Global warming - physicist's perspective - 05

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WCRP

World Climate Research Programme

☆ WORLD METEOROLOGICAL ORGANIZATION | United Nations Educational, Scientific and Cultural Organization | Intergovernmental Oceanographic Commission | International Science Council

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🏠 About WCRP ⌄   Core Projects   Unifying Themes ⌄   Grand Challenges ⌄   Initiatives & Activities ⌄   Events ⌄   News ⌄   Resources ⌄

WCRP Coupled Model Intercomparison Project (CMIP)

A Short Introduction to Climate Models - CMIP & CMIP6

This short movie gives insight into the world of climate modelling, particularly WCRP's initiative CMIP. It stresses the importance of sharing, comparing and analyzing the outcomes of global climate models to deliver high quality climate information, serving as the basis for climate assessments and negotiations.

The objective of the Coupled Model Intercomparison Project (CMIP) is to better understand past, present and future climate changes arising from natural, unforced variability or in response to changes in radiative forcing in a multi-model context. This understanding includes assessments of model performance during the historical period and quantifications of the causes of the spread in future projections. Idealized experiments are also used to increase understanding of the model responses.

WGCM

Overview
Members
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CMIP
A Short Introduction (Video)
CMIP Panel
Call for proposals to host a CMIP-IPO
WGCM Infrastructure Panel (WIP)
CMIP3
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CMIP6
Catalogue of MIPs
CMIP6-Endorsed MIPs
Other active MIPs
Former MIPs
Sessions

◀◀ Modelling Overview

Coupled Model Intercomparison Project (CMIP)
- Understanding past, present and future climate -

➤ CMIP is a project of the World Climate Research Programme (**WCRP**)'s Working Group of Coupled Modelling (**WGCM**).

➤ Since 1995, **CMIP** has coordinated climate model experiments involving multiple international modeling teams worldwide.

➤ CMIP has led to a better understanding of past, present and future climate change and variability in a **multi-model framework.**

➤ CMIP defines **common experiment protocols, forcings and output.**

➤ CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now completed, and the planning of the sixth phase, i.e. CMIP6, well underway.

➤ CMIP's central goal is to advance scientific understanding of the Earth system.

➤ CMIP model simulations have also been regularly assessed as part of the IPCC Climate Assessments Reports and various national assessments.

CMIP

The World Climate Research Programme's
Coupled Model Intercomparison Project

CMIP6 Design: Scientific Focus

- The **scientific backdrop** for CMIP6 is the **WCRP Grand Science Challenges**:

  1. Clouds, Circulation and Climate Sensitivity

  2. Changes in Cryosphere

  3. Climate Extremes

  4. Regional Sea-level Rise

  5. Water Availability

  6. Near-Term Climate Prediction

  7. Biogeochemical Cycles and Climate Change

- The specific experimental design is focused on **three broad scientific questions**:

  1. How does the Earth System respond to forcing?

  2. What are the origins and consequences of systematic model biases?

  3. How can we assess future climate changes given climate variability, predictability and uncertainties in scenarios?

Eyring et al., GMD, 2016

CMIP

The World Climate Research Programme's
Coupled Model Intercomparison Project

CMIP Continuity

A common suite of experiments for each phase of CMIP provides an opportunity to construct a multi-model ensemble using model output from various phases of CMIP

Eyring et al., CMIP6 Experimental Design and Organization, GMD, 2016
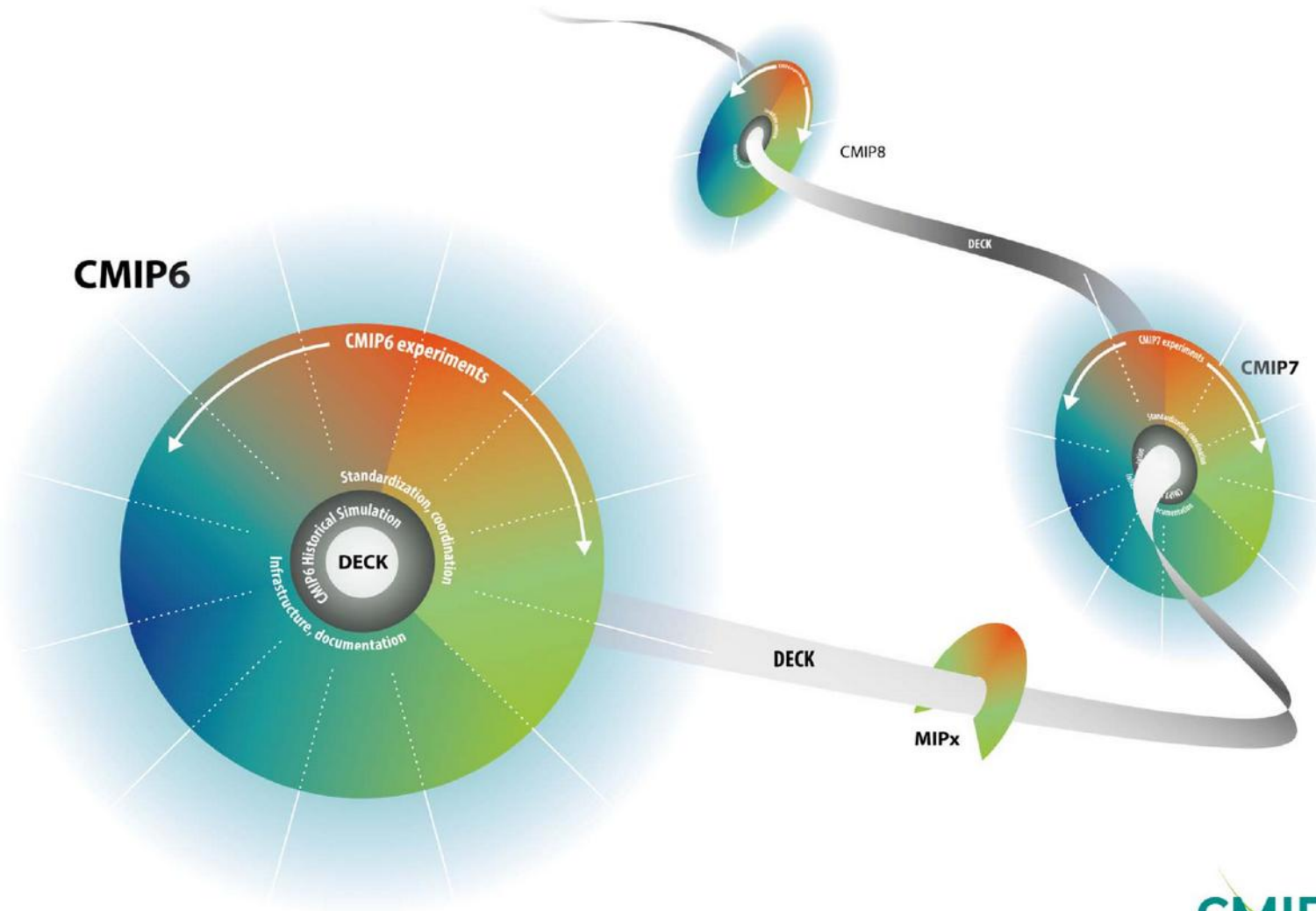
23 CMIP6-Endorsed MIPs

Eyring et al., GMD, 2016
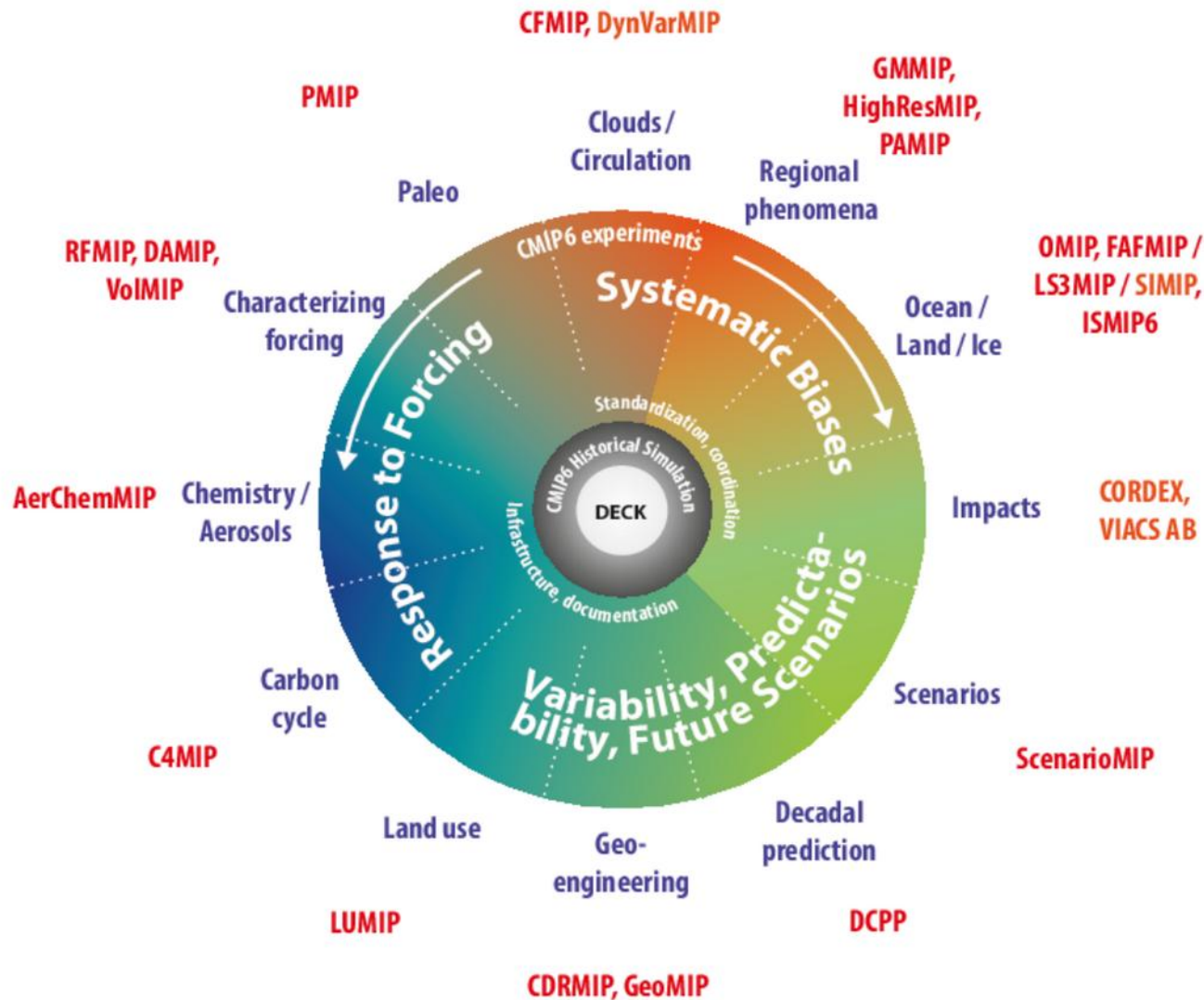
CMIP6: Participating Model Groups

	Institution	Country		Institution	Country		Institution	Country
1	AWI	Germany	12	DOE	USA	23	MRI	Japan
2	BCC	China	13	EC-Earth-Cons	Europe	24	NASA-GISS	USA
3	BNU	China	14	FGOALS	China	25	NCAR	USA
4	CAMS	China	15	FIO-RONM	China	26	NCC	Norway
5	CasESM	China	16	INM	Russia	27	NERC	UK
6	CCCma	Canada	17	INPE	Brazil	28	NIMS-KMA	Republic of Korea
7	CCCR-IITM	India	18	IPSL	France	29	NOAA-GFDL	USA
8	CMCC	Italy	19	MESSY-Cons	Germany	30	NUIST	China
9	CNRM	France	20	MIROC	Japan	31	TaiESM	Taiwan, China
10	CSIR-CSIRO	South Africa	21	MOHC	UK	32	THU	China
11	CSIRO-BOM	Australia	22	MPI-M	Germany	33	Seoul Nat.Uni	Republic of Korea

New in CMIP:

2 new model groups from Germany (AWI, MESSY-Consortium)
4 new model groups from China (CAMS, CasESM, NUIST, THU)
1 new model group from Brazil (INPE)
1 new model group from India (CCCR-IITM)
1 new model group from Taiwan, China (TaiESM)
1 new model group from USA (DOE)
2 new model group from Republic of Korea (NIMS-KMA, SAM0-UNICON)
1 new model group from South Africa / Australia (CSIR-CSIRO)

==

⇒ **13 new model groups so far**

More models (>70)
New models
More complex models
Higher resolution models

* Other models can join providing DECK and historical simulations are submitted

CMIP
The World Climate Research Programme's
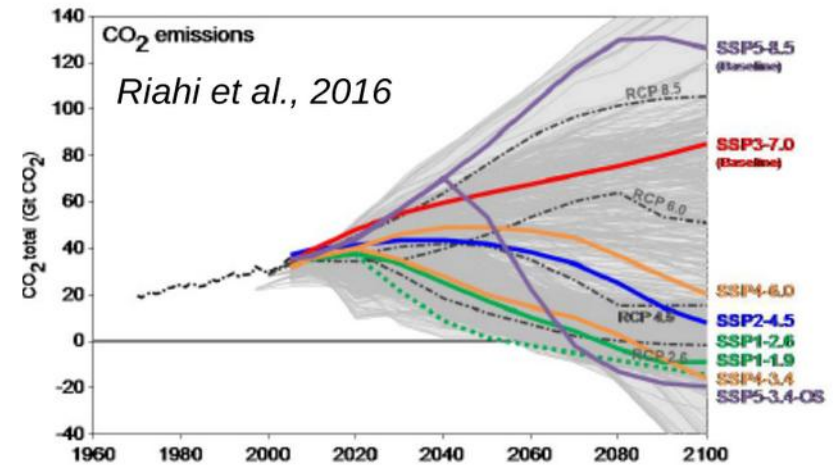Coupled Model Intercomparison Project

Key Messages: Model Projections / Predictions (2)

SSPs: set of baselines, with future developments in absence of new climate policies beyond those in place today
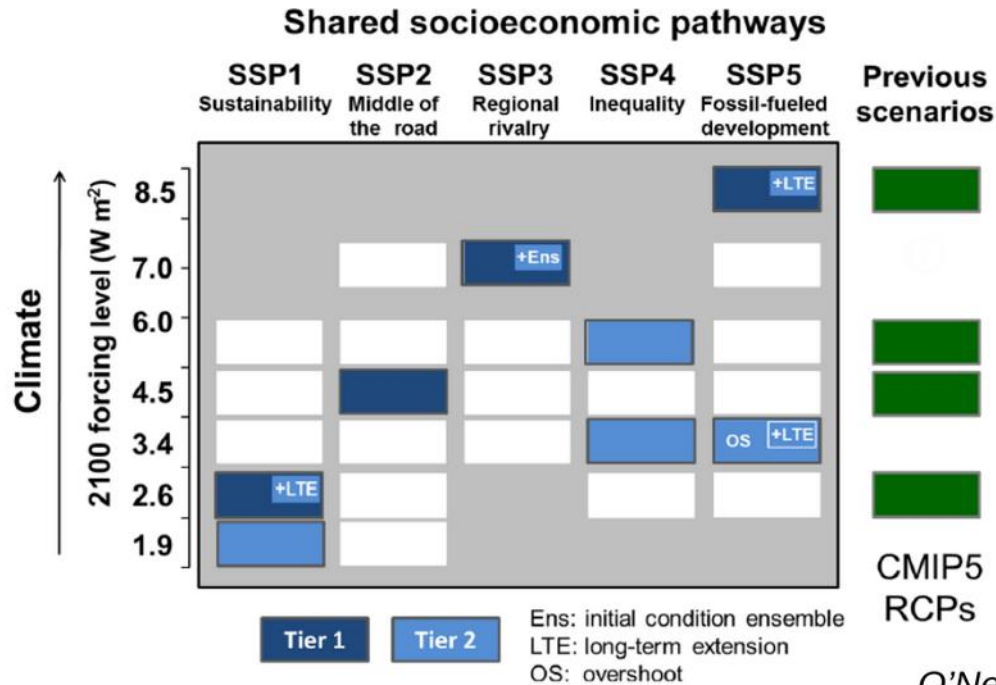
Future in CMIP6: 2015-2100 plus Extentions to 2300

Riahi et al., 2016

O'Neill et al., ScenarioMIP for CMIP6, GMD, 2016

ScenarioMIP: New scenarios span a similar range as the RCPs, but fill critical gaps, including
– Role of specific forcings such as land use and short-lived species (air quality)
– The effect of a peak and decline in forcing,
– The consequences of scenarios that limit warming to below 2 °C,

DCPP: Improvements in models, reanalysis, methods of initialization and ensemble generation, and data analysis will provide extended comprehensive decadal predictions

Program for Climate Model Diagnosis & Intercomparison

CMIP6 - Coupled Model Intercomparison Project Phase 6

Overview:

The WCRP Working Group on Coupled Modelling (WGCM) oversees the Coupled Model Intercomparison Project, which is now in its 6th phase. Background information about CMIP and its phases can be found on WGCM website as well as on the PCMDI-hosted pages. An introductory overview of CMIP6 is also provided by the WGCM.

Practical information for those interested in participating in CMIP6 is provided in three guides, tailored to different groups:

1. Modelers carrying out CMIP6 simulations,
2. Data managers responsible for data node operations, and
3. Data users analyzing and making use of CMIP6 model output

Model output Access:

- First see the Data Users Guide
- **Summary table** of currently available data
- The complete archive of CMIP6 output is accessible from any one of the following portals:
  - USA, PCMDI/LLNL (California) - https://esgf-node.llnl.gov/projects/cmip6/
  - France, IPSL - https://esgf-node.ipsl.upmc.fr/projects/cmip6-ipsl/
  - Germany, DKRZ - https://esgf-data.dkrz.de/projects/cmip6-dkrz/
  - UK, CEDA - https://esgf-index1.ceda.ac.uk/projects/cmip6-ceda/

CMIP6 Endorsed MIPs:

- WCRP Endorsed (Model Intercomparison Project) MIPs overview page
- CMIP6 Ocean Model Intercomparison Project (OMIP) overview page

## Additional information for CMIP6:

- CMIP6 license and terms of use

CMIP6 Modeling Groups (click on flags to reveal identity)

Document version: 13 February 2019

A number of new scenarios are also being used for CMIP6 in order to give a wider selection of futures for scientists to simulate. These scenarios are included in the chart below, which shows the annual CO2 emissions assumed under each scenario out to 2100. The new scenarios include SSP1-1.9 (purple line), SSP4-3.4 (blue solid), SSP5-3.4OS (blue dashed) and SSP3-7.0 (orange).

CO2 emissions in CMIP6 scenarios
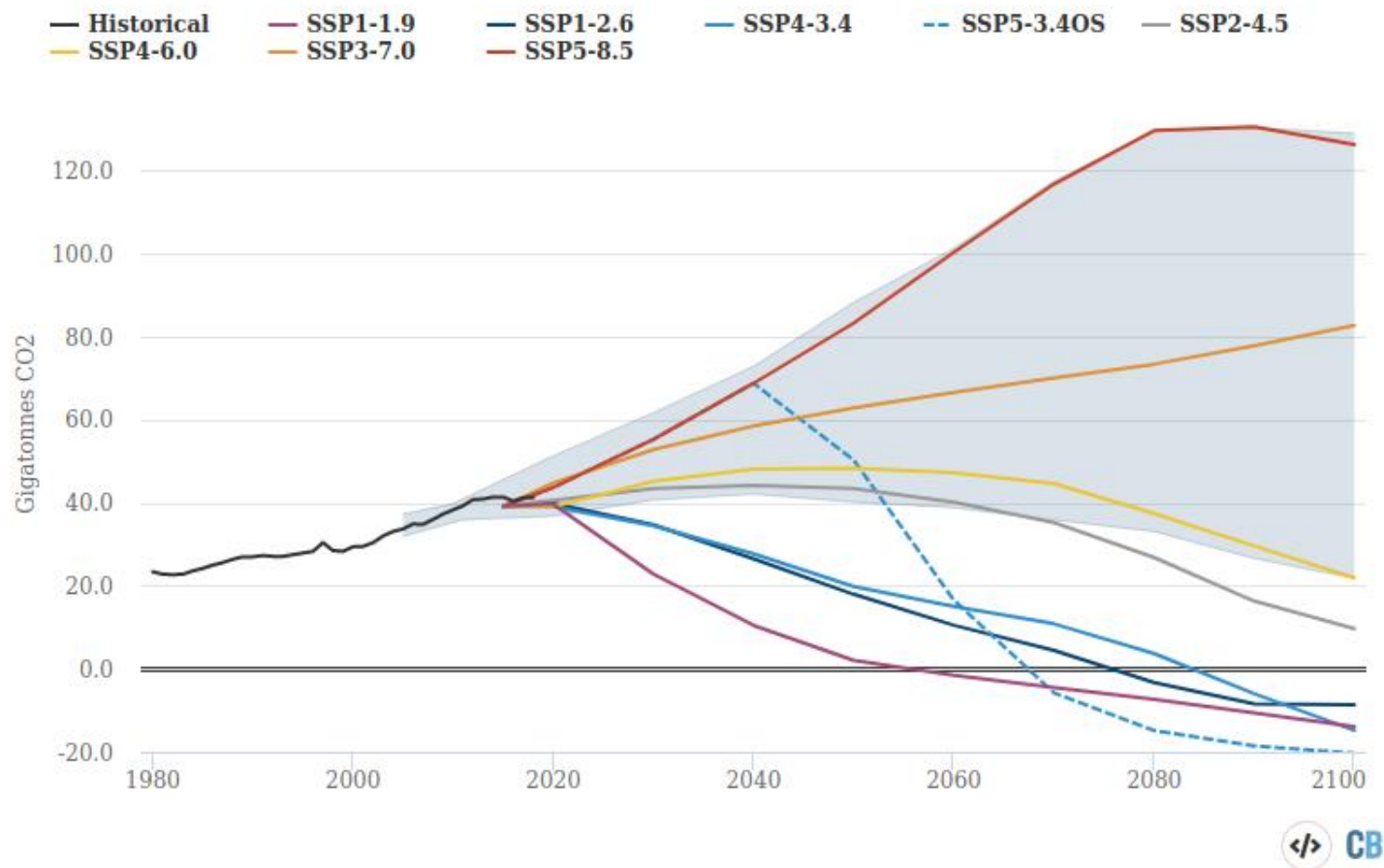
Future CO2 emissions scenarios featured in CMIP6, as well as historical CO2 emissions (in black). The shaded area represents the range of no-policy baseline scenarios. Data from the SSP database; chart by Carbon Brief using Highcharts.

CMIP6 models show a wider range of climate sensitivity
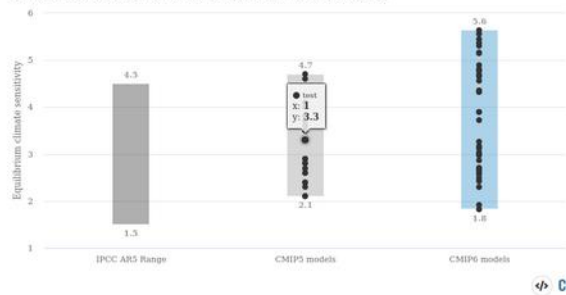
Likely ECS range (e.g. with an estimated 66% chance of occuring) from the IPCC AR5 (black bar), CMIP5 model ECS values (grey), and
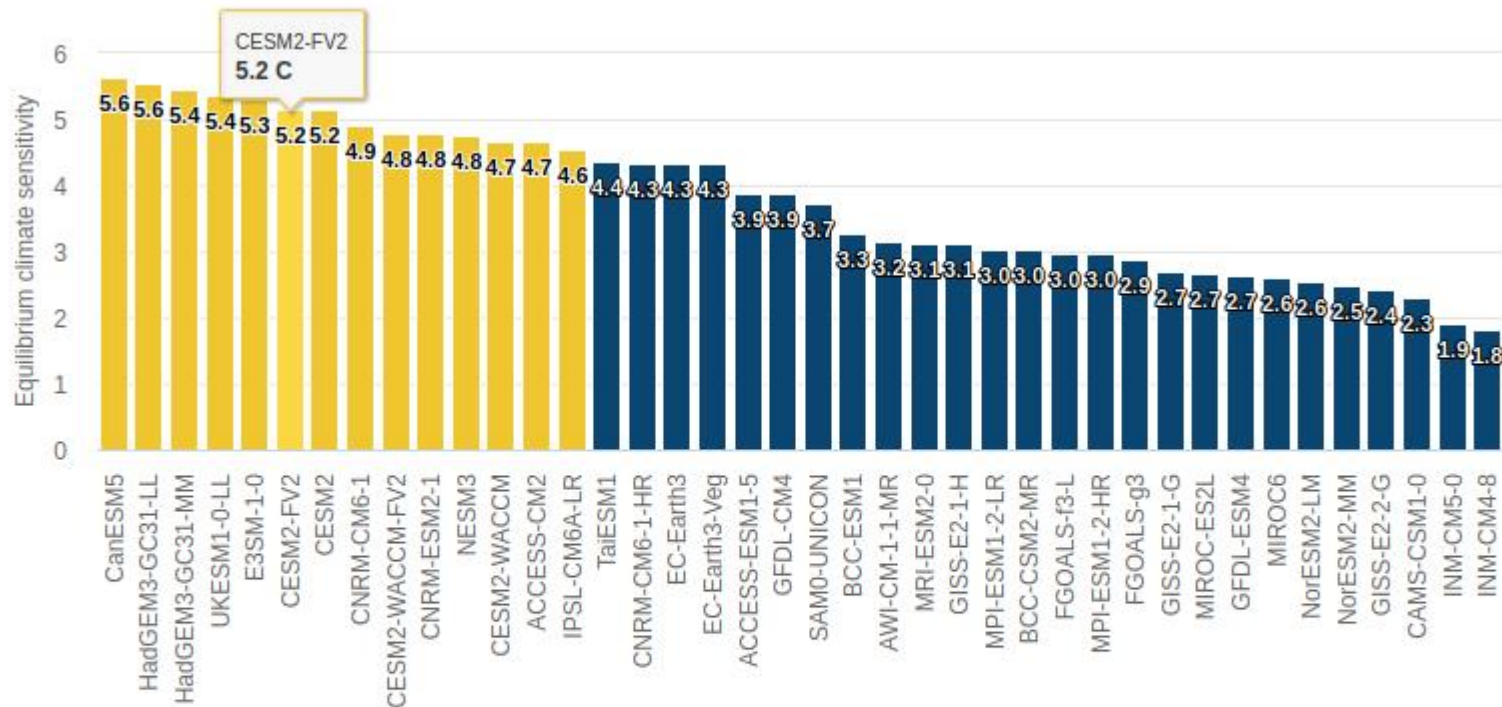

ECS values from the 40 CMIP6 models available as of May 2020 where necessary experiments to calculate ECS (using the Gregory method) are currently available. Models with an ECS above the IPCC AR5 likely range are shown in yellow. Note that not all models shown are independent, as some modeling groups – such as CESM2 – have multiple versions. Chart by Carbon Brief using Highcharts.

Global surface temperatures 1880-2019: CMIP5, CMIP6 and observations

For currently available CMIP6 runs. Observational data from NASA GISTEMP.
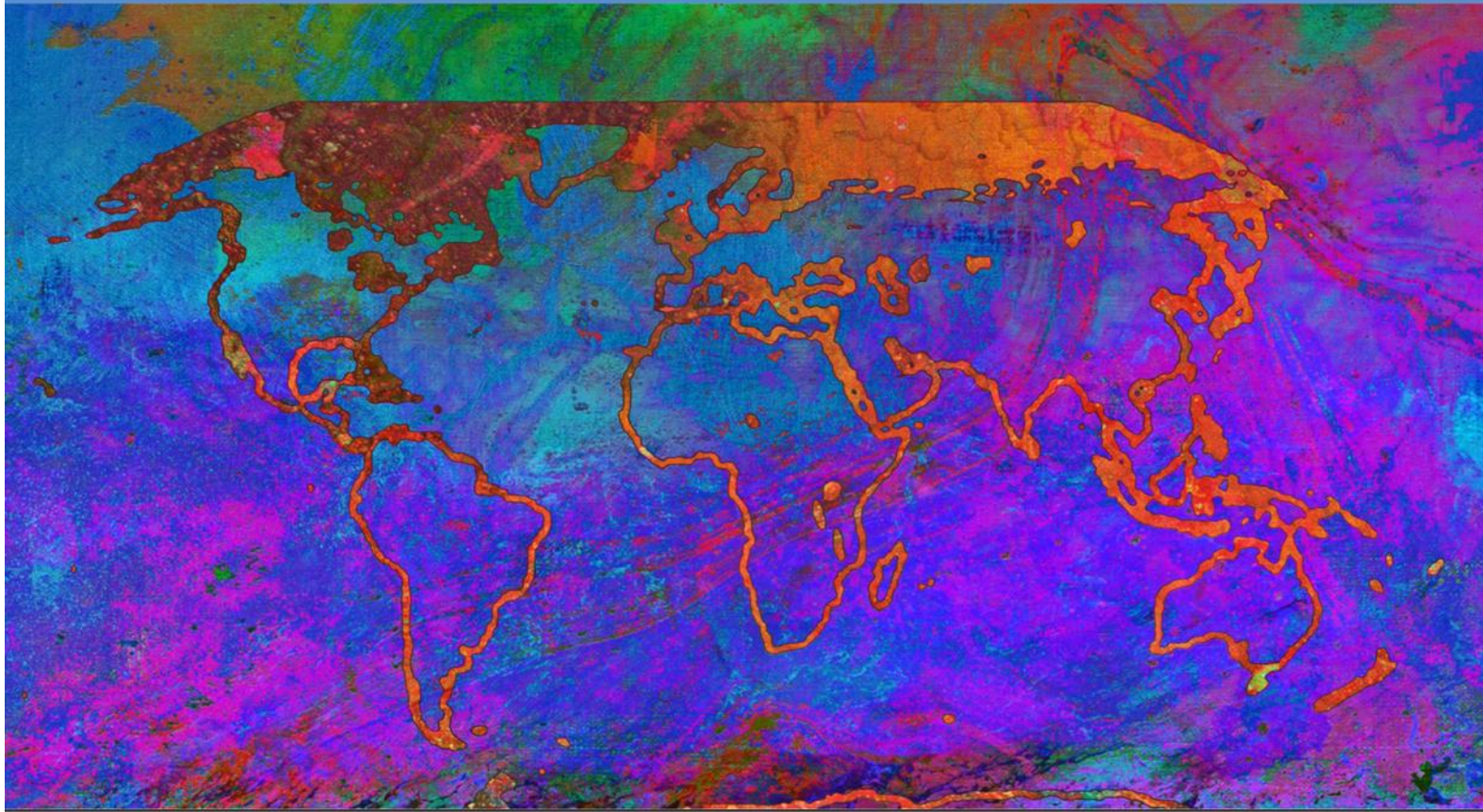

— **Observed**　— **CMIP6**　— CMIP5
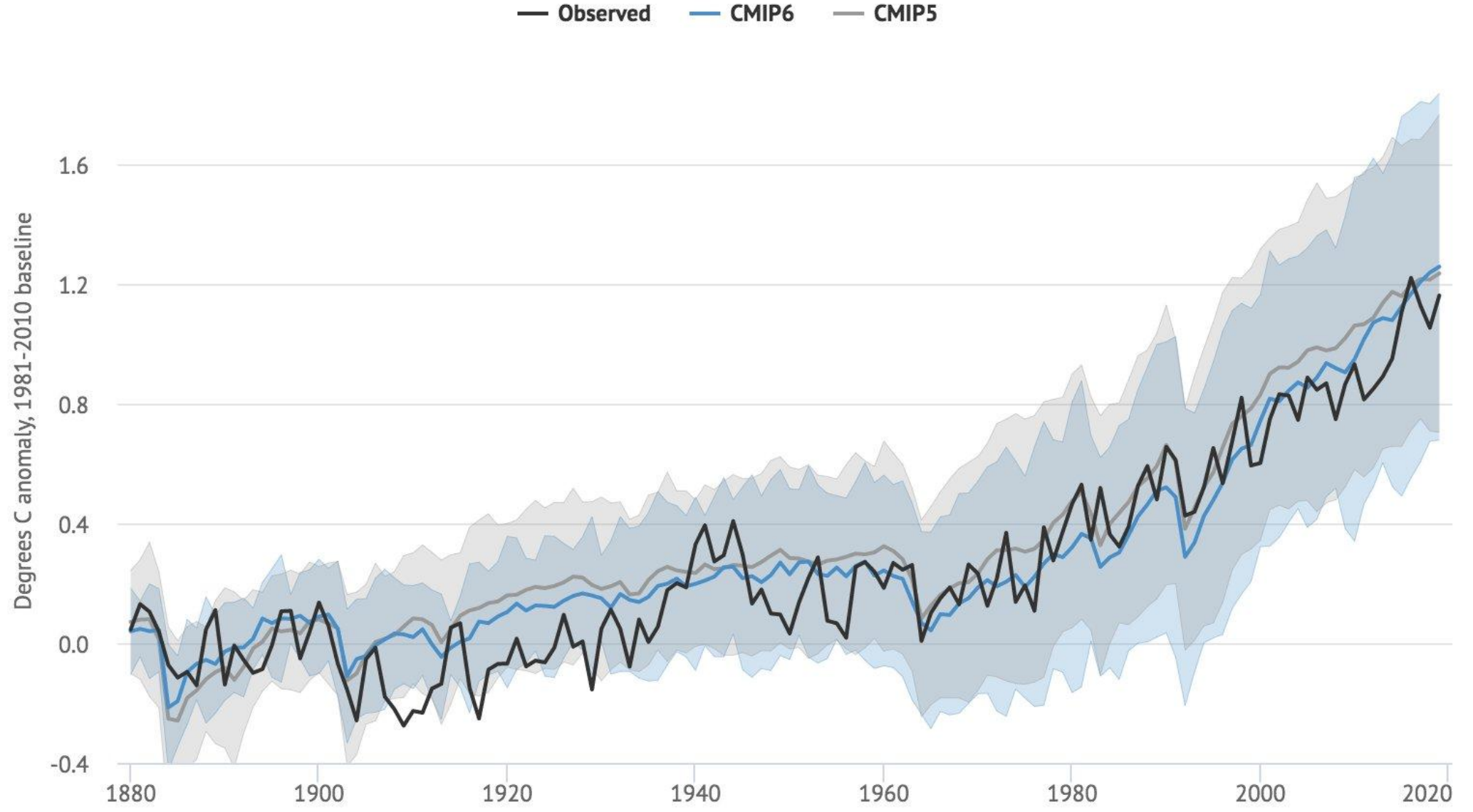
ipcc
INTERGOVERNMENTAL PANEL ON climate change

Climate Change 2021
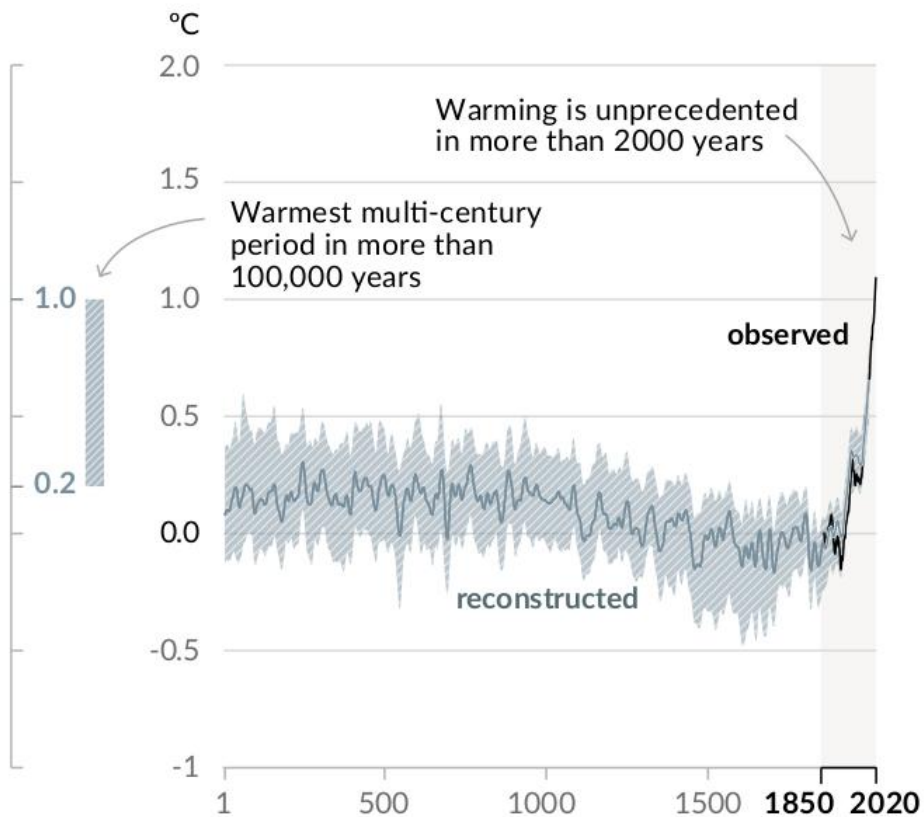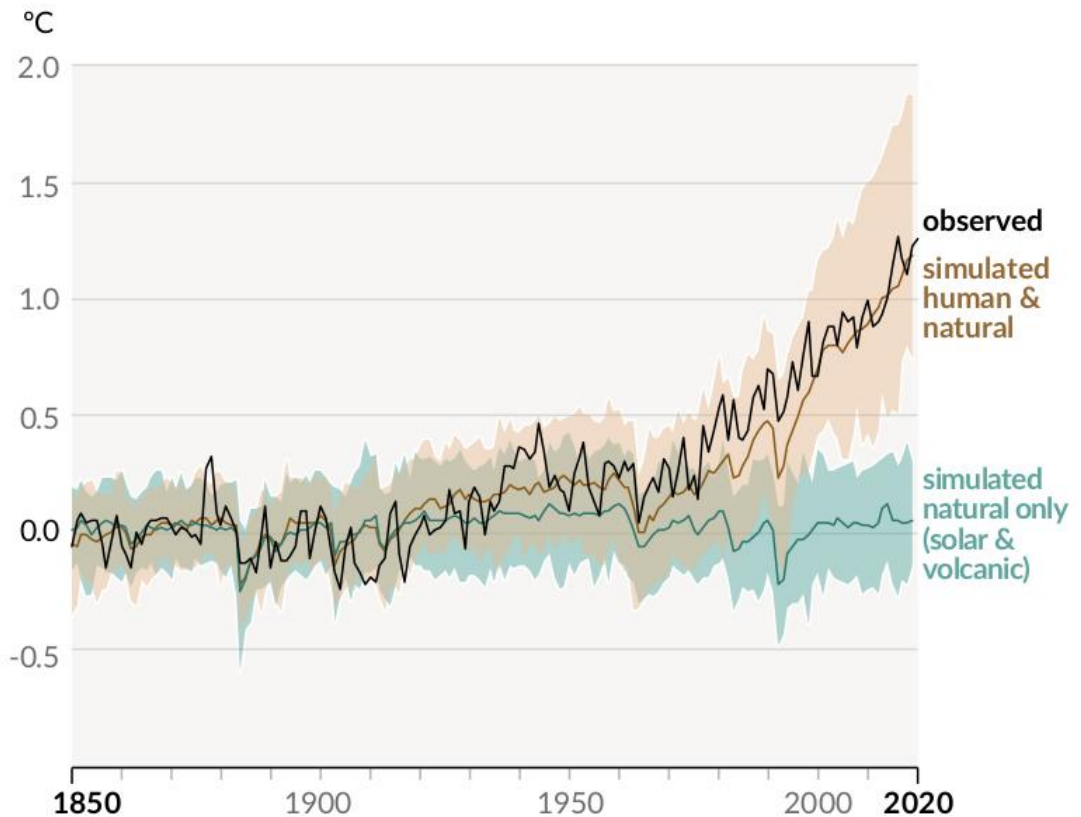## The Physical Science Basis

Summary for Policymakers

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

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)

b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850-2020)

°C

Warming is unprecedented in more than 2000 years

Warmest multi-century period in more than 100,000 years

observed

reconstructed

observed

simulated human & natural

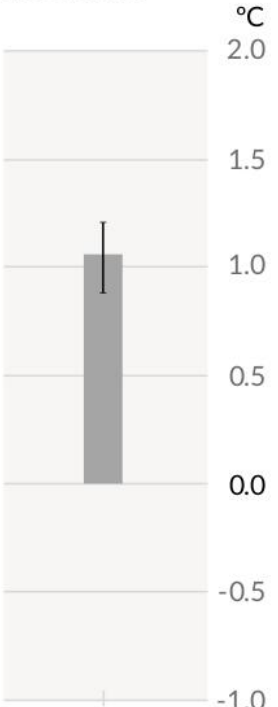simulated natural only (solar & volcanic)

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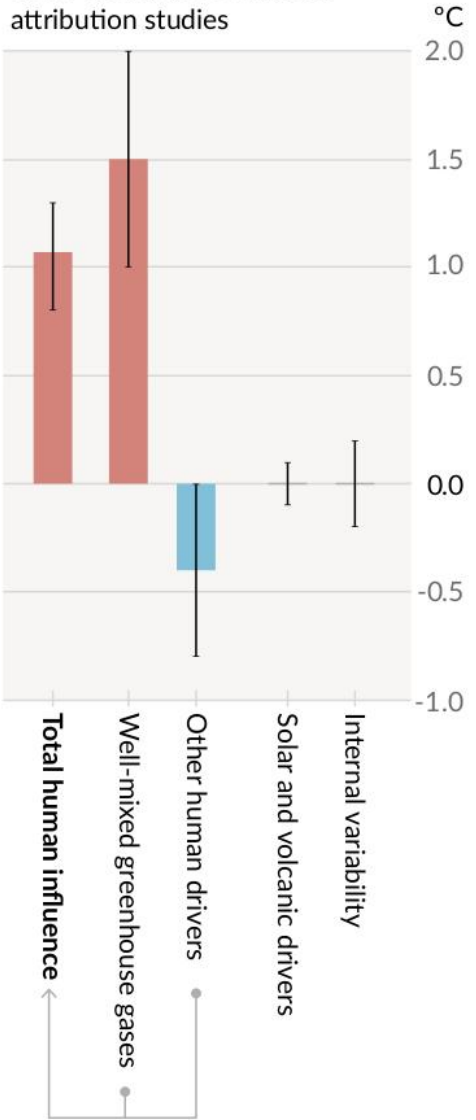
Observed warming

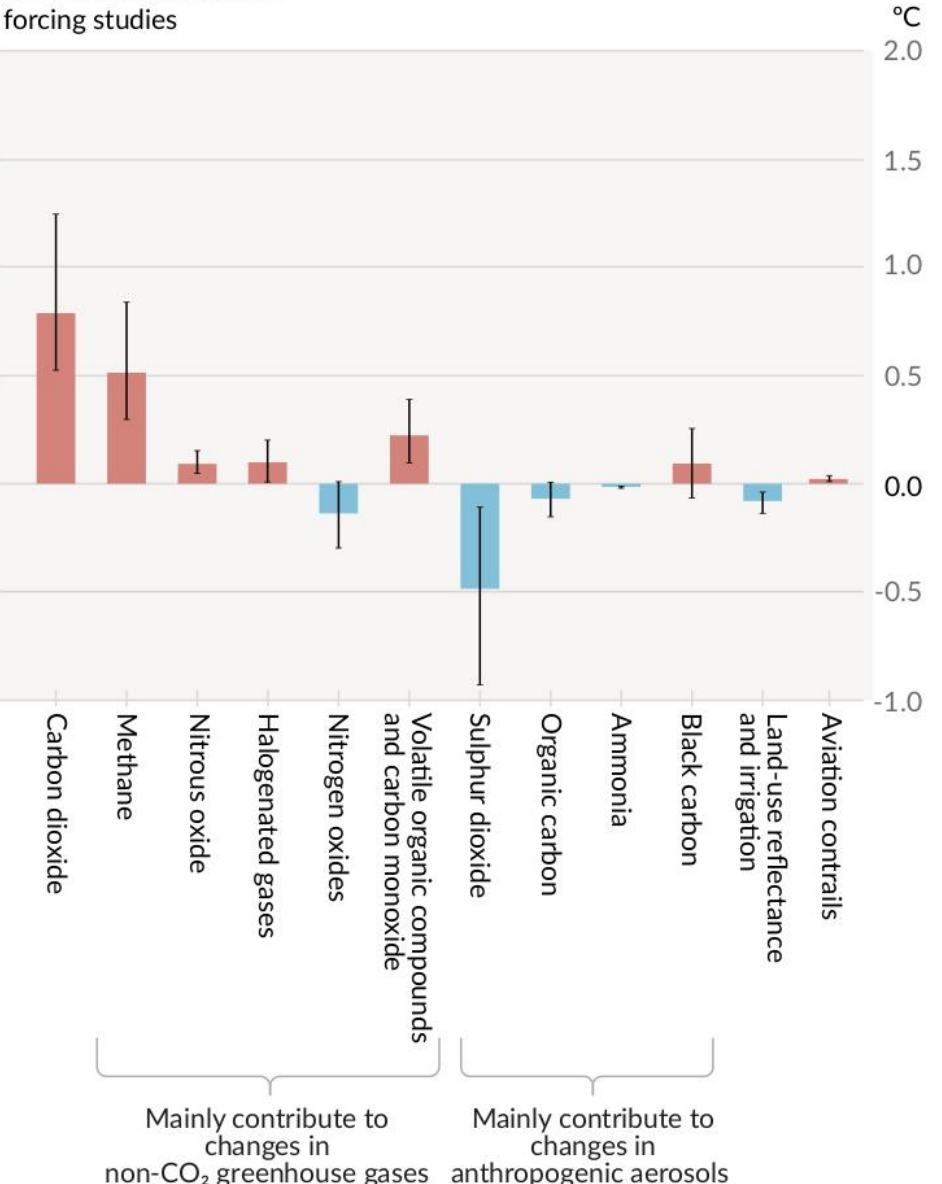a) Observed warming 2010-2019 relative to 1850-1900

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

Panel b categories: Total human influence, Well-mixed greenhouse gases, Other human drivers, Solar and volcanic drivers, Internal variability

Panel c categories: Carbon dioxide, Methane, Nitrous oxide, Halogenated gases, Nitrogen oxides, Volatile organic compounds and carbon monoxide, Sulphur dioxide, Organic carbon, Ammonia, Black carbon, Land-use reflectance and irrigation, Aviation contrails

Mainly contribute to changes in non-CO₂ greenhouse gases

Mainly contribute to changes in anthropogenic aerosols

Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

a) Future annual emissions of CO_2 (left) and of a subset of key non-CO_2 drivers (right), across five illustrative scenarios

Carbon dioxide (GtCO₂/yr)

Selected contributors to non-CO_2 GHGs
Methane (MtCH₄/yr)

Nitrous oxide (MtN₂O/yr)

One air pollutant and contributor to aerosols
Sulfur dioxide (MtSO₂/yr)
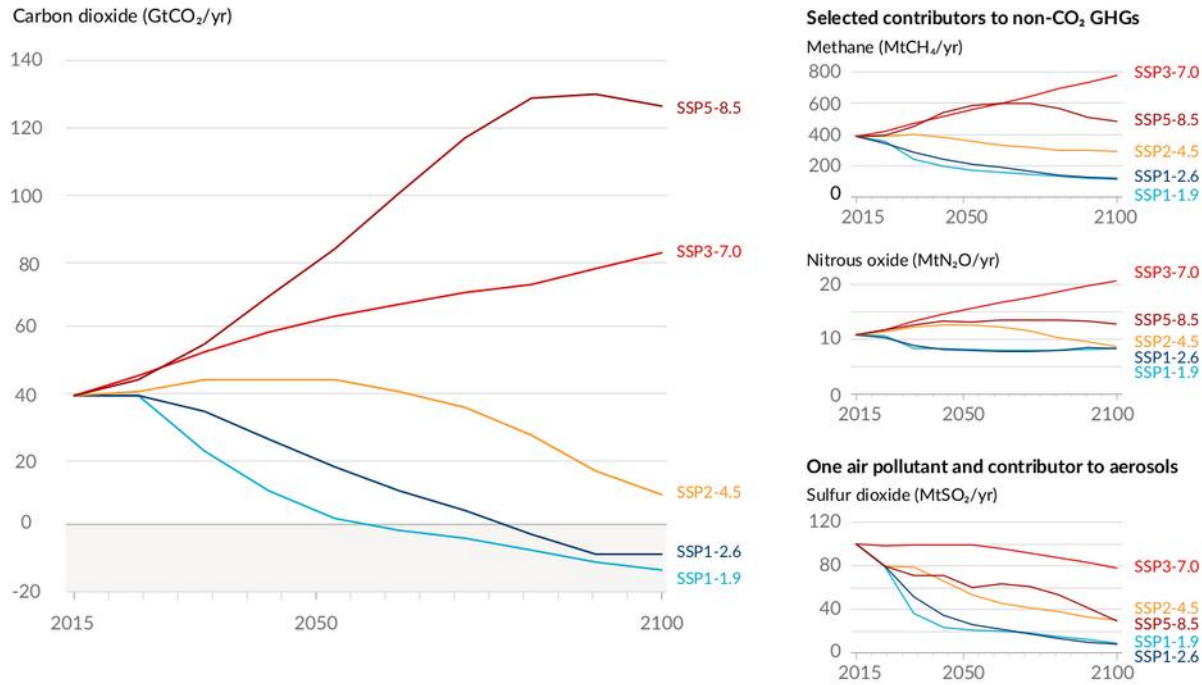
b) Contribution to global surface temperature increase from different emissions, with a dominant role of CO_2 emissions

Change in global surface temperature in 2081-2100 relative to 1850-1900 (°C)
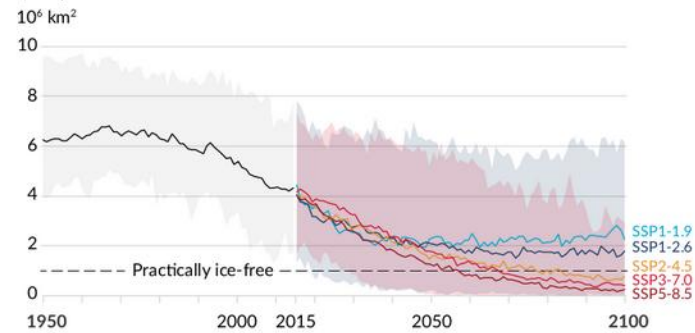
SSP1-1.9   SSP1-2.6   SSP2-4.5   SSP3-7.0   SSP5-8.5
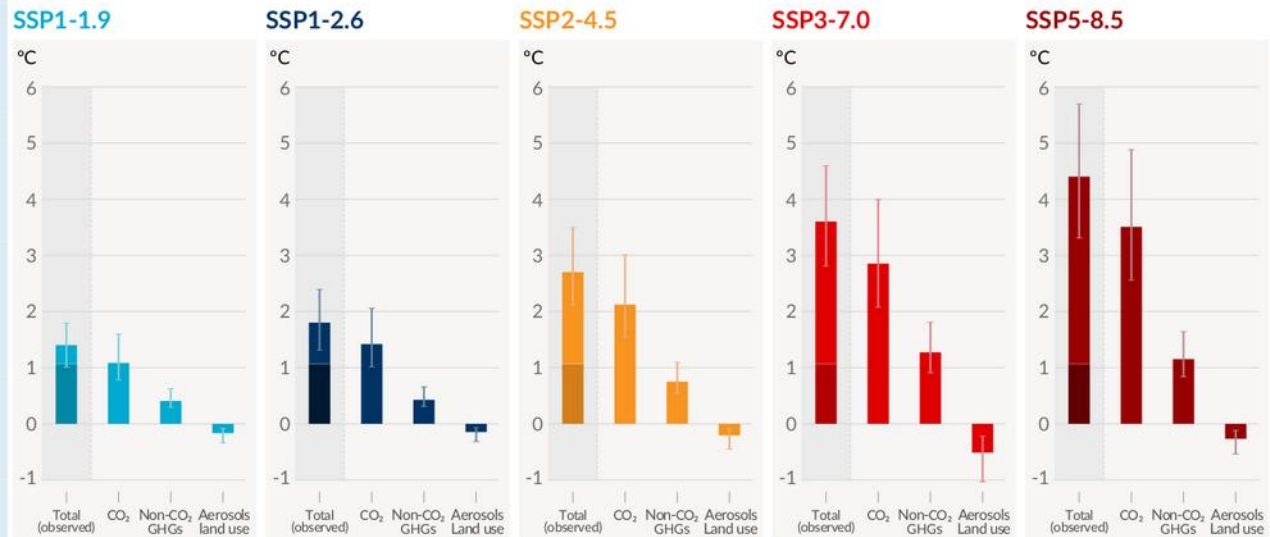
Total warming (observed warming to date in darker shade), warming from CO_2, warming from non-CO_2 GHGs and cooling from changes in aerosols and land use

Human activities affect all the major climate system components, with some responding over decades and others over centuries
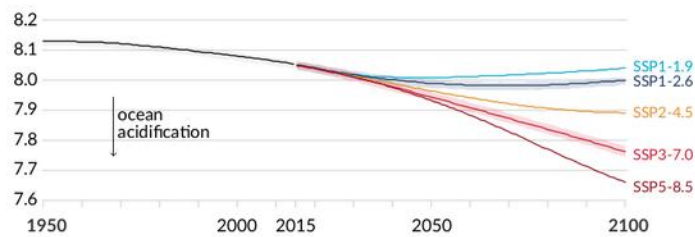
a) Global surface temperature change relative to 1850-1900

°C

- SSP5-8.5
- SSP3-7.0
- SSP2-4.5
- SSP1-2.6
- SSP1-1.9
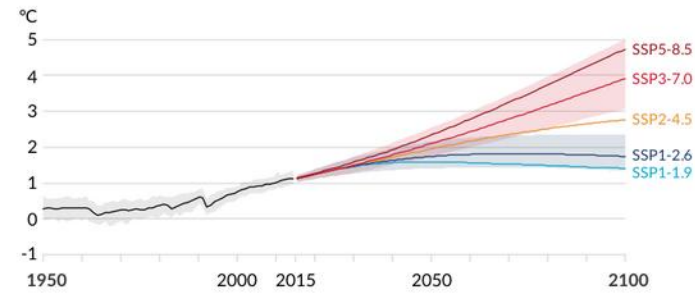
b) September Arctic sea ice area

10⁶ km²

Practically ice-free

- SSP1-1.9
- SSP1-2.6
- SSP2-4.5
- SSP3-7.0
- SSP5-8.5

c) Global ocean surface pH (a measure of acidity)

ocean acidification

- SSP1-1.9
- SSP1-2.6
- SSP2-4.5
- SSP3-7.0
- SSP5-8.5

d) Global mean sea level change relative to 1900

m

Low-likelihood, high-impact storyline, including ice sheet instability processes, under SSP5-8.5 →

- SSP5-8.5
- SSP3-7.0
- SSP2-4.5
- SSP1-2.6
- SSP1-1.9
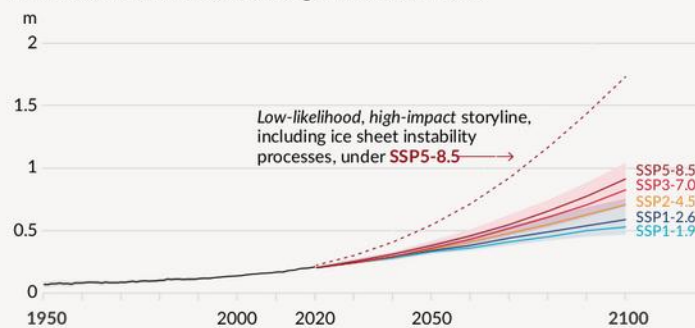
e) Global mean sea level change in 2300 relative to 1900

Sea level rise greater than 15m **cannot** be ruled out with high emissions

SSP5-8.5

SSP1-2.6
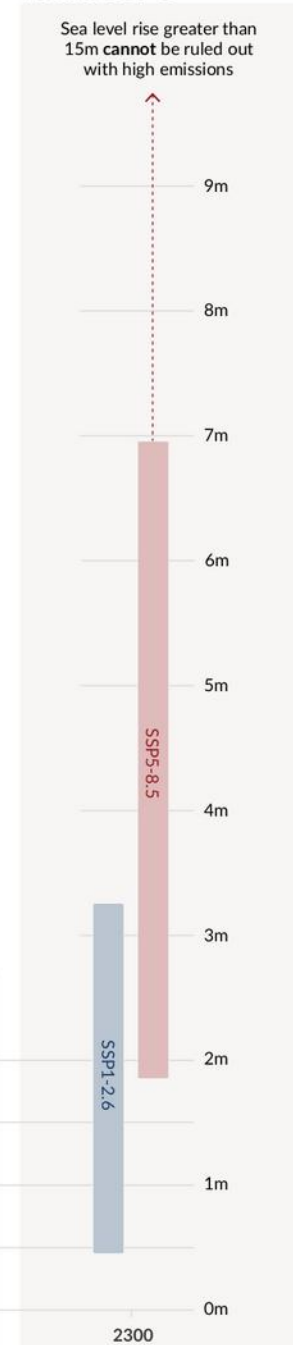
Every tonne of CO₂ emissions adds to global warming

Global surface temperature increase since 1850-1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)

The near **linear relationship** between the cumulative CO_2 emissions and global warming for five illustrative scenarios **until year 2050**

SSP5-8.5
SSP3-7.0
SSP2-4.5
SSP1-2.6
SSP1-1.9

Historical global warming

Cumulative CO_2 emissions since 1850

°C

Future cumulative CO_2 emissions differ across scenarios, and determine how much warming we will experience

SSP1-1.9
SSP1-2.6
SSP2-4.5
SSP3-7.0
SSP5-8.5

time
1850 1900 1950 2000 2019 2020 2030 2040 2050

HISTORICAL
Cumulative CO_2 emissions between **1850** and **2019**

PROJECTIONS
Cumulative CO_2 emissions between **2020** and **2050**

Plik   Edycja   Widok   Historia   Zakładki   Narzędzia   Pomoc

Press release: The N ×   Nauka o klimacie | n ×   Klimatyczne ABC   ×   Colloquium, Institut ×   AMTD - Cloud micro ×   IPCC WGI Interactiv ×   +

← → C ⌂   https://interactive-atlas.ipcc.ch   ★   Q ⚐ ⊙ ⬇ ⫶⫶⫶ ● ● yD » ≡

Pierwsze kroki   Często odwiedzane   arXiv.org   Gazeta.pl   Rp.pl: Najważniejsze wi…   FNMOC WXMAP   Nauka o klimacie | nau…   Nextcloud   Monitor UW   Windy   Pozostałe zakładki

ipcc

INTERGOVERNMENTAL PANEL ON climate change

IPCC Working Group I (WGI): Sixth Assessment Report

OUR POSSIBLE CLIMATE FUTURES

+1.5°C

+2°C

+3°C

+4°C

Temperature

Precipitation

IPCC WGI Interactive Atlas

A novel tool for flexible spatial and temporal analyses of much of the observed and projected climate change information underpinning the Working Group I contribution to the Sixth Assessment Report, including regional synthesis for Climatic Impact-Drivers (CIDs).

Participate in the user testing survey 🔗   Errata and problem reporting ⊙

Simple (CLIMATE FUTURES)

Advanced
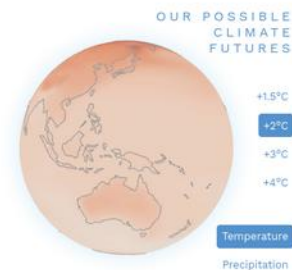
REGIONAL INFORMATION   REGIONAL SYNTHESIS   DOCUMENTATION

Video: Introducing the Interactive Atlas
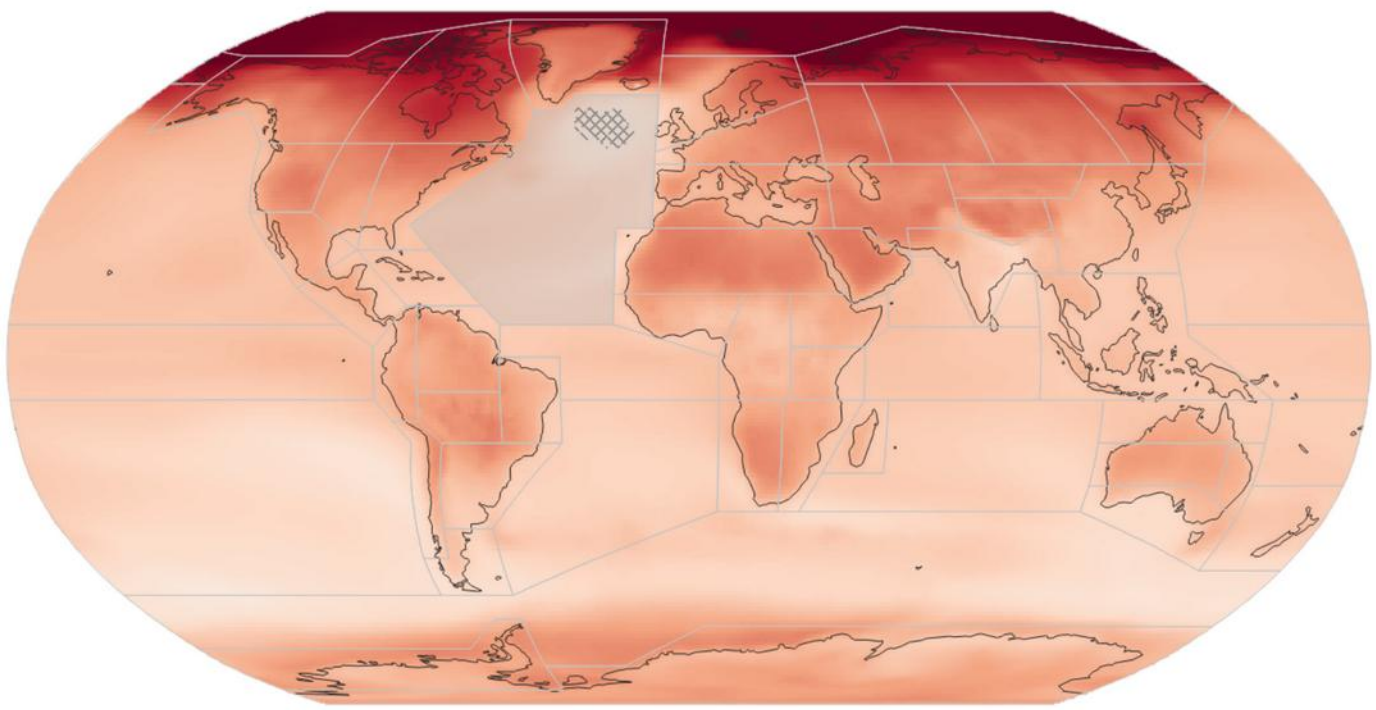
CMIP6 - Mean temperature (T) Change deg C - Warming 2°C SSP5-8.5 (rel. to 1850-1900) - Annual (34 models)