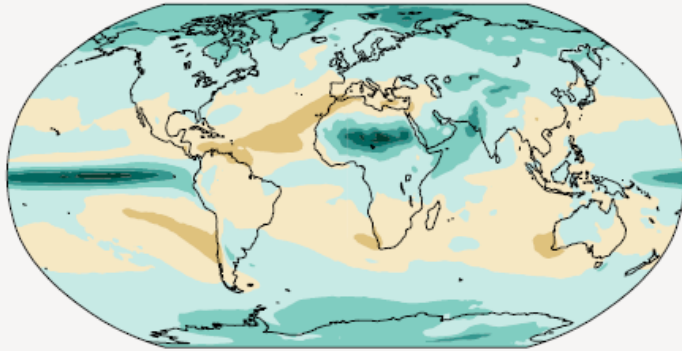
Simulated change at 4 °C global warming



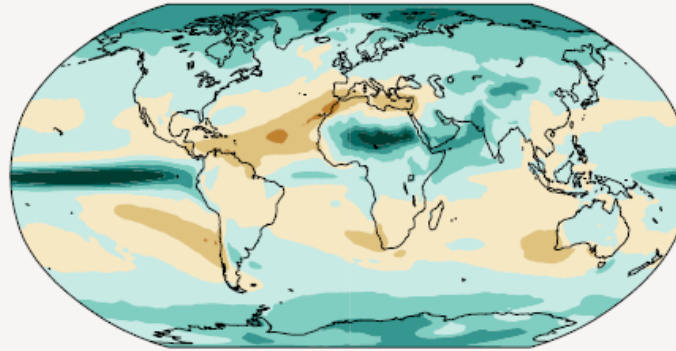
c) Annual mean precipitation change (%) relative to 1850-1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.

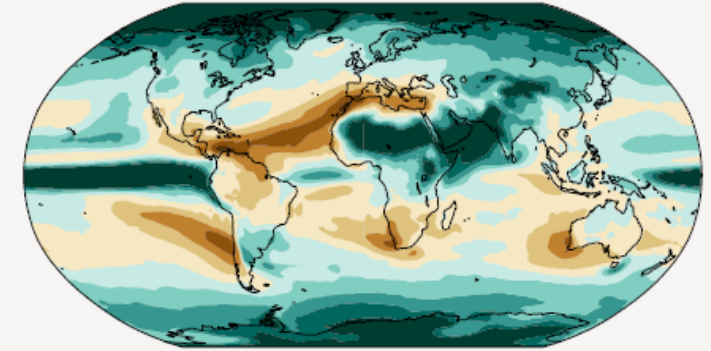
Simulated change at 1.5 °C global warming



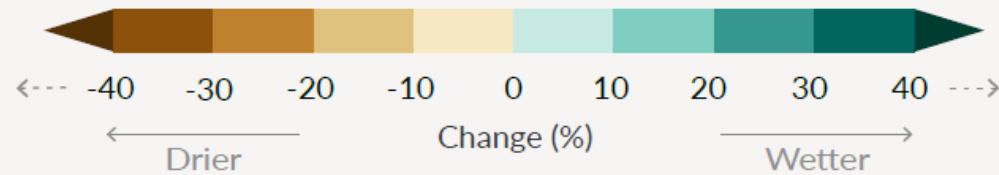
Simulated change at 2 °C global warming



Simulated change at 4 °C global warming



Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions



Precipitation anomalies in 2023

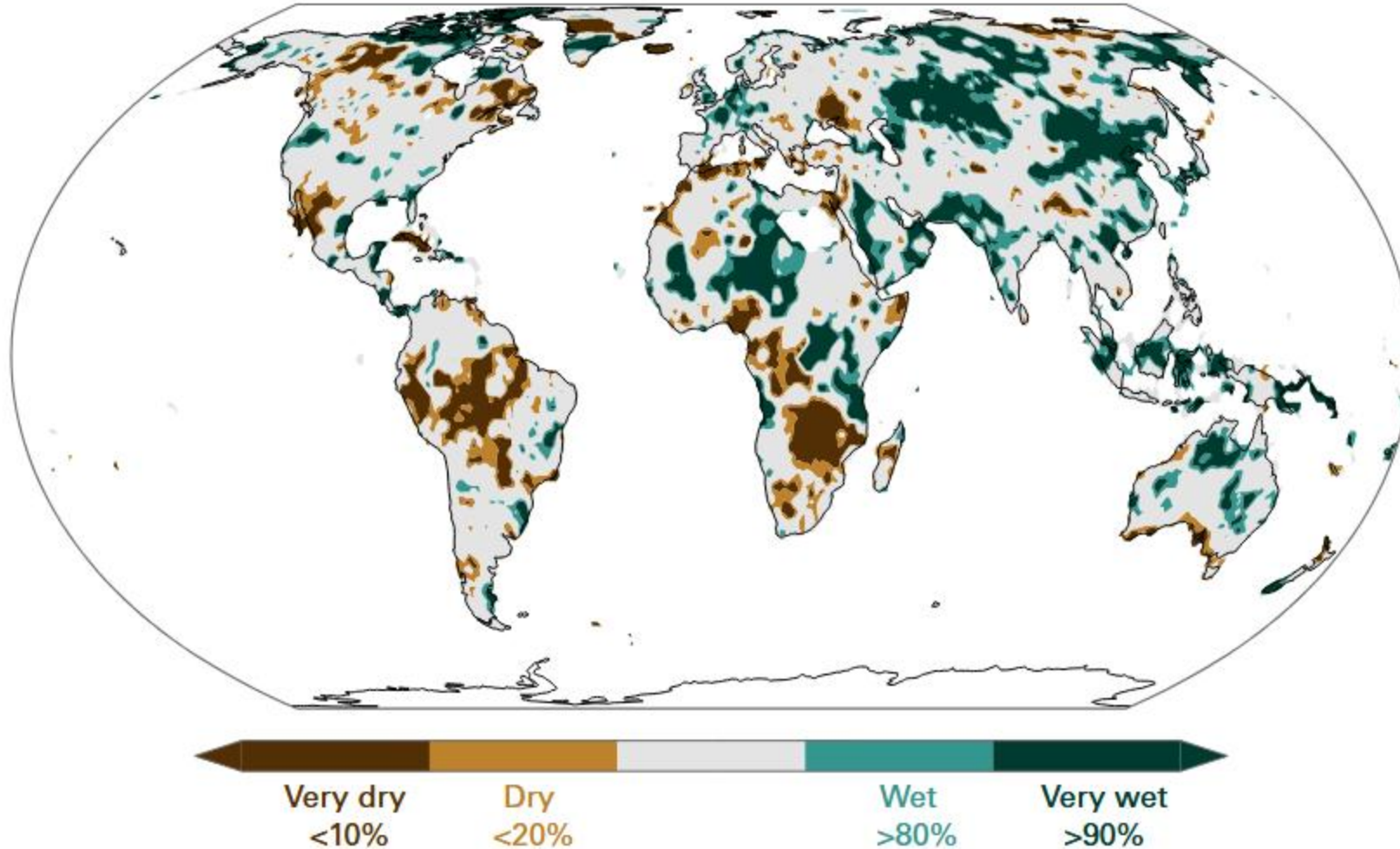


Figure 10. Annual precipitation 2024 expressed as percentiles of the 1991–2020 distribution. Brown areas are unusually dry. Green areas are unusually wet.

Source: Data from Global Precipitation Climatology Centre (GPCC).



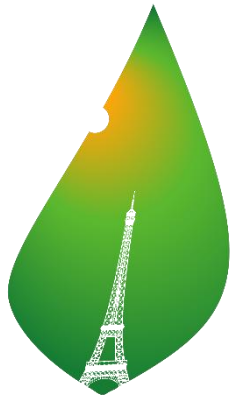
The UNFCCC is a political body. It entered into force on 21 March 1994. Today, it has near-universal membership. The 198 countries that have ratified the Convention are called Parties to the Convention. **Preventing “dangerous” human interference with the climate system is the ultimate aim of the UNFCCC.**

Conference of the Parties (COP)

The COP is the supreme decision-making body of the Convention. All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements. **The COP meets annually.**

KYOTO PROTOCOL

The **Kyoto Protocol**, which was signed in 1997 and ran from 2005 to 2020, was the first implementation of measures under the UNFCCC.




PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

The Kyoto Protocol was superseded by the **Paris Agreement**, which entered into force in 2016

*“The **Paris Agreement** central aim is to [...] **keep global temperature rise [...] well below 2°C above pre-industrial levels and to pursue efforts to limit the [...] increase [...] to 1.5 °C.**”*

<https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

Paris France



*In 2021, at the Conference of the Parties (COP) in Glasgow, the international community agreed to strive for a maximum warming of **1.5 °C**.*

<https://unfccc.int/process-and-meetings/the-paris-agreement/the-glasgow-climate-pact-key-outcomes-from-cop26>

- The Paris Agreement is a **legally binding international treaty on climate change**. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016.
- The Paris agreement:
 - Has 16 introductory paragraphs and 29 articles
 - contains procedural articles (e.g., the criteria for its entry into force) and operational articles (covering, for example, mitigation, adaptation and finance).
 - is a binding agreement, but many of its articles do not imply obligations.
 - facilitates international collaboration.
 - covers most greenhouse gas emissions, but does not apply to international aviation and shipping, which fall under the responsibility of the International Civil Aviation Organization and the International Maritime Organization.

- Its goal is to **limit global warming** to well below 2, **preferably to 1.5 degrees Celsius**, compared to pre-industrial levels (**Article 2**).
- To achieve this long-term temperature goal, countries aim to **reach global peaking of greenhouse gas emissions as soon as possible** to achieve a climate neutral world by mid-century (**Article 4**).
- Implementation of the Paris Agreement requires **economic and social transformation**, based on the best available science. The Paris Agreement works on a **5- year cycle** of increasingly ambitious climate action carried out by countries. By 2020, countries submit their plans for climate action known as **nationally determined contributions (NDCs, Article 3)**.
- In 2023 the first **global stock take** has taken place.

Nationally determined contributions

Reductions of emissions to reach Paris Agreement goals.

The Paris Agreement and NDCs

- Nationally determined contributions (NDCs) are at the heart of the Paris Agreement and the achievement of these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. The [Paris Agreement](#) (Article 4, paragraph 2) requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.

What does this mean?

- The Paris Agreement requests each country to outline and communicate their post-2020 climate actions, known as their NDCs.
- **Together, these climate actions determine whether the world achieves the long-term goals of the Paris Agreement and to reach global peaking of greenhouse gas (GHG) emissions as soon as possible** and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of this century. It is understood that the peaking of emissions will take longer for developing country Parties, and that emission reductions are undertaken on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty, which are critical development priorities for many developing countries.

- The Paris Agreement recognizes that the long-term goals specified in its Articles 2 and 4.1 will be achieved through time and, therefore, builds on a ratcheting up of aggregate and individual ambition over time.
- NDCs are submitted every five years to the UNFCCC secretariat. In order to enhance the ambition over time the Paris Agreement provide that successive NDCs will represent a progression compared to the previous NDC and reflect its highest possible ambition.
- Parties are requested to submit the next round of NDCs (new NDCs or updated NDCs) by 2020 and every five years thereafter (e.g. by 2020, 2025, 2030), regardless of their respective implementation time frames.
- Conditional NDCs (as opposed to unconditional): Some countries attached conditions to the implementation of some measures. In total, about 78% of the NDCs in the first round in 2015 included conditional contributions. In addition to conditions relating to collective ambition or the framework of the PA, over 80 % of the NDCs are attached to international financial and technical support.

Swiss Nationally Determined Contribution: 2nd NDC 2031-2035

Switzerland's second NDC

Switzerland is committed to follow the recommendations of the IPCC in order to limit global warming to 1.5 degrees Celsius. Switzerland's second NDC is to reduce its greenhouse gas emissions by at least 65 percent by 2035 compared to 1990 levels, to be implemented as an emission budget covering 2031–2035. Thus, the target corresponds to a greenhouse gas budget of 106.8 million tonnes of CO₂ equivalents¹, which is equivalent to an average reduction of greenhouse gas emissions by at least 59 percent over the period 2031–2035. The methodological approaches underlying the Swiss NDC are included in this communication.

Further, Switzerland communicates a net-zero target for all greenhouse gas emissions by 2050².

The Federal Act on Climate Protection Targets, Innovation and Strengthening Energy Security (Climate and Innovation Act) adopted by popular vote in 2023 defines intermediate targets for emission development (compared to 1990 emission levels) towards net-zero as well as a net-negative pathway thereafter:

- Between 2031 and 2040: minus at least 64 percent on average;
- Until 2040: minus at least 75 percent;
- Between 2041 and 2050: minus at least 89 percent on average.

Figure 1

Relative changes in Switzerland's greenhouse gas and CO₂ emissions from 1990 to 2022 compared to Switzerland's population (1990=100).
 Excluding international aviation, maritime transport and land-use change / forestry.

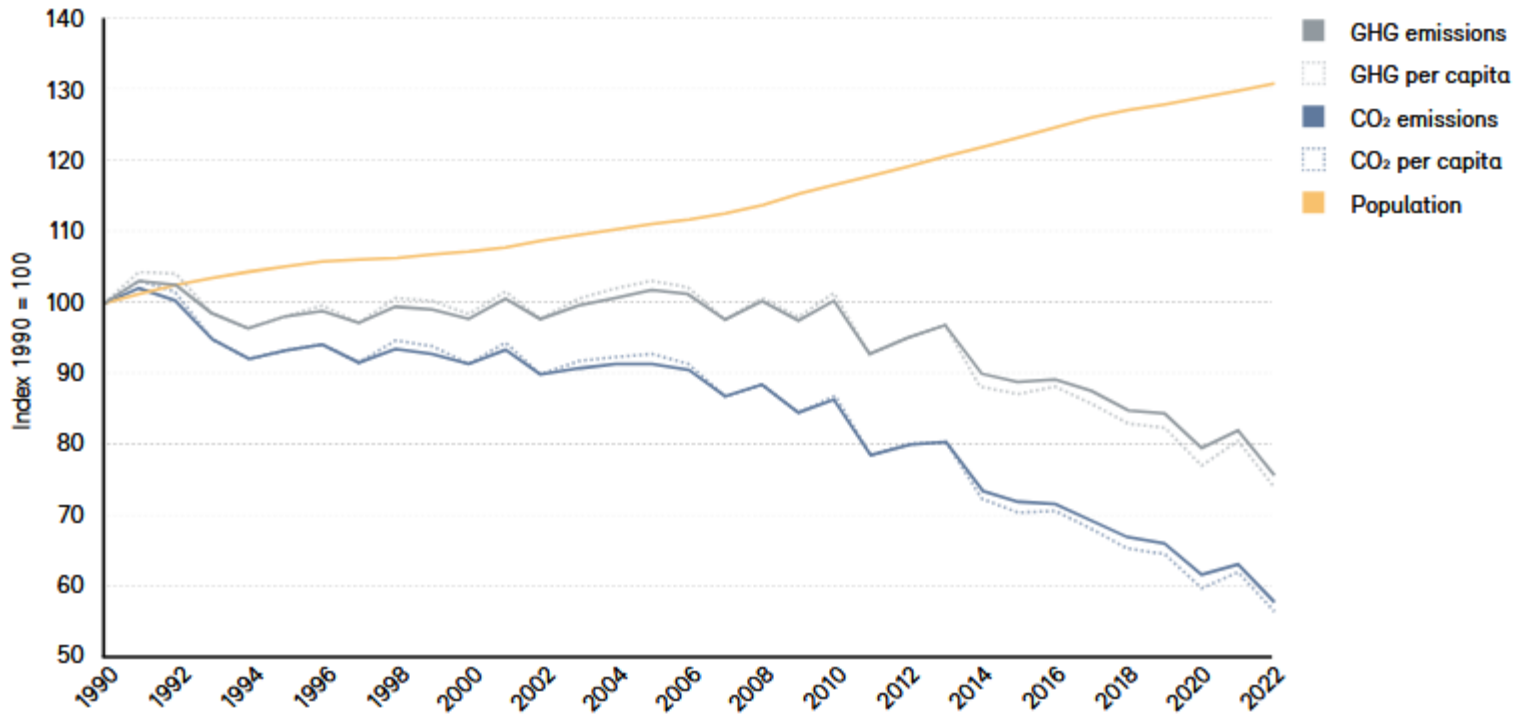
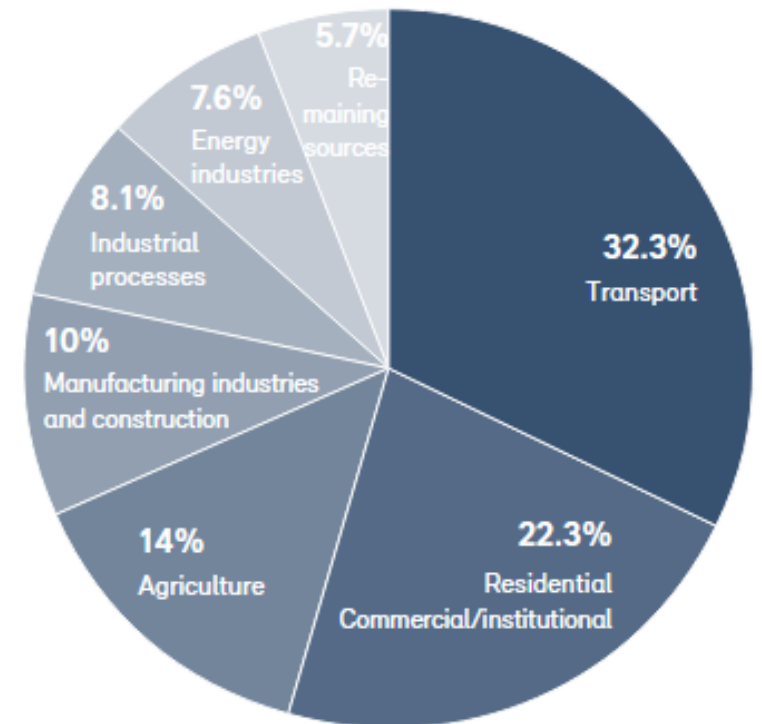


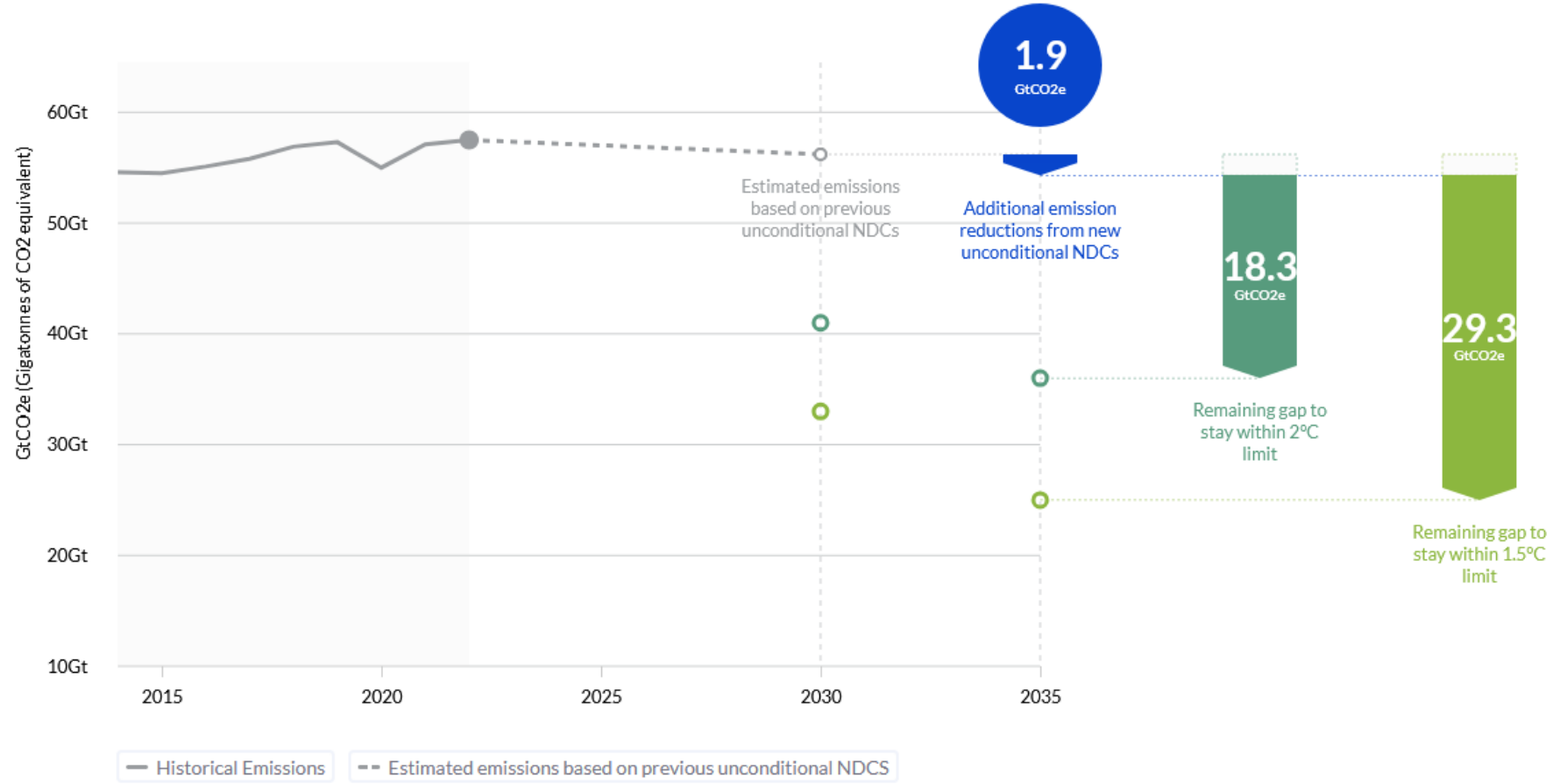
Figure 3

Switzerland's greenhouse gas emissions in 2022 by sector. Total emissions: 42.1 million tonnes of CO₂ equivalents.
 Including domestic civil aviation (excluding military), excluding international aviation, maritime transport, including land-use change / forestry.



Current NDC situation

UNCONDITIONAL NDCS CONDITIONAL NDCS



Last updated on October 30, 2025



- More than 60 countries have so far submitted national plans
- Taken together, these plans would cut carbon by only about 10% by 2035 compared with 2019 levels. This is only about a sixth of the drop in global emissions needed to limit global heating to 1.5C.
- ...several significant countries were missing. China and the EU have yet to detail their NDCs, though they have made announcements indicating their emissions-cutting targets.
- China's pledge to cut its carbon output by between 7% and 10% of its peak by 2035 was widely denounced as too weak, while the EU has been squabbling over its commitment to a possible range of 62% to 72.5% within the decade. (the 10% estimate includes China and the EU)
- At Belem, the task will be to show how the world can be put on track to meet the Paris goals, despite the inadequacy of the NDCs.

COP30 @ Belém, Brazil

10-21 November 2025



- Key expectations include
 - the presentation of new national climate action plans (NDCs),
 - progress on the finance roadmap from COP29, and
 - discussions on scaling up innovative climate finance mechanisms.
 - The conference will also feature the COP30 Action Agenda, a programme to engage businesses, civil society, and various levels of government in practical climate solutions.

Different types of COPs

- **UN Convention on Climate Change** – meets annually - <https://unfccc.int/>
- **UN Convention on Biological Diversity** – meets every 2nd year
The Convention on Biological Diversity (CBD) is the international legal instrument for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" that has been ratified by 196 nations. The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993.
<https://www.cbd.int/>
- **UN Convention to Combat Desertification** – meets every 2nd year
The United Nations Convention to Combat Desertification (UNCCD) was established in 1994 to protect and restore our land and ensure a safer, just, and more sustainable future. The UNCCD is the only legally binding framework set up to address desertification and the effects of drought.
[UNCCD COP16 | Riyadh, Saudi Arabia | 2-13 December 2024](#)

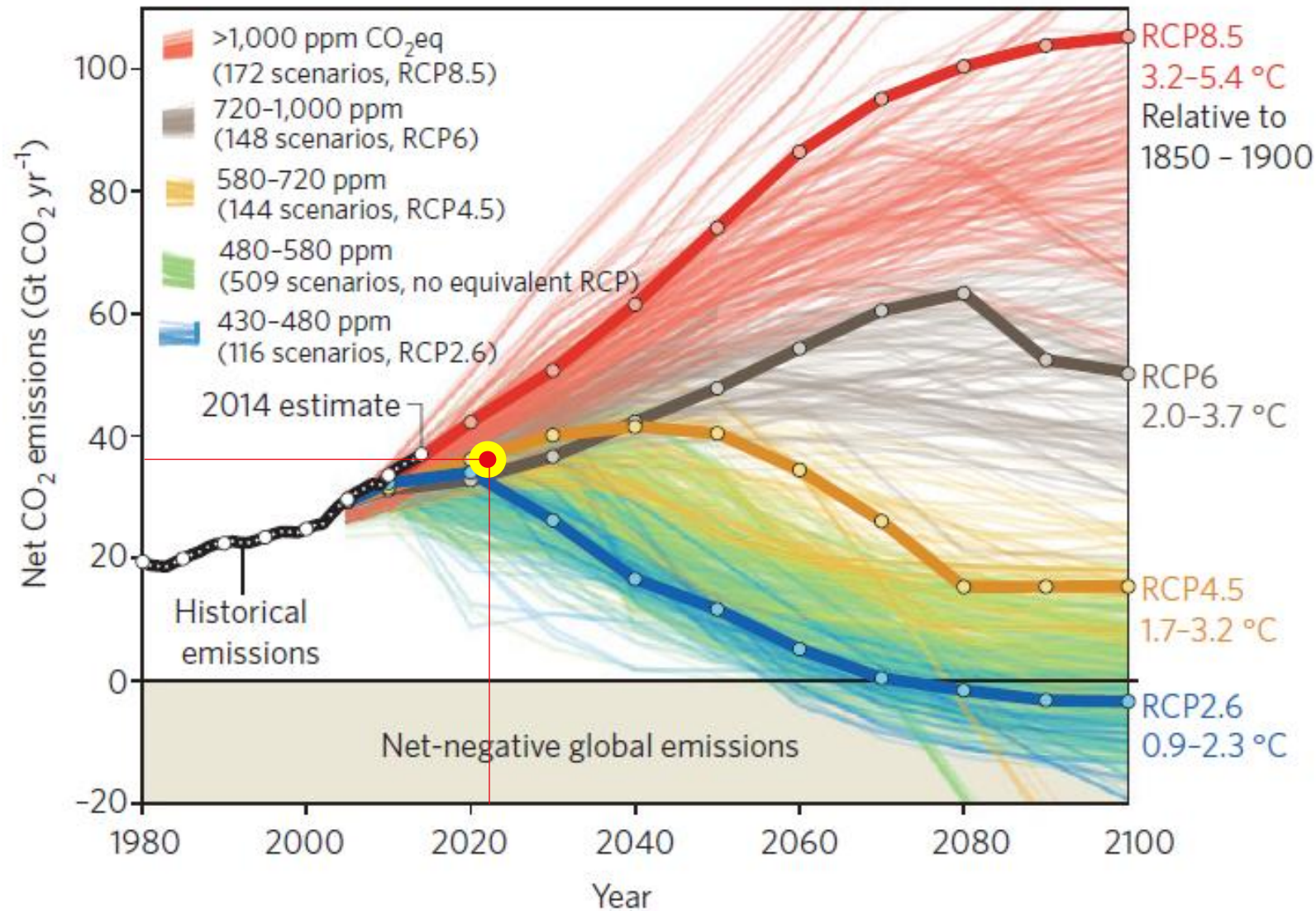
How will our planet look like in 2100?



Representative Concentration Pathways (RCPs)

- Focus on atmospheric CO₂ concentrations.
- They focus on anthropogenic emissions and do not include changes in natural drivers such as solar or volcanic forcing or natural emissions, for example, of CH₄ and N₂O.
- They are identified by their **approximate total radiative forcing** in year 2100 relative to 1750:
 - 2.6 W m⁻² for RCP2.6 – in 2100: 430-480 ppm CO₂ (mitigation scenario)
 - 4.5 W m⁻² for RCP4.5 – in 2100: 480 - 720 ppm CO₂ (stabilization scenario)
 - 6.0 W m⁻² for RCP6.0 – in 2100: 720 - 1000 ppm CO₂ (stabilization scenario)
 - 8.5 W m⁻² for RCP8.5 – in 2100: > 1000 ppm CO₂ (“uncontrolled growth”)

CO₂ emissions of RCPs



2019: 36.4 Gt
 2020: 34.8 Gt
 2021: ~36.4 Gt
 2022: ~37.5 Gt
 2023: ~37.5 Gt

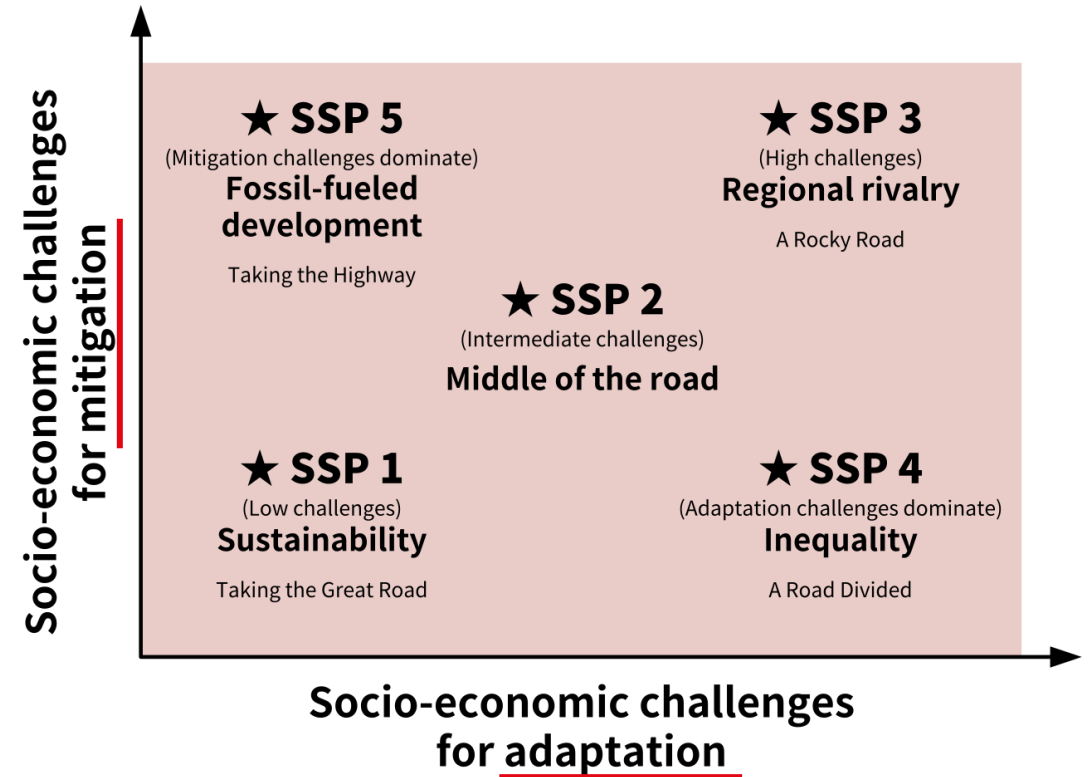
[Global Carbon Project](#)

Anything that strikes you in this graph?

Negative emissions needed to stay < 2 °C.

■ Fuss et al., 2014, Nat. Clim. Change

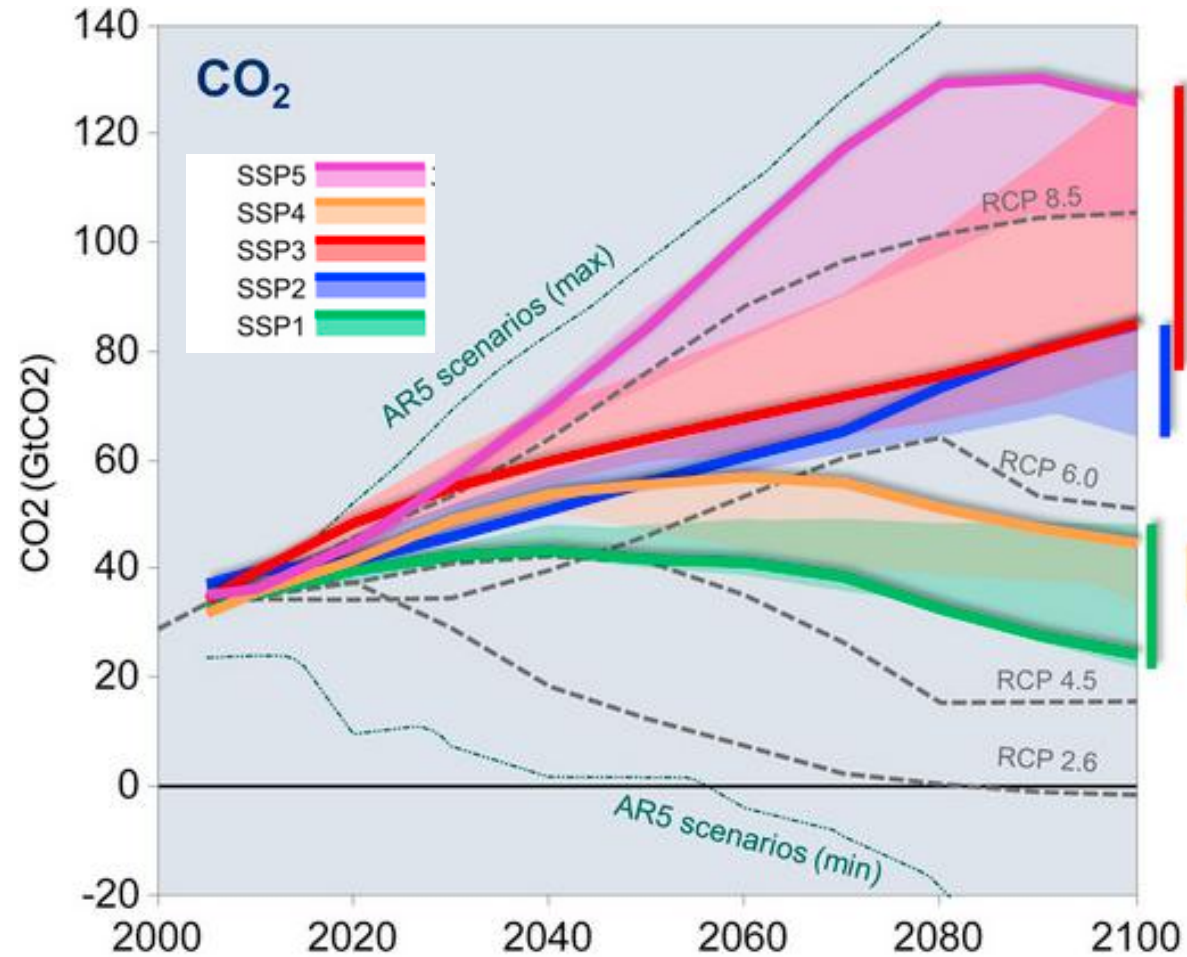
- SSPs are scenarios of projected socioeconomic global changes up to 2100. They are used to derive greenhouse gas emissions scenarios with different climate policies.
- Used in IPCC AR6
- **SSPs** are:
 - narratives describing alternative socio-economic developments.
 - qualitative description of logic relating elements of the narratives to each other.
 - quantitative elements: they provide data accompanying the scenarios on national population, urbanization and GDP (per capita).



Shared Socio-economic Pathways (SSPs)



SSP baseline scenarios (no mitigation)

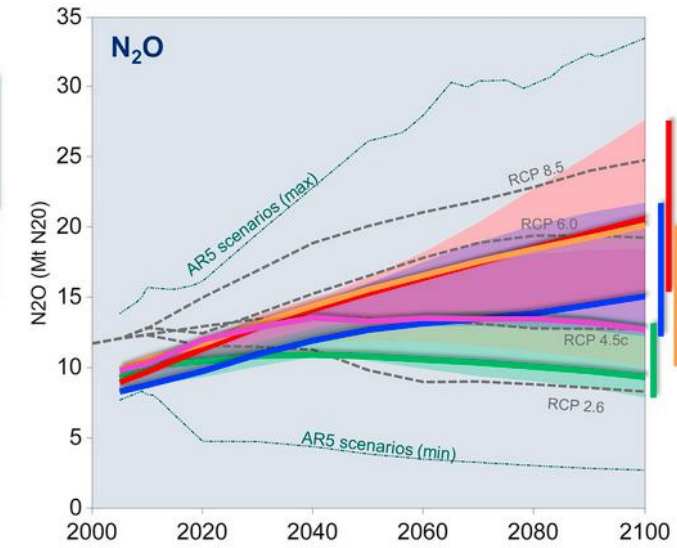
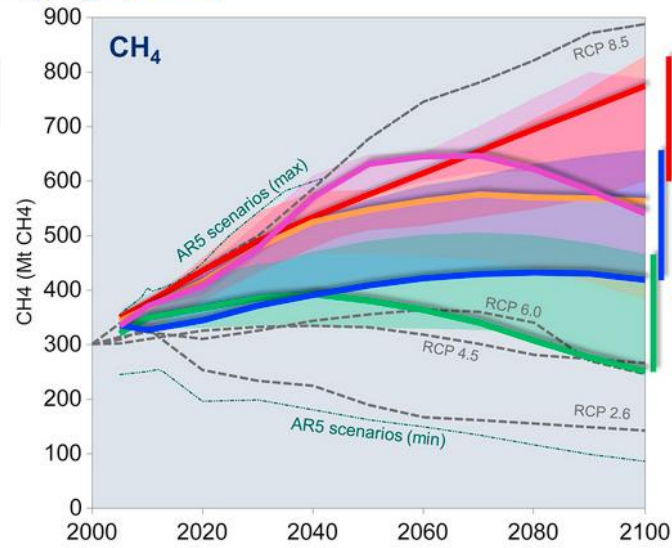
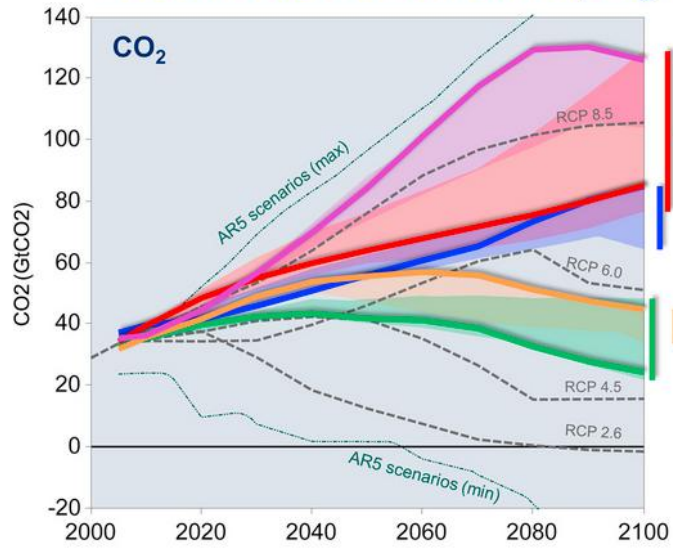


The **baseline** scenarios do not take into account any climate policy.

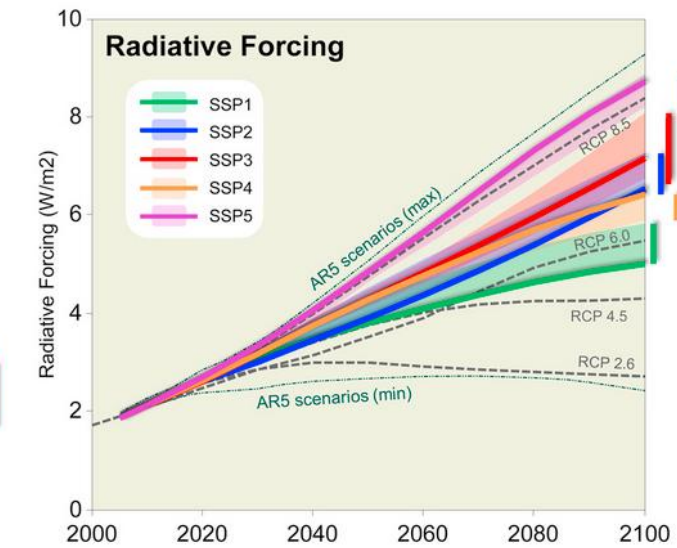
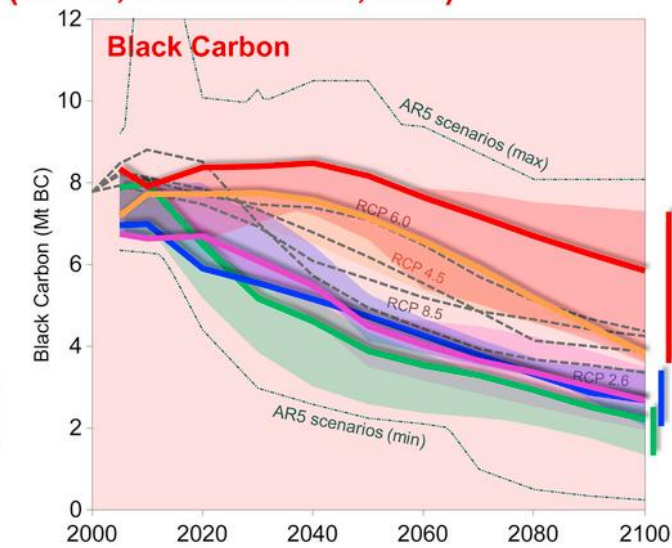
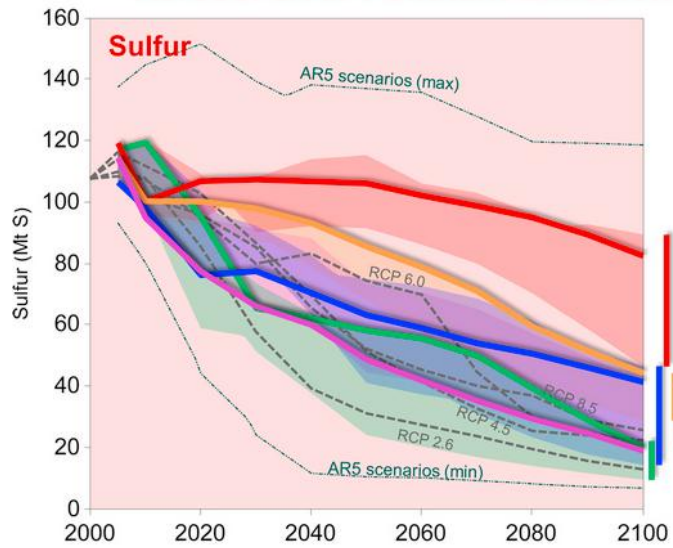
→ Even the best SSPs (1, 4) are higher in CO₂ emissions than RCP2.6 and RCP4.5. **This means that even today's «sustainability» level is not good enough to meet the Paris Agreement.**

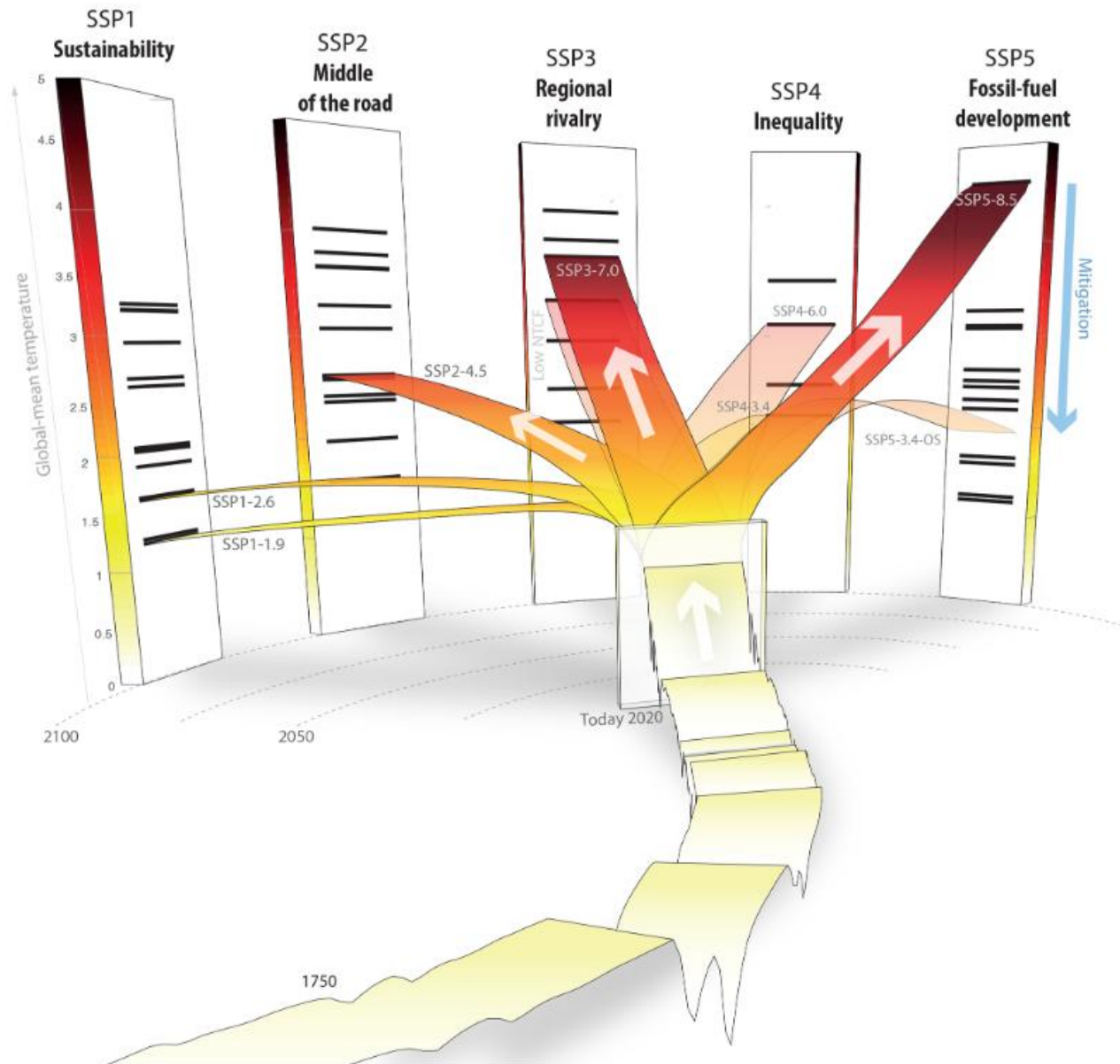
SSPs include many types of emissions

Greenhouse Gas Emissions (CO₂, CH₄, N₂O, etc..)



Aerosol & Air Pollutant Emissions (Sulfur, Black Carbon, etc..)



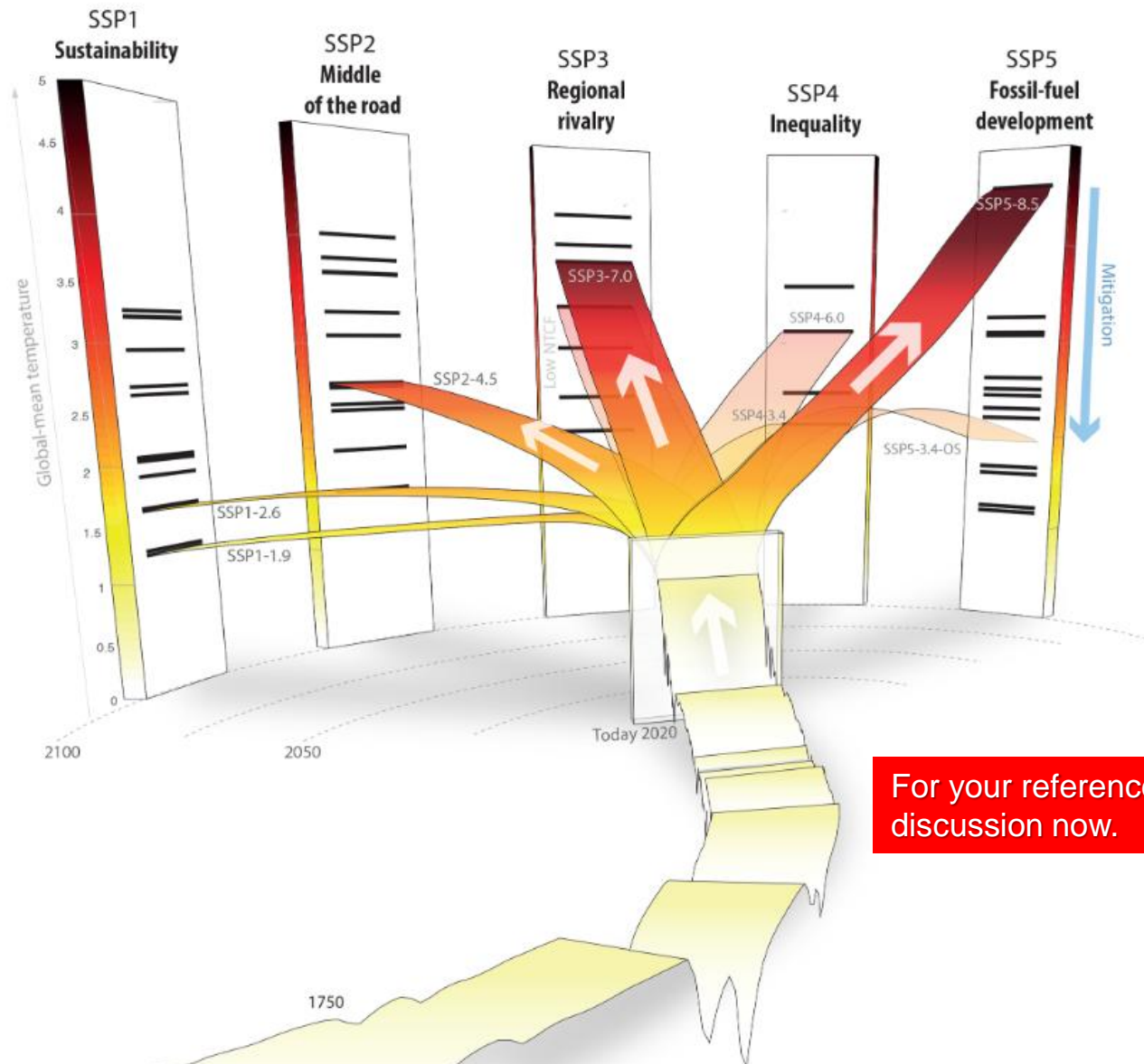


There are 23 SSP “marker” scenarios. These are the **5 IPCC priority** scenarios.

- **SSP5-8.5** represents the high end of the range of future pathways, corresponding to RCP8.5.
- **SSP3-7.0** lies between RCP6.0 and RCP8.5, and represents the medium to high end of the range of future forcing pathways.
- **SSP2-4.5** represents the medium part of the range of future forcing pathways and updates RCP4.5.
- **SSP1-2.6** is similar to RCP2.6. It is anticipated that it will produce a multi-model mean of less than 2°C warming by 2100.
- **SSP1-1.9** are scenarios with very low and low GHG emissions, and CO₂ emissions declining to net zero around or after 2050, followed by varying levels of net negative CO₂ emissions.

L e s s w a r m i n g

How do SSP and RCP scenarios go together?



Shown are illustrative temperature levels relative to pre-industrial levels with historical temperatures (front band), current (2020) temperatures (small block in middle), and the branching of the respective scenarios over the 21st century along the five different socio-economic families.

The small black horizontal bars on the 2100 pillars for each SSP indicate illustrative temperature levels (obtained by a model).

The more opaque bands over the 21st century indicate the five SSP scenarios SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 that are used as priority scenarios in the IPCC AR6.

The more transparent bands indicate the remaining “Tier 2” SSP scenarios, namely SSP3-7.0, SSP4-3.4, SSP4-6.0, and SSP5-3.4.

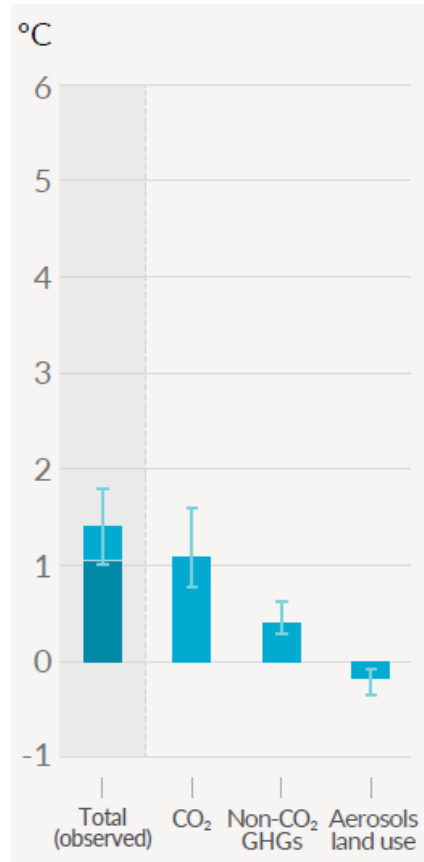
Also shown is a blue indicative bar on the right side, indicating the effect of mitigation action, which reduces temperature levels in 2100 and throughout the 21st century – depending on the respective reference scenario and level of mitigation

Contribution to warming

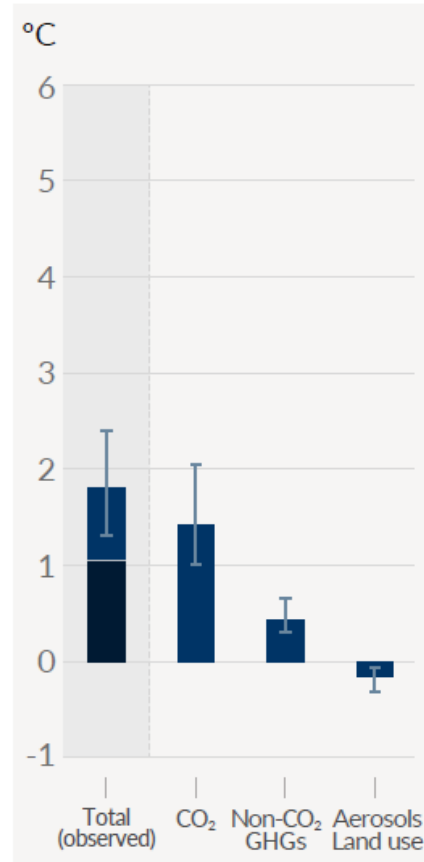
b) Contribution to global surface temperature increase from different emissions, with a dominant role of CO₂ emissions

Change in global surface temperature in 2081-2100 relative to 1850-1900 (°C)

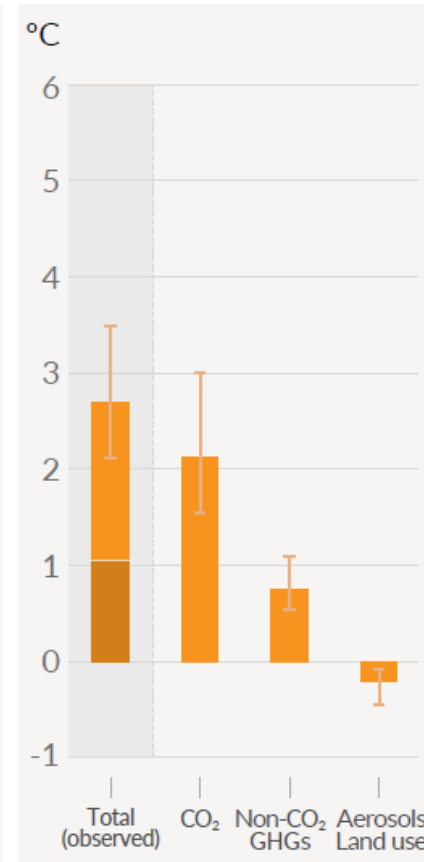
SSP1-1.9



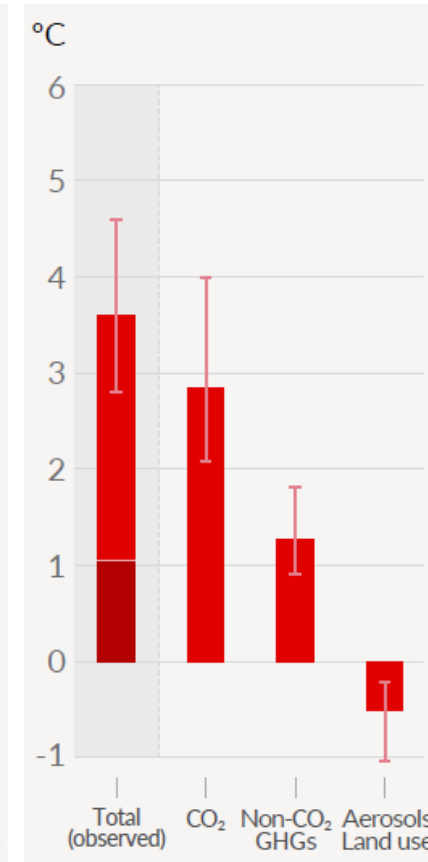
SSP1-2.6



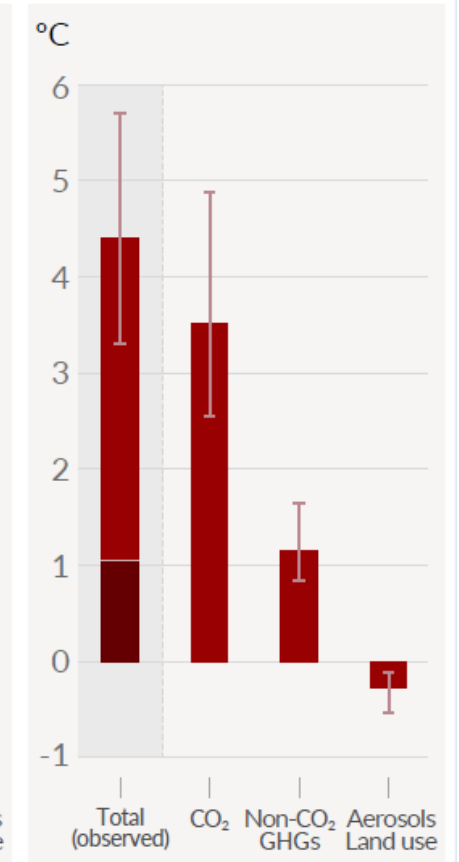
SSP2-4.5



SSP3-7.0

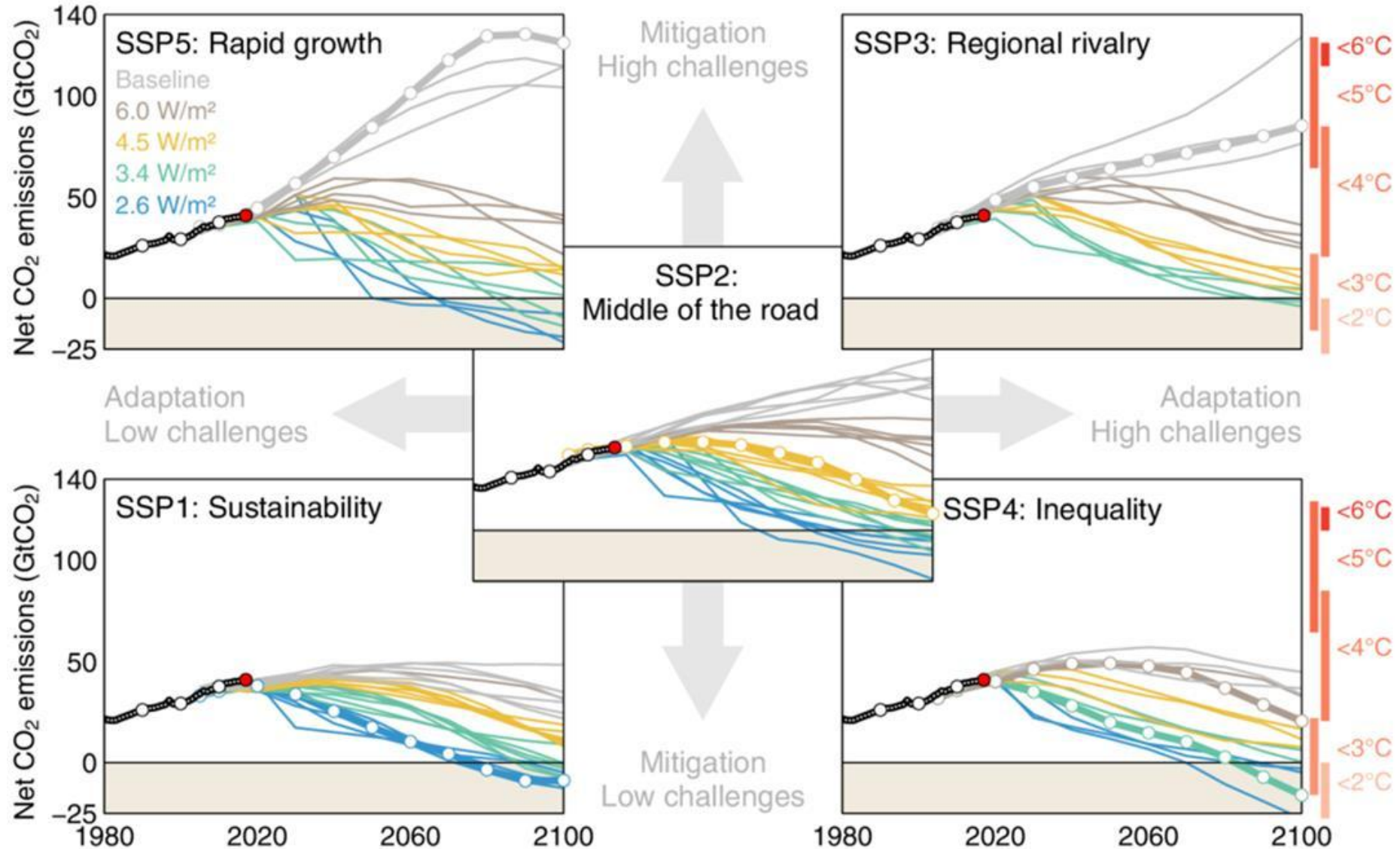


SSP5-8.5



Total warming (observed warming to date in darker shade), warming from CO₂, warming from non-CO₂ GHGs and cooling from changes in aerosols and land use

Which path are we on right now?



Expected warming by scenario

For your reference, no discussion now.

Scenario	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)	Best estimate (°C)	<i>Very likely</i> range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

- **World's major cities hit by 25% leap in extremely hot days since the 1990s**
- <https://www.theguardian.com/environment/2025/sep/30/worlds-major-cities-hit-by-25-leap-in-extremely-hot-days-since-the-1990s>

- **Focus on:**
 - **What has been calculated?**
 - **What's the main finding and why is it important?**
 - **Why 35°C?**

Socio-Economic Challenges to Mitigation	Socio-Economic Challenges to Adaptation		
	Low	Medium	High
High	<p>SSP5: Fossil-fuelled development</p> <ul style="list-style-type: none"> • low population • very high economic growth per capita • high human development • high technological progress • ample fossil fuel resources • very resource intensive lifestyles • high energy and food demand per capita • economic convergence and global cooperation 		<p>SSP3: Regional rivalry</p> <ul style="list-style-type: none"> • high population • low economic growth per capita • low human development • low technological progress • resource-intensive lifestyles • resource-constrained energy and food demand per capita • focus on regional food and energy security • regionalization and lack of global cooperation
Medium		<p>SSP2: Middle of the road</p> <ul style="list-style-type: none"> • medium population • medium and uneven economic growth • medium and uneven human development • medium and uneven technological progress • resource-intensive lifestyles • medium and uneven energy and food demand per capita • limited global cooperation and economic convergence 	
Low	<p>SSP1: Sustainable development</p> <ul style="list-style-type: none"> • low population • high economic growth per capita • high human development • high technological progress • environmentally oriented technological and behavioural change • resource-efficient lifestyles • low energy and food demand per capita • economic convergence and global cooperation 		<p>SSP4: Inequality</p> <ul style="list-style-type: none"> • Medium to high population • Unequal low to medium economic growth per capita • Unequal low to medium human development • unequal technological progress: high in globalized high-tech sectors, slow in domestic sectors • unequal lifestyles and energy /food consumption: resource intensity depending on income • Globally connected elite, disconnected domestic work forces

Sustainability – Taking the Green Road (Low challenges to mitigation and adaptation)

SSP1 *The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity.*

Middle of the Road (Medium challenges to mitigation and adaptation)

SSP2 *The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain.*

Regional Rivalry – A Rocky Road (High challenges to mitigation and adaptation)

SSP3 *A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. Policies shift over time to become increasingly oriented toward national and regional security issues. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Investments in education and technological development decline. Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. Population growth is low in industrialized and high in developing countries. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.*

Inequality – A Road Divided (Low challenges to mitigation, high challenges to adaptation)

SSP4 *Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Over time, a gap widens between an internationally-connected society that contributes to knowledge- and capital-intensive sectors of the global economy, and a fragmented collection of lower-income, poorly educated societies that work in a labor intensive, low-tech economy. Social cohesion degrades and conflict and unrest become increasingly common. Technology development is high in the high-tech economy and sectors. The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle and high income areas.*

Fossil-fueled Development – Taking the Highway (High challenges to mitigation, low challenges to adaptation)

SSP5 *This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary.*