

THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

<https://www.ipcc.ch>

THE IPCC: INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE [HTTPS://WWW.IPCC.CH](https://www.ipcc.ch)

- Working Group I: The Physical Science
- Working Group II: Impacts, Adaptation and Vulnerabilities
- Working Group III: Mitigation of climate change. Limit or prevent emissions and remove gases from atmosphere
- Synthesis Report

Current Assessment Report: IPCC AR6 2022 (Synthesis Report in 2023)

<https://www.ipcc.ch/assessment-report/ar6/>

Previous Assessment Report: IPCC AR5 2014

Global Warming of 1.5°C (October 2018)

The IPCC reports builds on possible future scenarios for the analysis:
Representative Concentration Pathways (RCPs) and
Shared Socio-economic Pathways (SSPs)

SCENARIOS: RCPs AND SSPs

- Representative Concentration Pathways (RCPs)
- Shared Socioeconomic Pathways (SSPs)
- Scenarios: SSP+RCP
- Summary

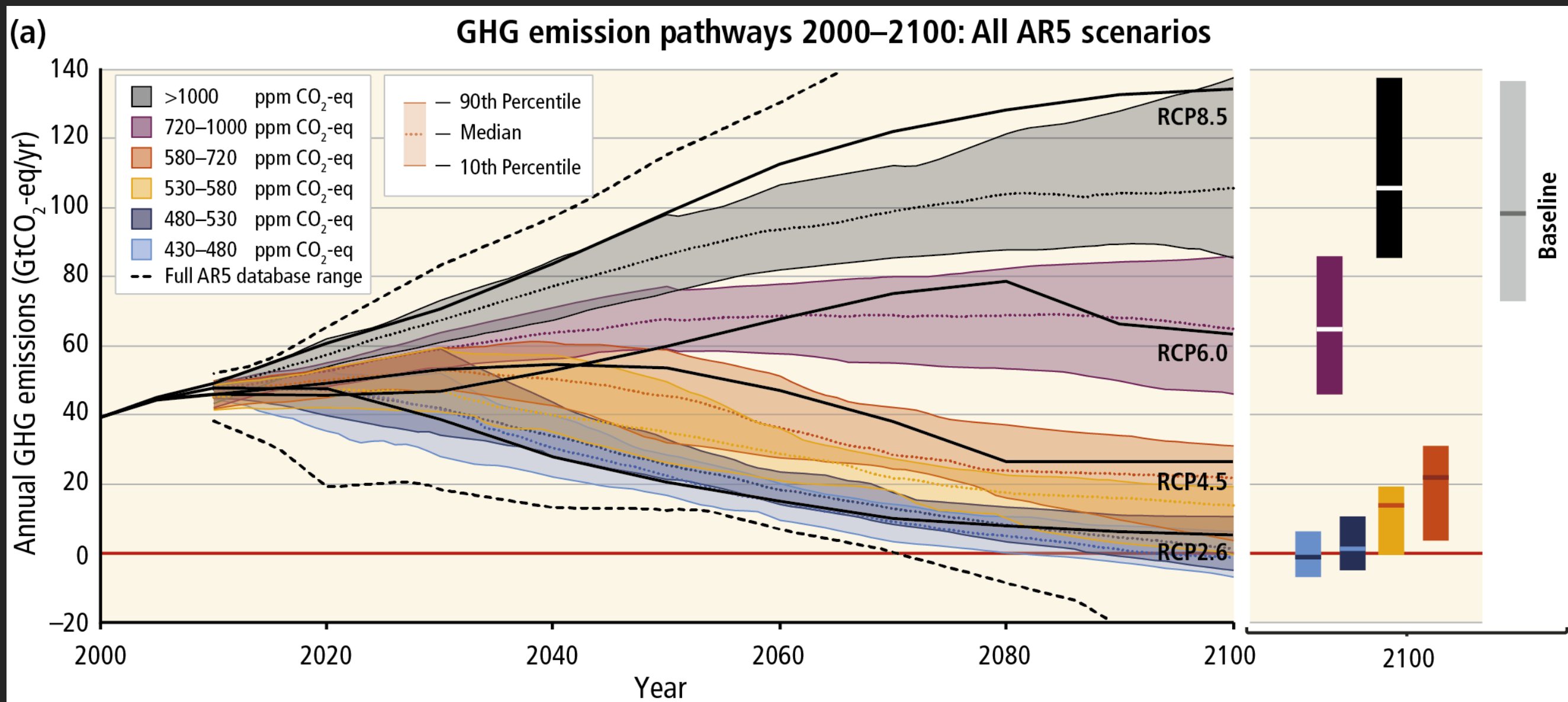
SCENARIOS : ALTERNATIVE FUTURES””

- A **scenario** is a plausible description of how the future might unfold, a conditional prediction on future emissions based on the initial state of the climate.
Scenarios can help us to understand the possible range of alternative futures and the uncertainty associated with them.
- The IPCC has fed from two complementary efforts
 - Representative Concentration Pathways: **RCPs** [IPCC AR5 - 2014]
 - Shared Socio-economic Pathways: **SSPs** [IPCC AR6 – 2021]

Scenario = SSP + RCP

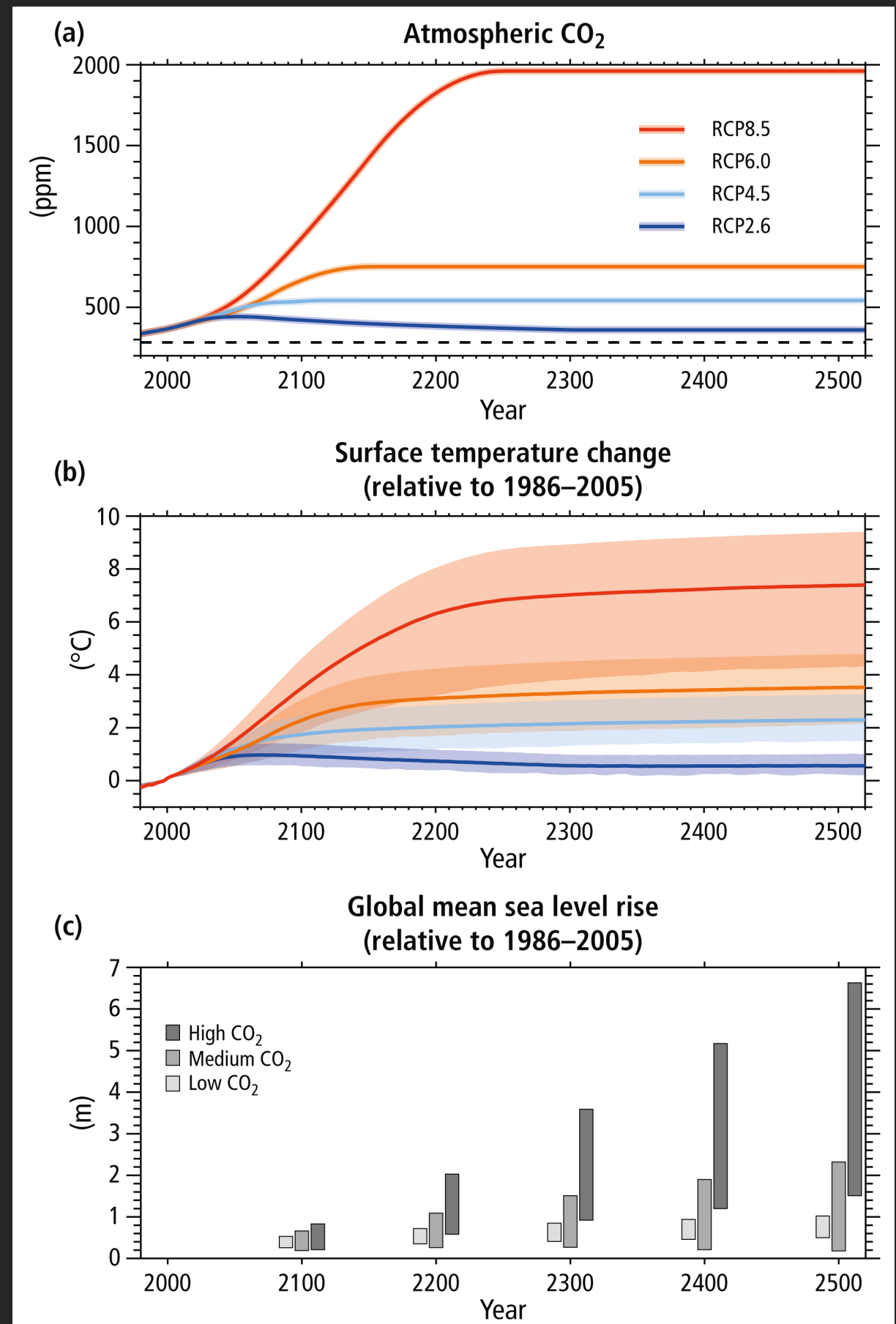
REPRESENTATIVE CONCENTRATION PATHWAYS (RCPs)

- The RCPs set plausible pathways for emissions
- They are identified by their forcing in 2100: 2.6, 4.5, 6.0, & 8.5 watts/squared meter.
- They do not include any socioeconomic “narratives” to go alongside them.



REPRESENTATIVE CONCENTRATION PATHWAYS (RCPs)

The RCPs derive long term predictions of atmospheric CO₂ concentrations, the amount of warming, and the sea level rise.



SHARED SOCIOECONOMIC PATHWAYS (SSPs)

- SSPs are “conditional predictions” that depend on socio-economic assumptions, the level of climate change mitigation and the air pollution controls.

SSPS NARRATIVES

SSP1

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

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.

SSP2

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

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.

SSP3

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

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.

SSP4

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

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.

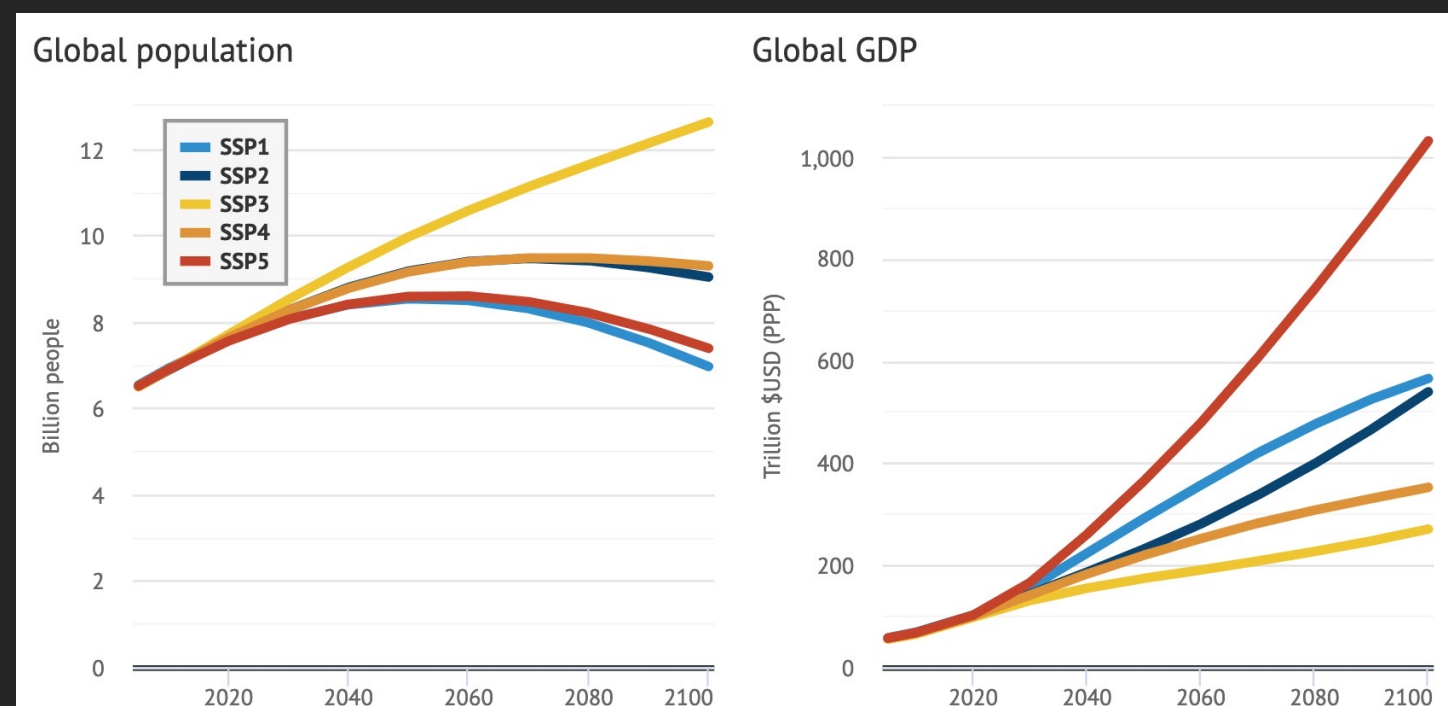
SSP5

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

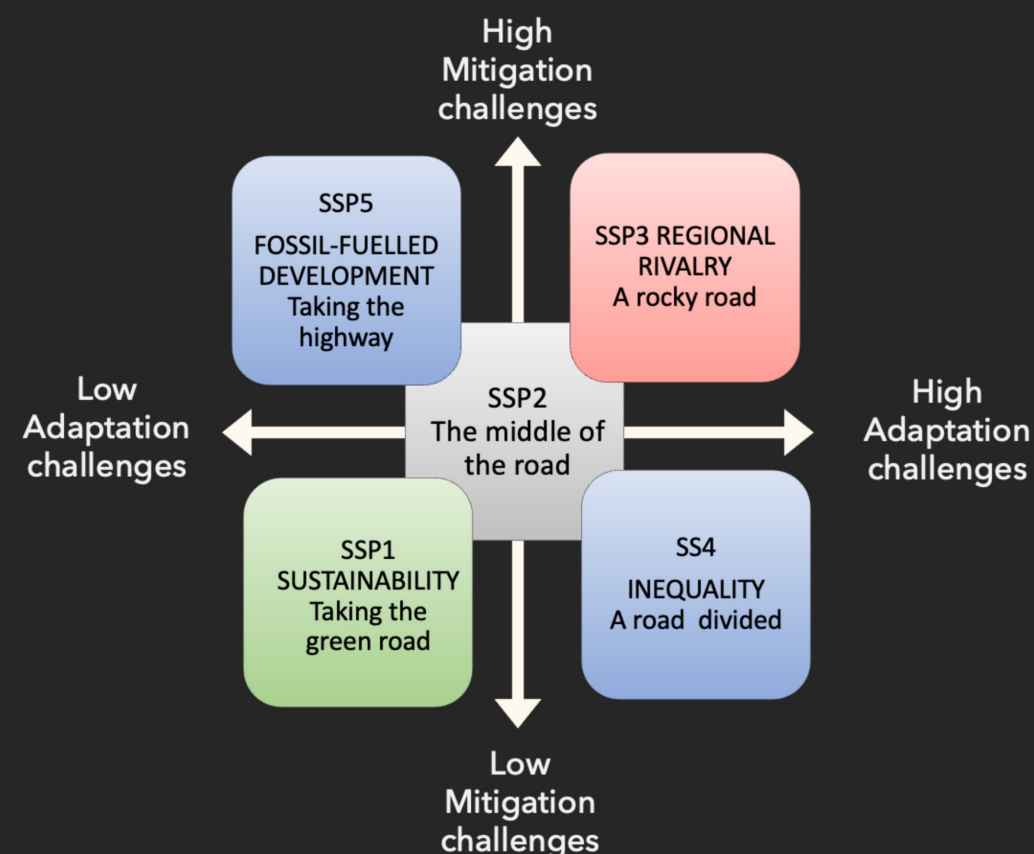
This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, 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.

SHARED SOCIOECONOMIC PATHWAYS (SSPs) : ASSUMPTIONS

- **SSP1 & SSP5**: relatively optimistic trends for human development, with “substantial investments in education and health, rapid economic growth, and well-functioning institutions”. While in SSP5 this will be driven by an energy-intensive, fossil fuel-based economy; in SSP1 there is an increasing shift toward sustainable practices.
- **SSP3** and **SSP4** are more pessimistic in their future economic and social development.
- **SSP2** represents a “middle of the road” scenario following historical patterns of development.



MITIGATION AND ADAPTATION ASSUMPTIONS

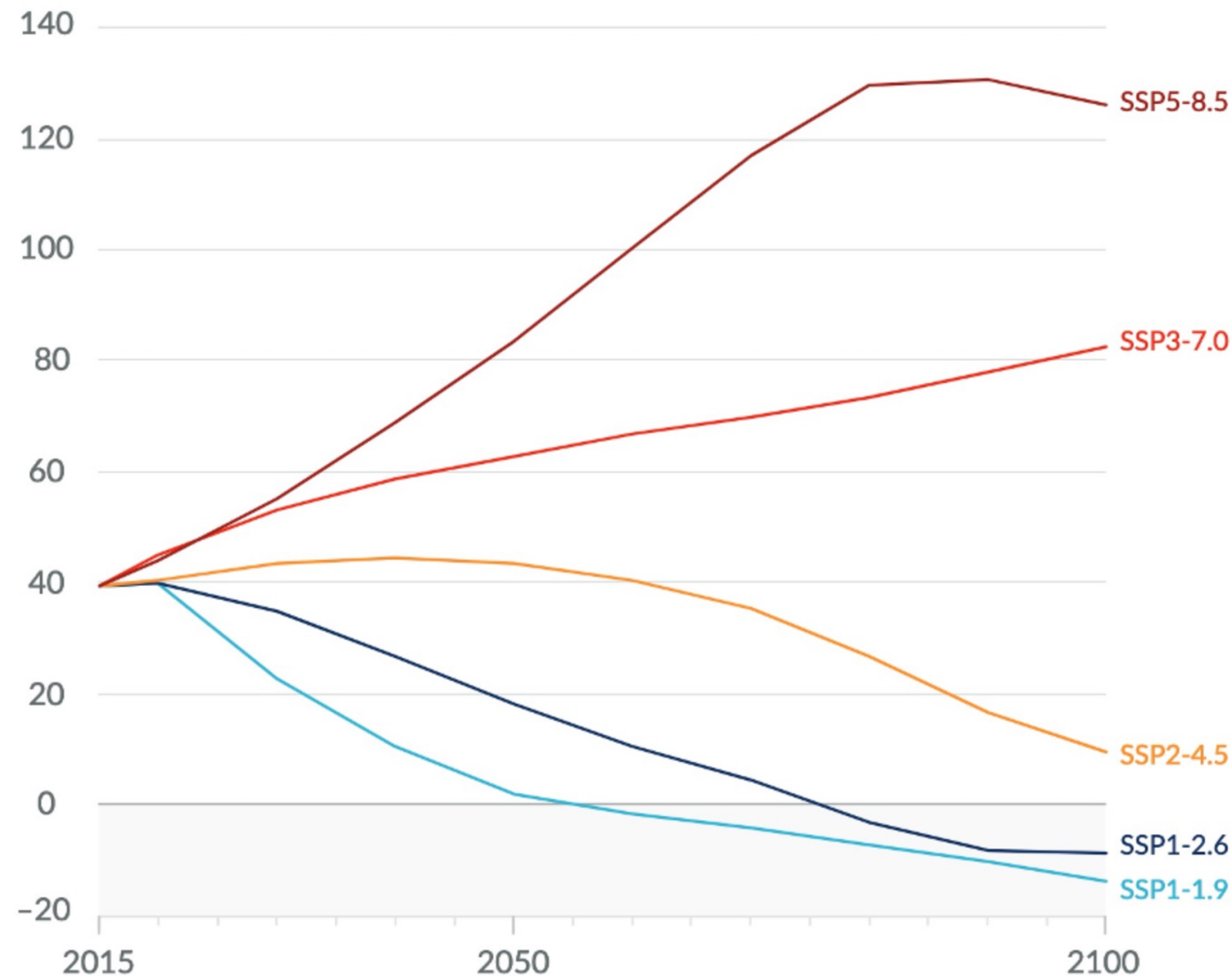


SCENARIOS: SSP+RCP

SSPx-y: Shared Socio-economic Pathway under scenario “x” and radiative forcing “y” in 2100

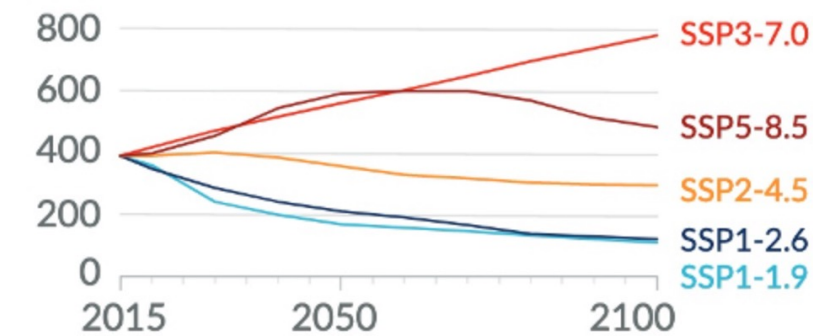
(a) Future annual emissions of CO₂ (left) and of a subset of key non-CO₂ drivers (right), across five illustrative scenarios

Carbon dioxide (GtCO₂/yr)

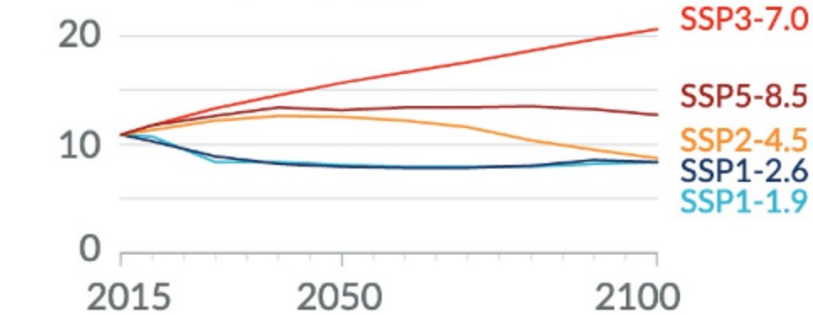


Selected contributors to non-CO₂ GHGs

Methane (MtCH₄/yr)

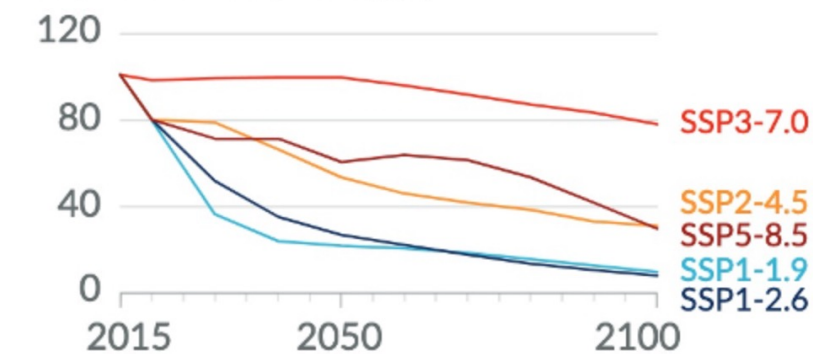


Nitrous oxide (MtN₂O/yr)



One air pollutant and contributor to aerosols

Sulphur dioxide (MtSO₂/yr)



- Very high emissions **SSP5-8.5** (x2 emissions by 2050); ~4.4°C by 2100
- High emissions **SSP3-7.0** (x2 emissions by 2100); ~3.6°C by 2100
- Intermediate **SSP2-4.5** (~ until 2050 and then decline); ~2.7°C by 2100
- Low emissions **SSP1-2.6** (net zero emissions by 2075); ~1.8°C by 2100
- Very low **SSP1-1.9** (net zero emissions by 2050); ~1.4°C by 2100

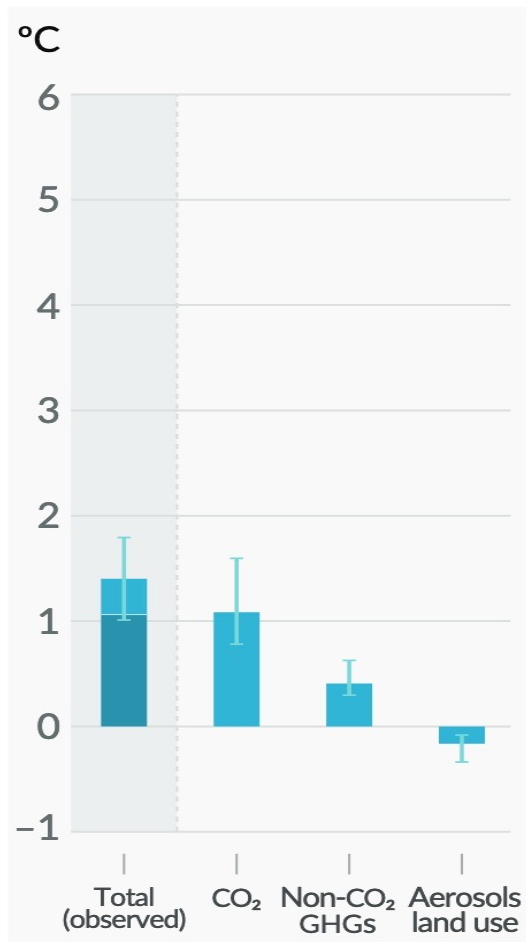
SCENARIOS: SSP+RCP

SSPx-y: Shared Socio-economic Pathway under scenario “x” and radiative forcing “y” in 2100

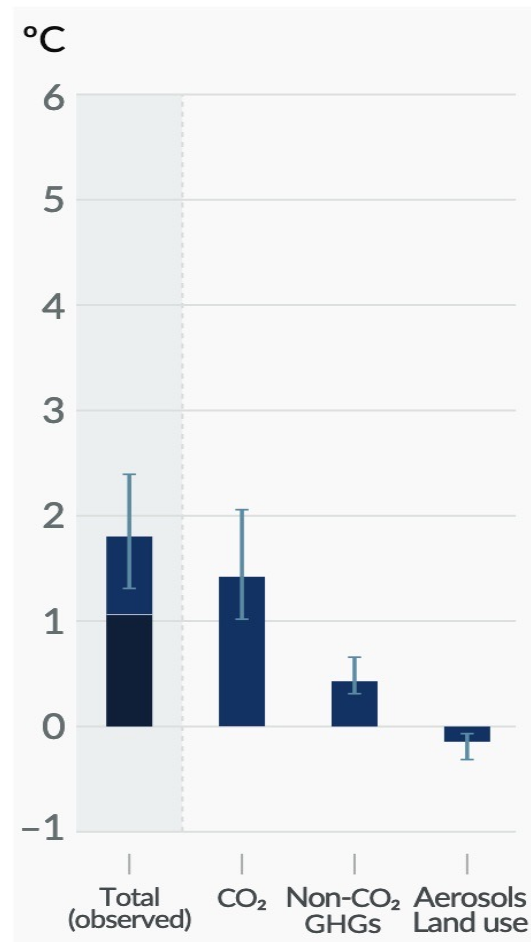
(b) Contribution to global surface temperature increase from different emissions, with a dominant role of CO₂ emissions

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

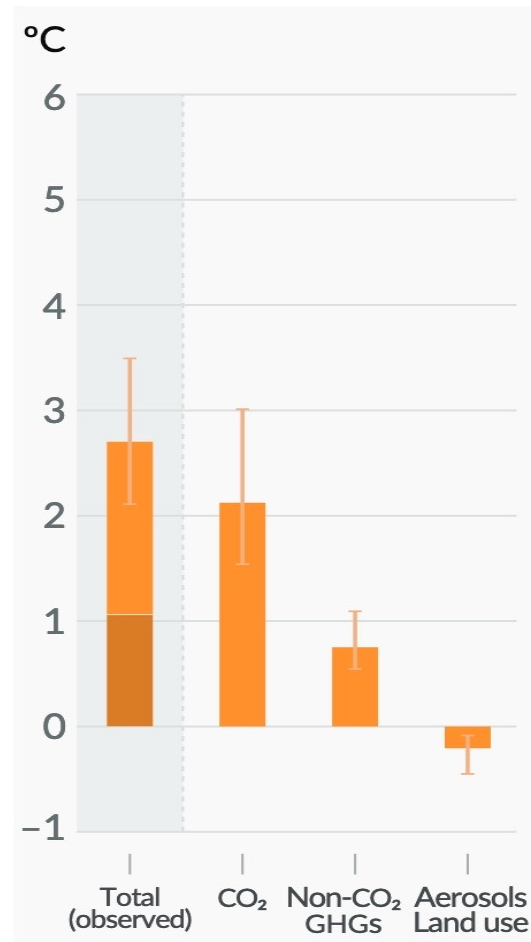
SSP1-1.9



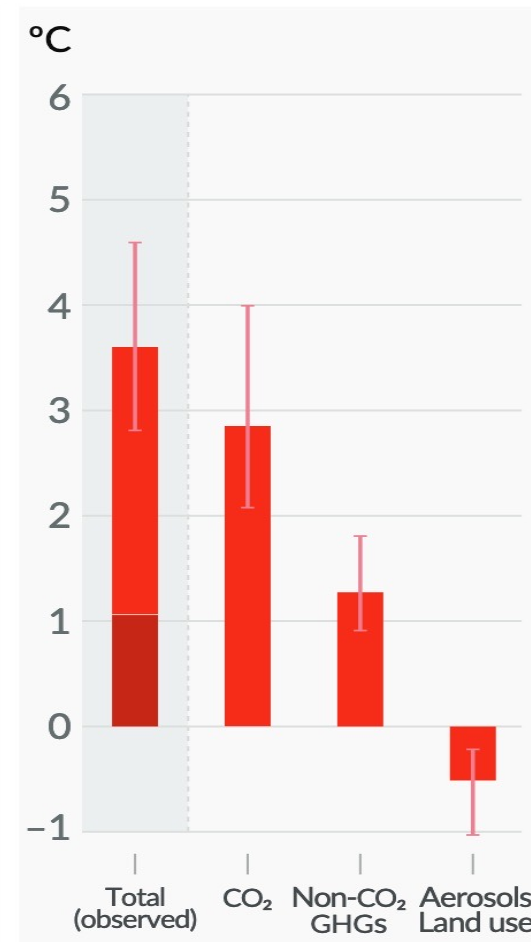
SSP1-2.6



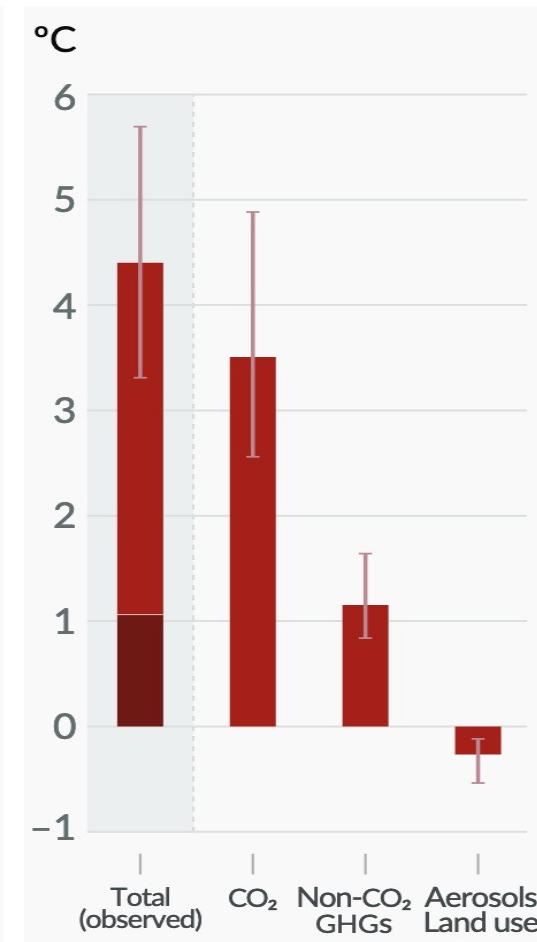
SSP2-4.5



SSP3-7.0



SSP5-8.5



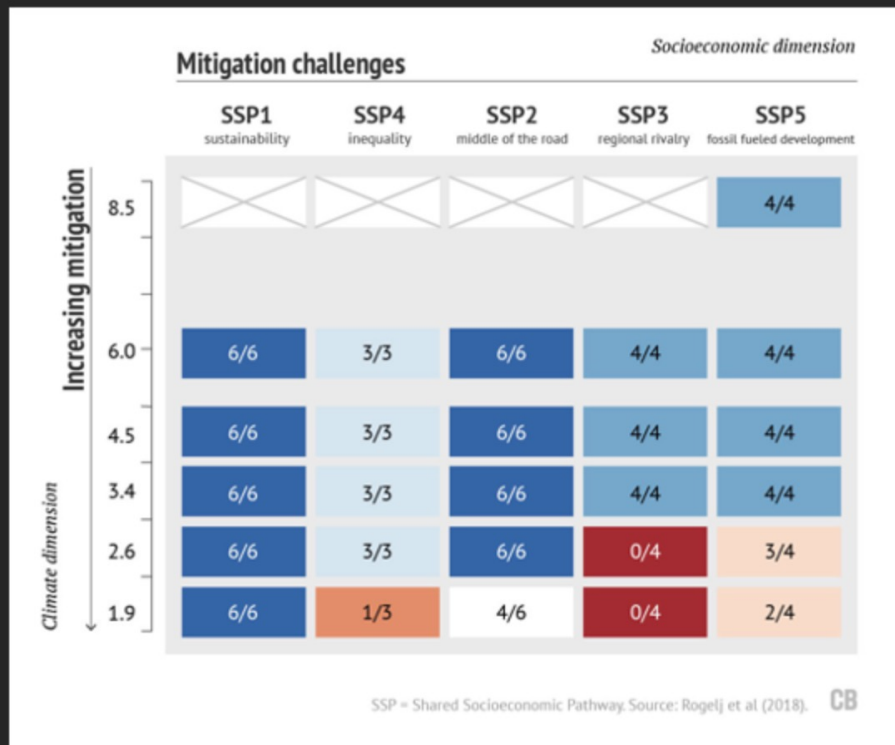
Total warming (observed warming to date in darker shade), warming from CO₂, warming from non-CO₂ GHGs and cooling from changes in aerosols and land use

- Very high emissions **SSP5-8.5** (x2 emissions by 2050); ~4.4°C by 2100
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SCENARIOS: SSP+RCP (ADDITIONAL INFO.)

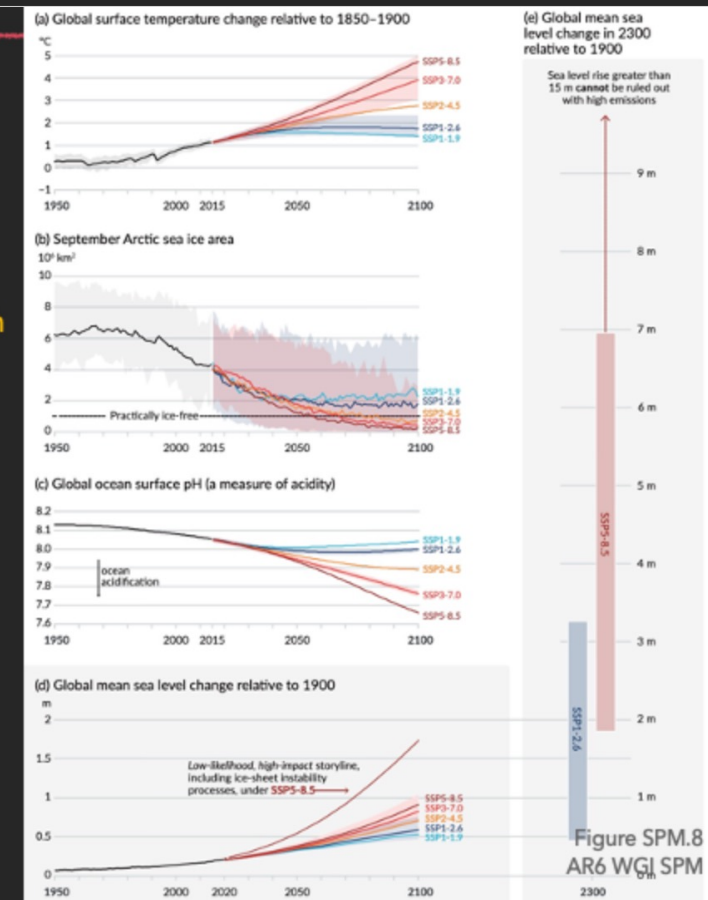
SSP+RCP: FEASIBLE COMBINATIONS

- Combination of SSP and RCP model runs in the SSP Database
- RCPs listed in order of increasing mitigation
- SSPs in the (rough) order of increasing mitigation difficulty.
- Ratios in cells indicate the number of models that succeeded in making the scenario "work" out of the total number of models available for the SSP.

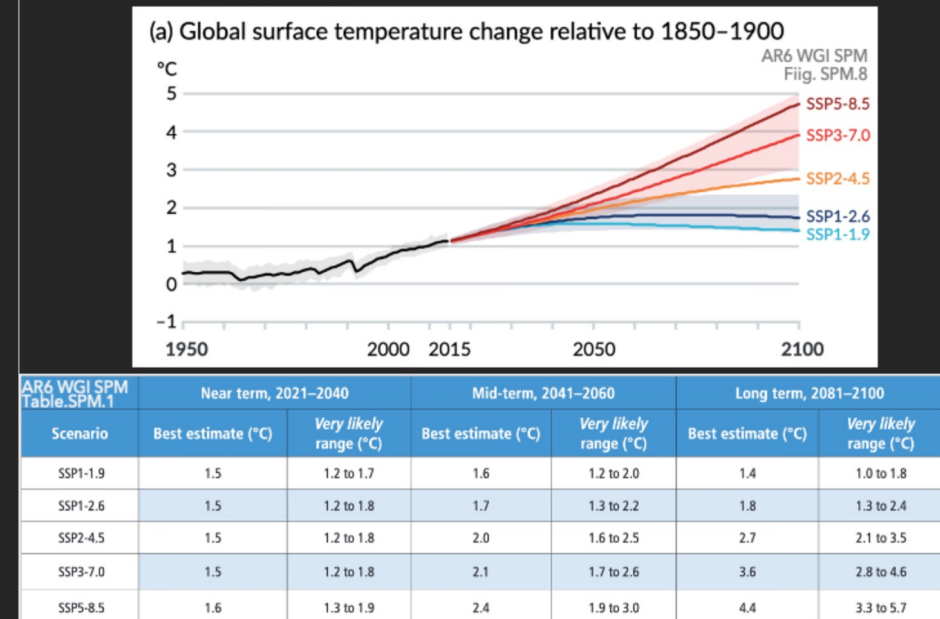


SCENARIOS: IMPACTS

- Global surface temperature will continue to increase until at least mid-century under all emissions scenarios considered.
- Many changes become larger with the increasing warming
 - frequency and intensity of extremes: hot temperatures, marine heatwaves, heavy precipitation, droughts;
 - proportion of intense tropical cyclones;
 - reductions in Arctic sea ice, snow cover and permafrost.
- Some changes from past and future emissions are irreversible, but there are still feasible scenarios with considerable low impacts.



SCENARIOS: TEMPERATURE



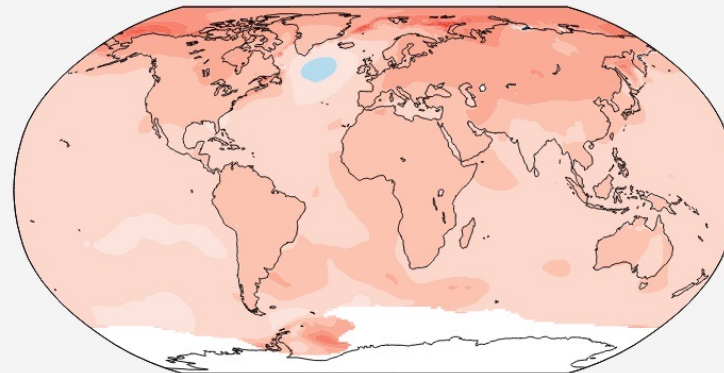
WORLD VARIABILITY

- Different effects on different regions of the planet
- Warming will be more pronounced towards the poles, in winter, at night, and over land.

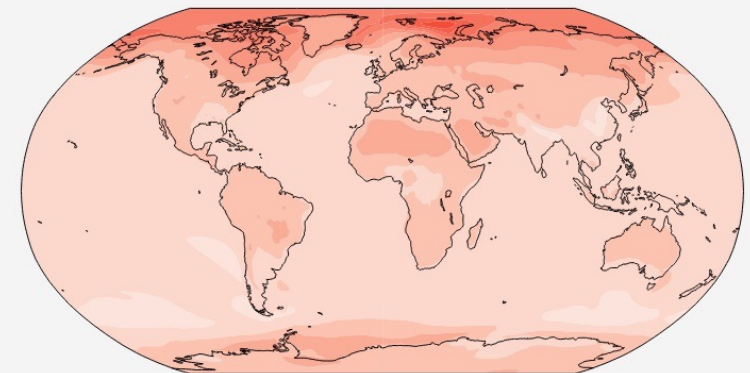
(a) Annual mean temperature change (°C) at 1°C global warming

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



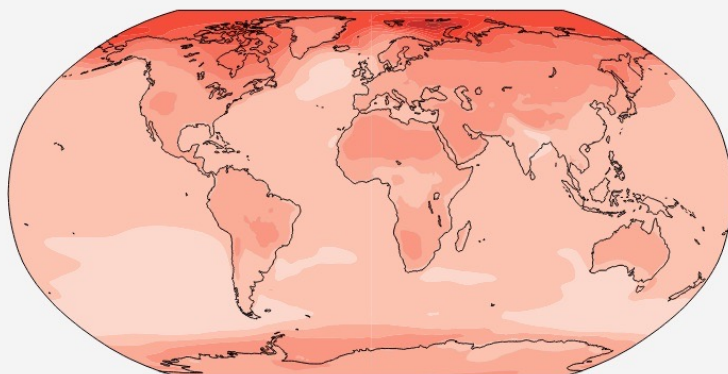
Simulated change at 1°C global warming



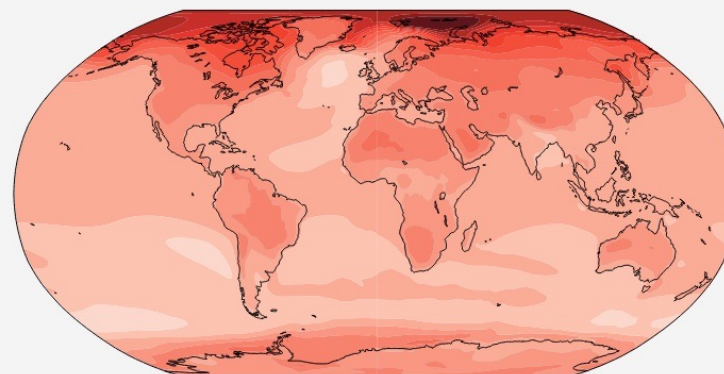
(b) Annual mean temperature change (°C) relative to 1850–1900

Across warming levels, land areas warm more than ocean areas, 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

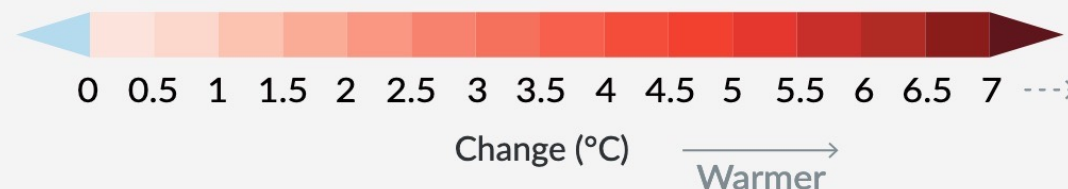
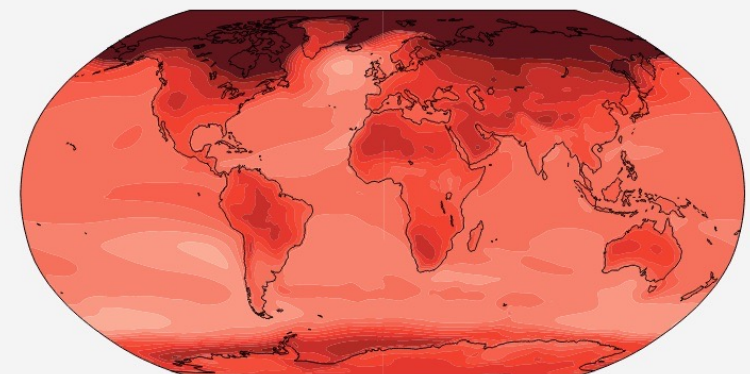


Figure SPM.5
AR6 WGI SPM

SUMMARY

- Scenarios are plausible descriptions of how the future might unfold, a conditional prediction on future emissions based on the initial state of the climate.
- RCPs are plausible paths of emissions without a socio-economic background. They are characterized by their radiative forcing in 2100
- SSPs describe socio-economic scenarios, and levels of climate change mitigation and air pollution controls of determine emission paths.
- Scenarios use Integrated Assessment Models [IAMs]: economic + climate models
- The reference scenarios are:
 - SSP1-1.9 SSP1-2.6
 - SSP2-4.5
 - SSP3-7.0
 - SSP5-8.5
- Only SSP1-1.9 and SSP1-2.6 give a chance to $\Delta T \leq 2^\circ\text{C}$.

REFERENCES

- IPCC, AR6 Climate Change 2021: The Physical Science Basis. Summary for policymakers. Sixth Assessment Report (AR6) WG1 <https://www.ipcc.ch/report/ar6/wg1/>
- Hausfather, Zeke (2018) “Explainer: How ‘Shared Socioeconomic Pathways’ explore future climate change” Online resource. <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change>
- <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change>