Climate Change 24.11.2021

EMMISION SCENARIOS

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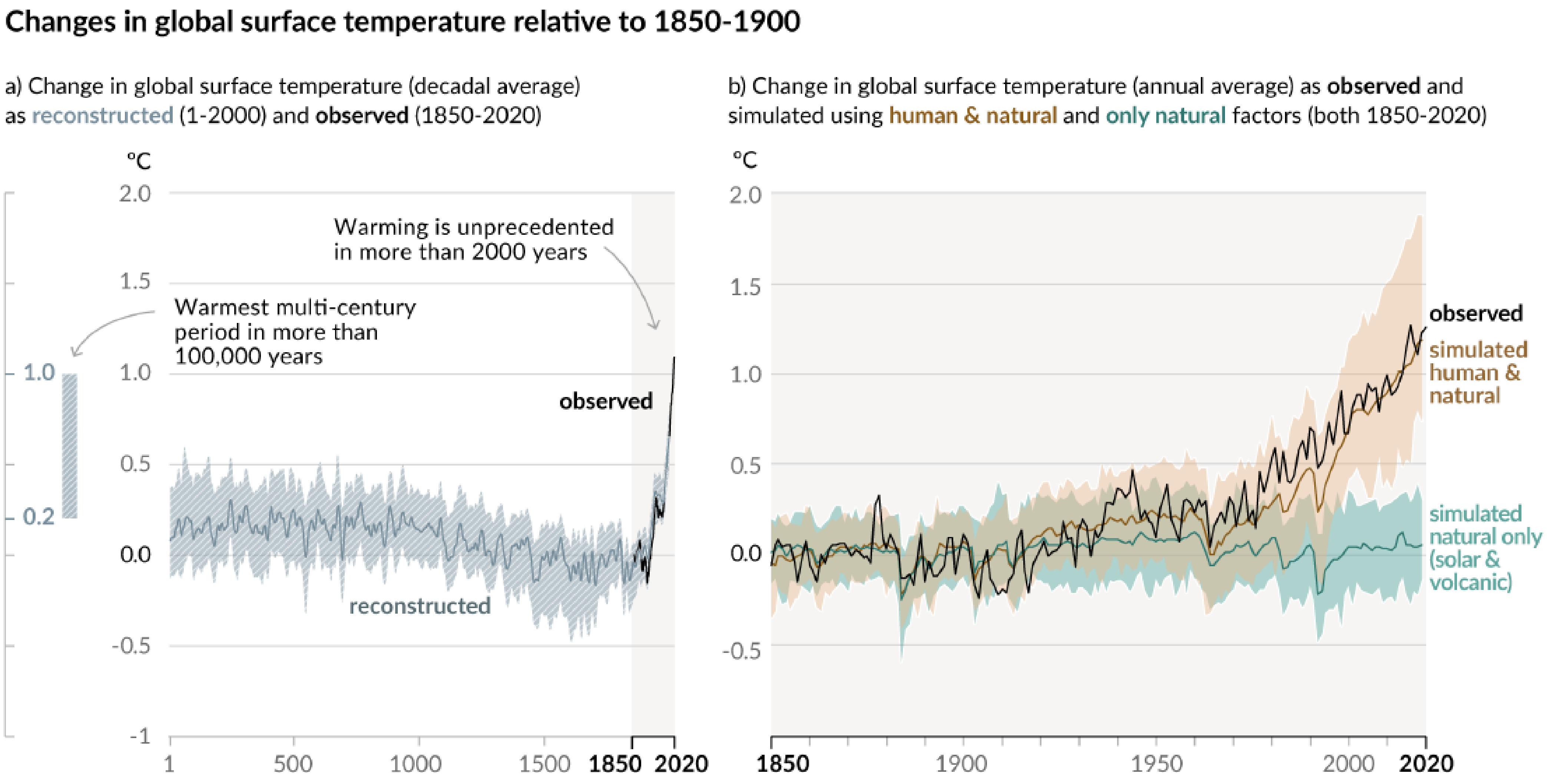
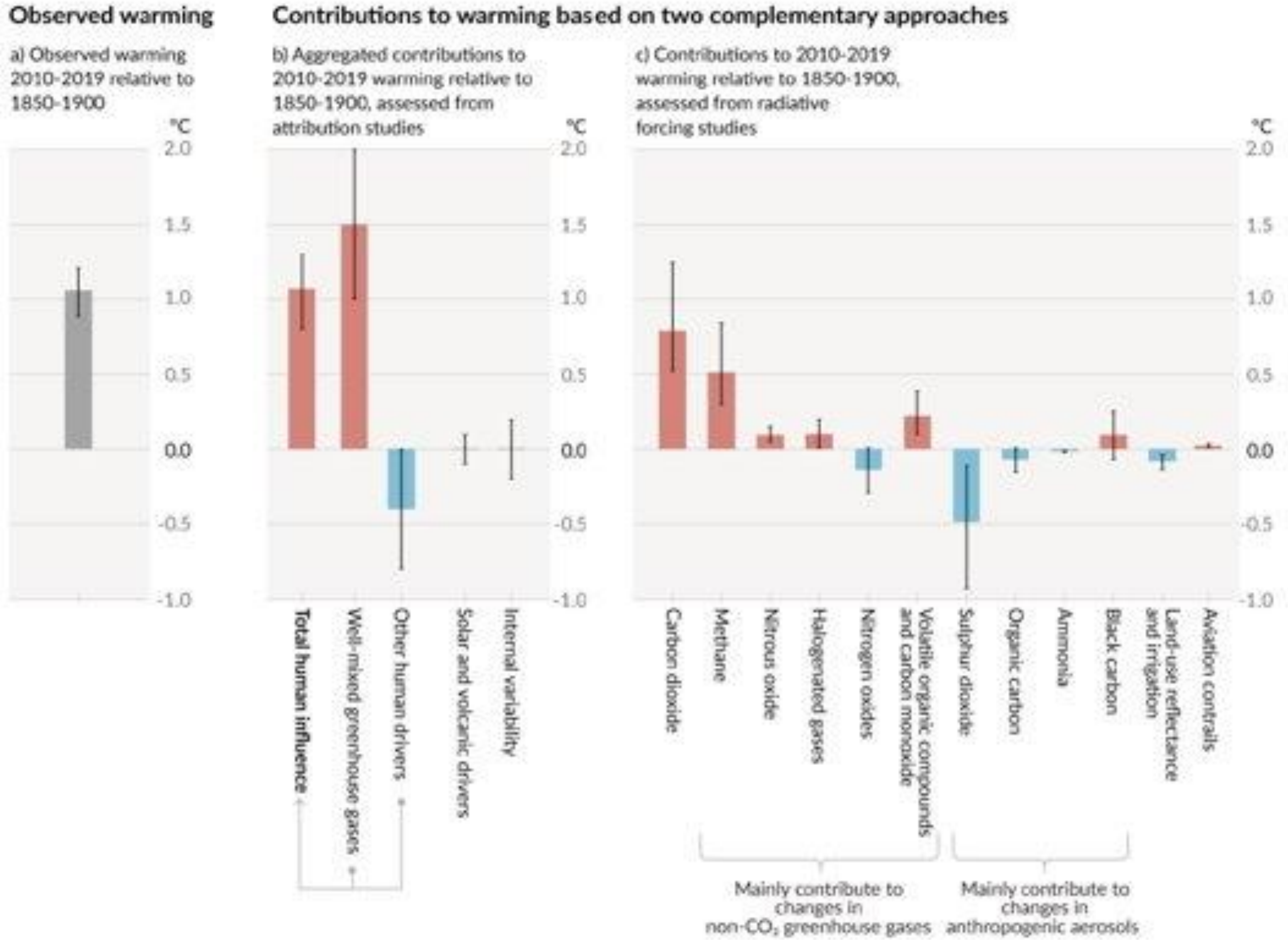
Historic Temperature Changes



Contributions to Warming



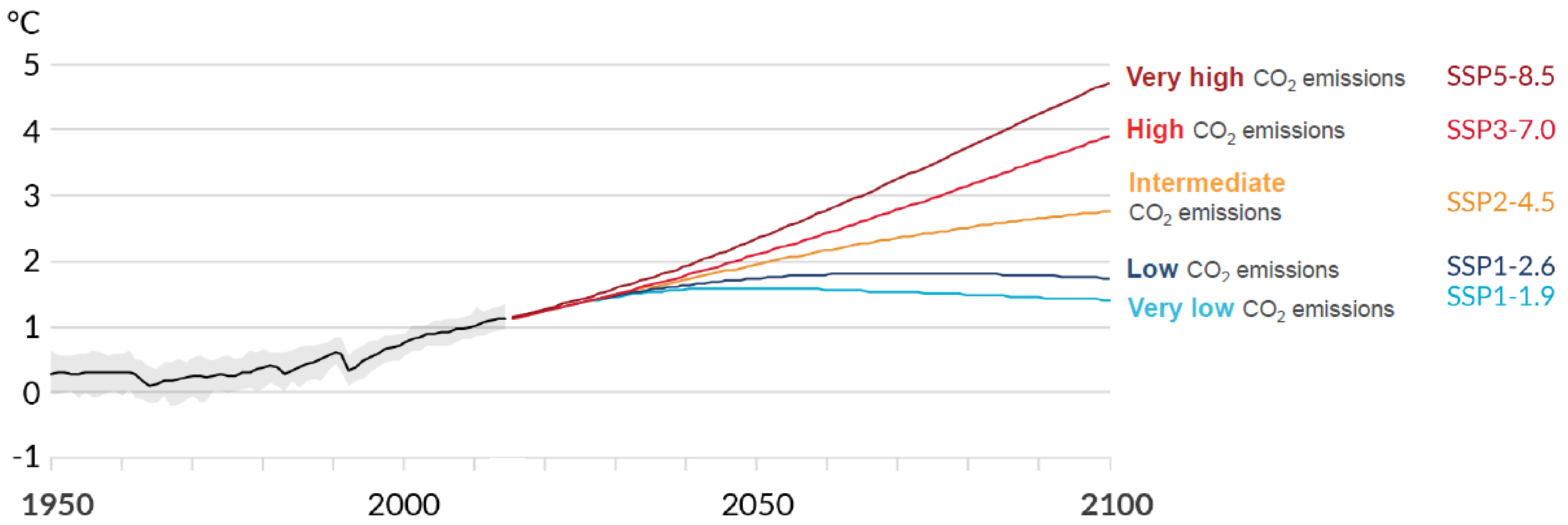
Shared Socioeconomic Pathways (SSPs)

AR6 Climate Change 2021 by IPCC

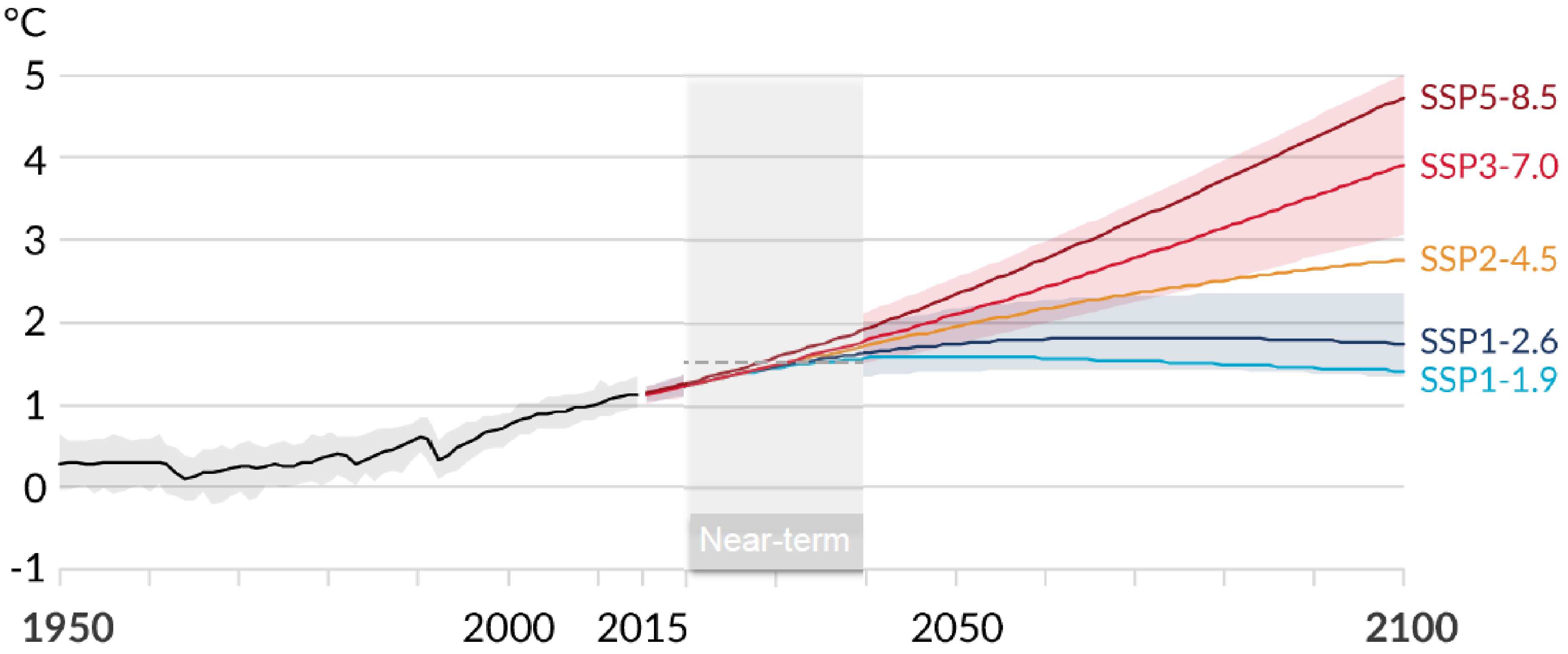
raport presents state of climate now and what the future might hold

1 st part about physical science basis published in 2021, 2 parts about human impact & how to respond coming in 2022

Emission Scenarios- Introduction

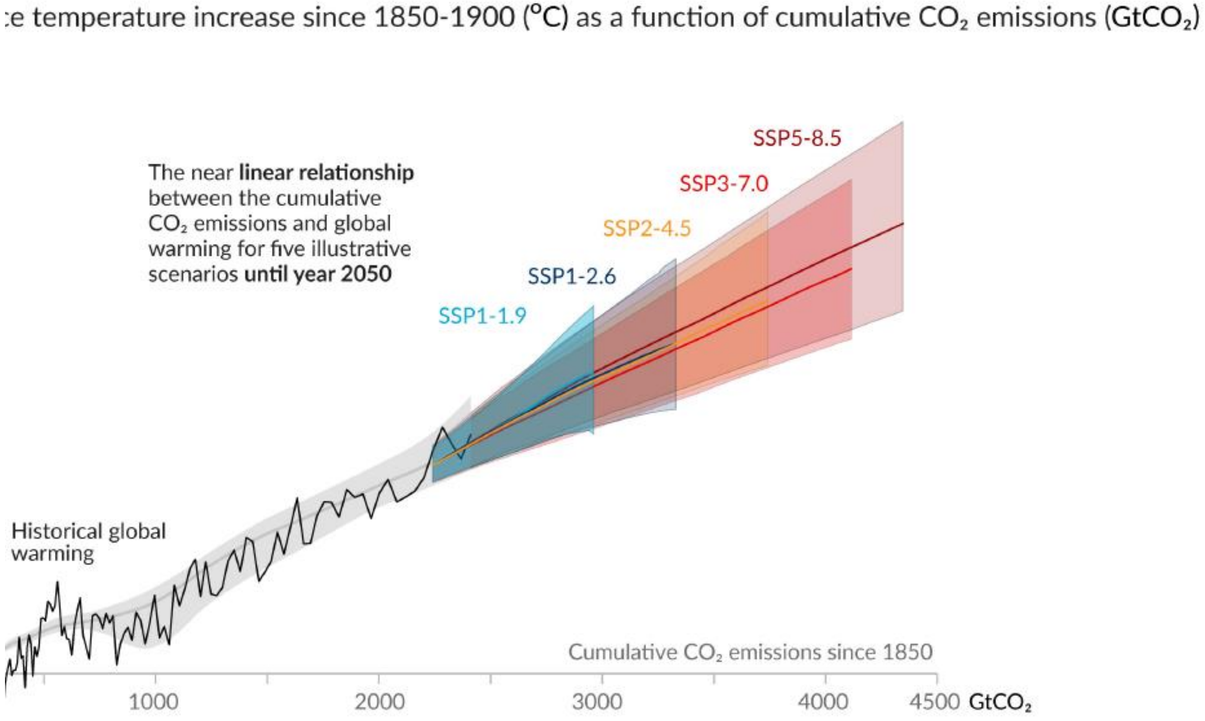


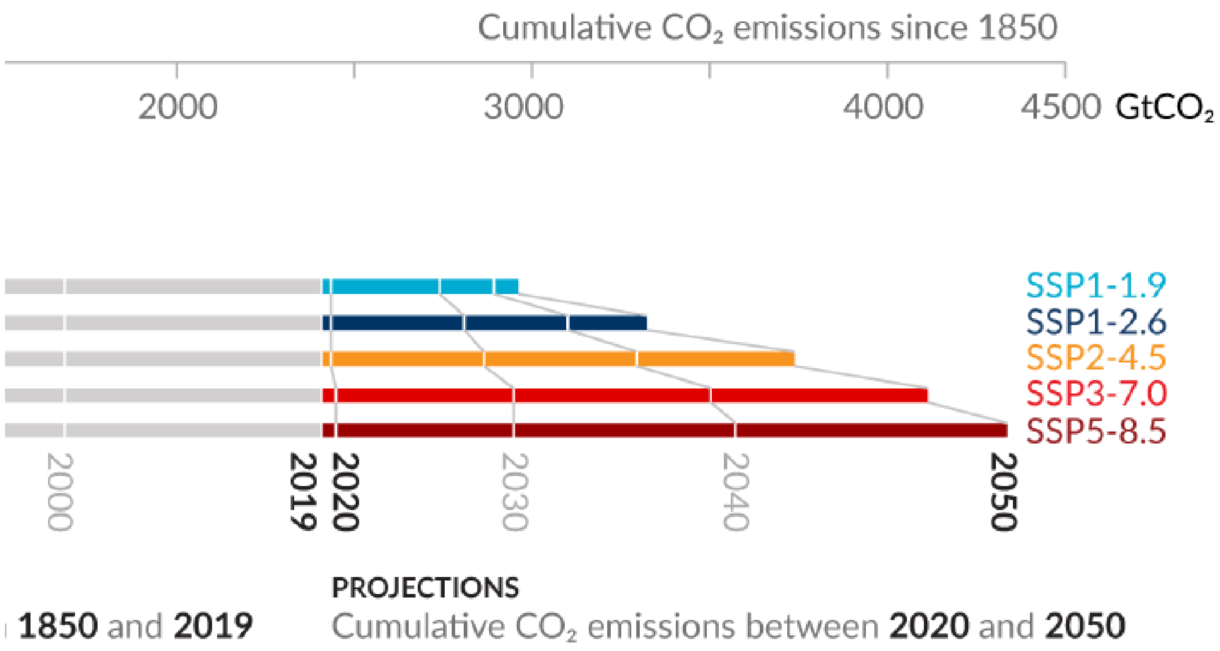
Emission Scenarios- Introduction



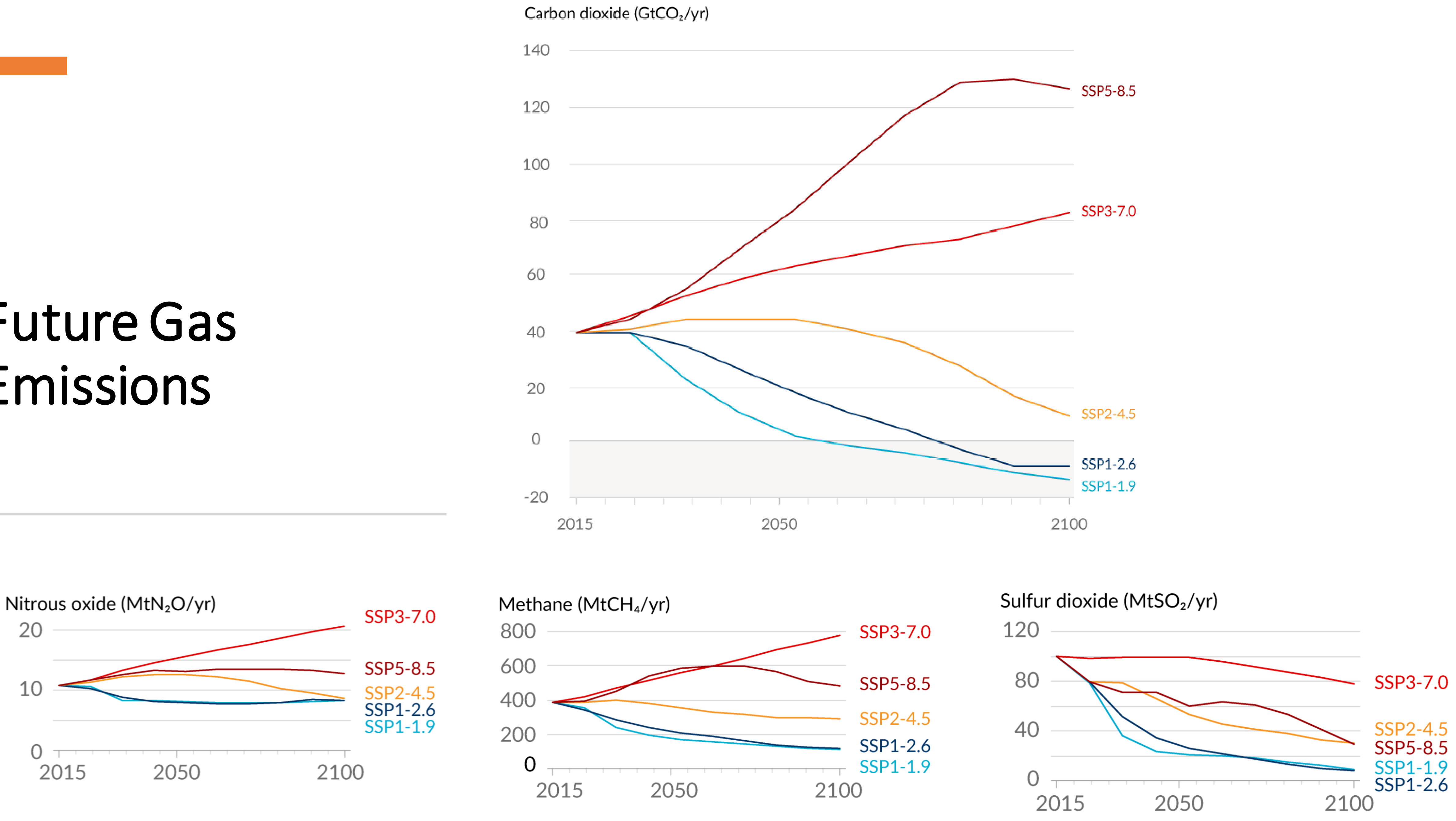
Under these contrasting scenarios, discernible differences in trends of global surface temperature would begin to emerge from natural variability within **around 20 years**, and over longer time periods for many other climatic impact-drivers

CO2 Emissions Timeline

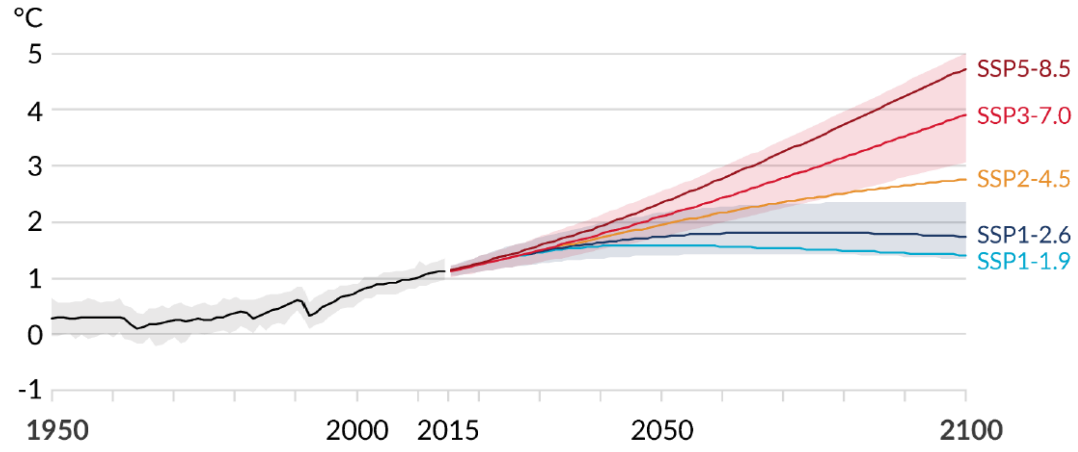




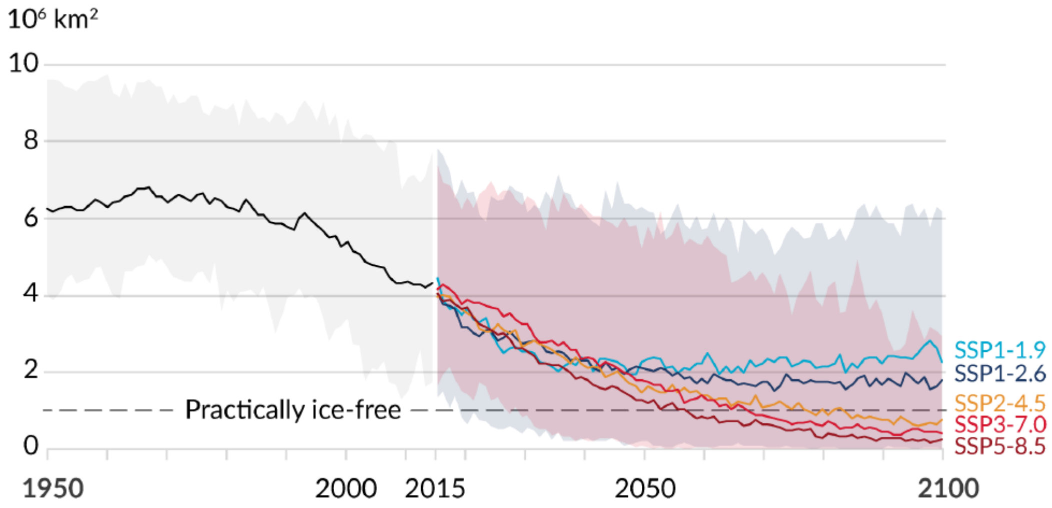
Future Gas Emissions



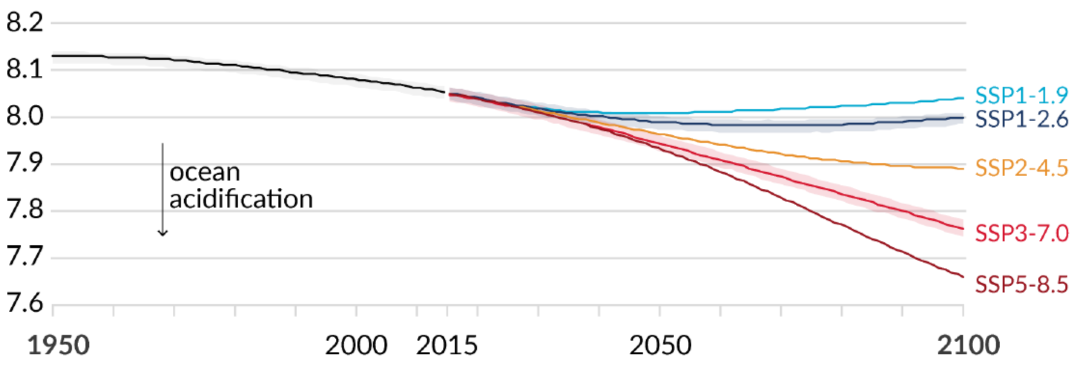
a) Global surface temperature change relative to 1850-1900



b) September Arctic sea ice area



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



Climatic Impact Drivers

Number of land & coastal regions (a) and **open-ocean regions** (b) where each **climatic impact-driver** (CID) is projected to increase or decrease with ***high** confidence* (dark shade) or ***medium** confidence* (light shade)

ASSESSED FUTURE CHANGES

Changes refer to a 20–30 year period centred around 2050 and/or consistent with 2°C global warming compared to a similar period within 1960-2014 or 1850-1900.

BAR CHART LEGEND

Regions with ***high confidence*** increase

Regions with ***medium confidence*** increase

Regions with ***high confidence*** decrease

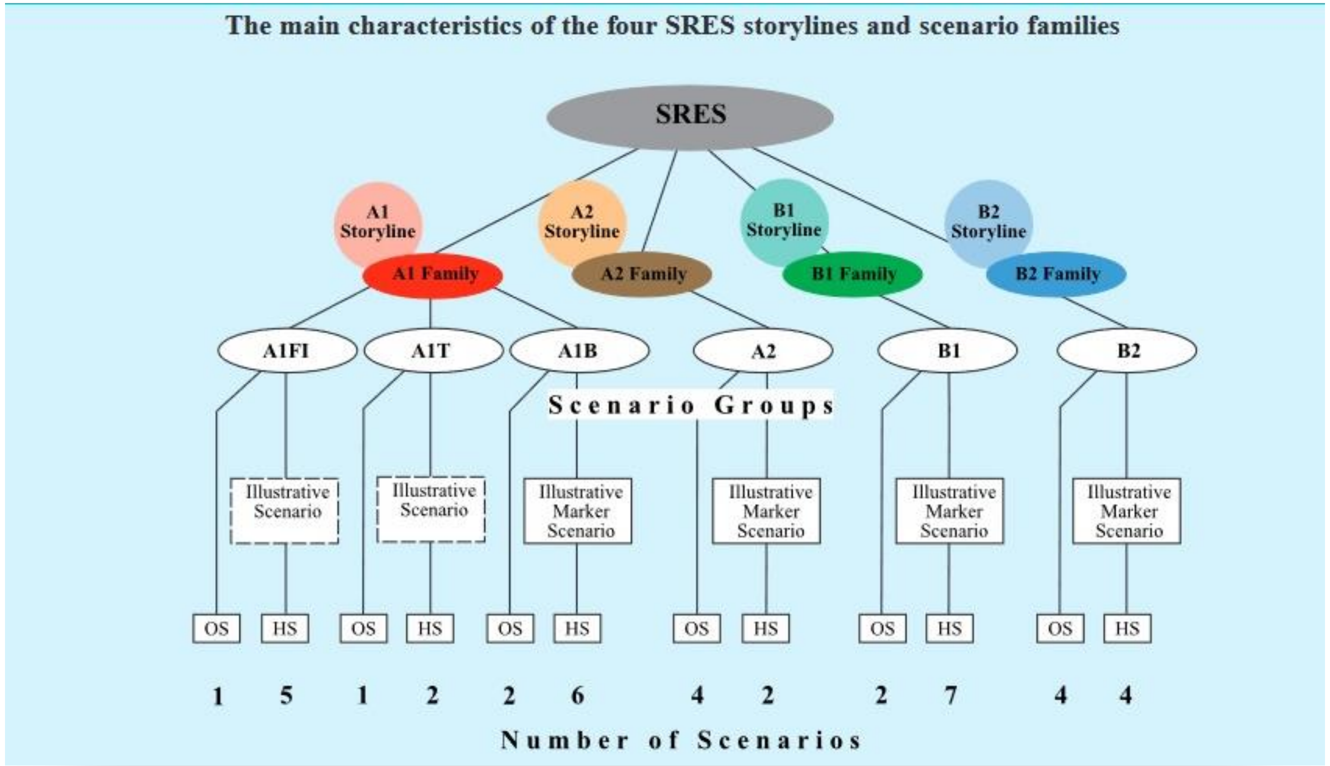
Regions with ***medium confidence*** decrease

LIGHTER-SHADED ‘ENVELOPE’ LEGEND

The height of the lighter shaded ‘envelope’ behind each bar represents the maximum number of regions for which each CID is relevant. The envelope is symmetrical about the x-axis showing the maximum possible number of relevant regions for CID increase (upper part) or decrease (lower part).

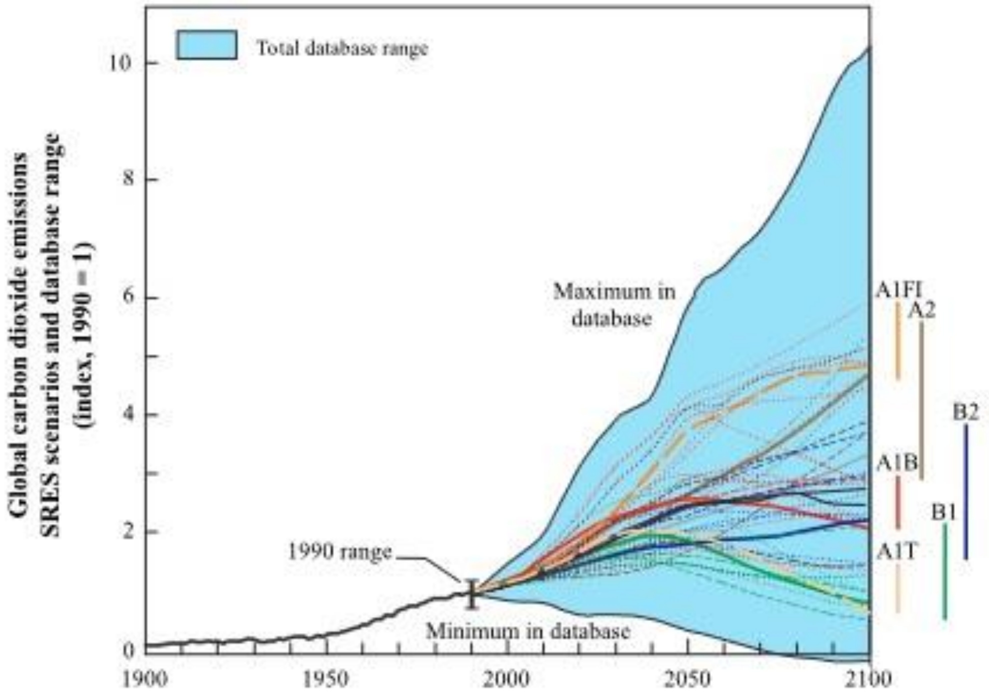
Special Report on Emissions Scenarios (SRES)

- released in 2000
- used in 3rd (TAR) and 4th (AR) IPCC report
- the GHG emissions baseline scenarios have been used to forecast possible future climate changes
- scenario families were divided into:
  - A1 – more integrated world
  - A2 – more divided world
  - B1 – more integrated, and more ecologically friendly world
  - B2 – more divided, but more ecologically friendly world
- the main driving forces of future GHG trajectories will continue to be demographic change, social and economic development, and the rate and direction of technological change
- Biased towards exaggerated resource availability and unrealistic expectations on future production outputs from fossil fuels

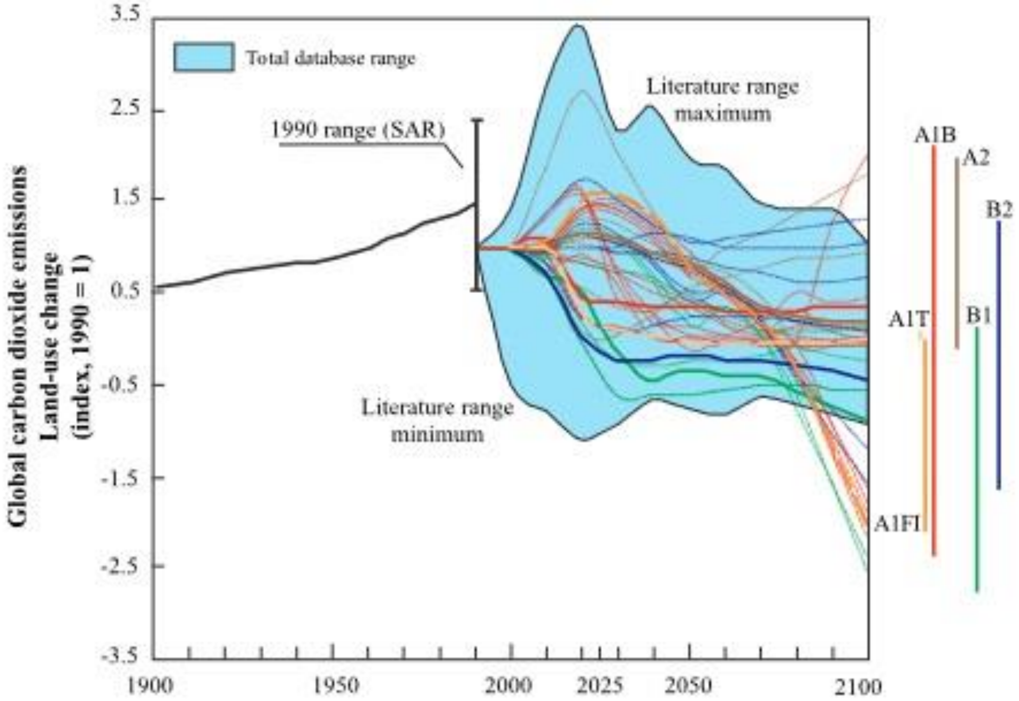


Concentration of GHG over 21st century

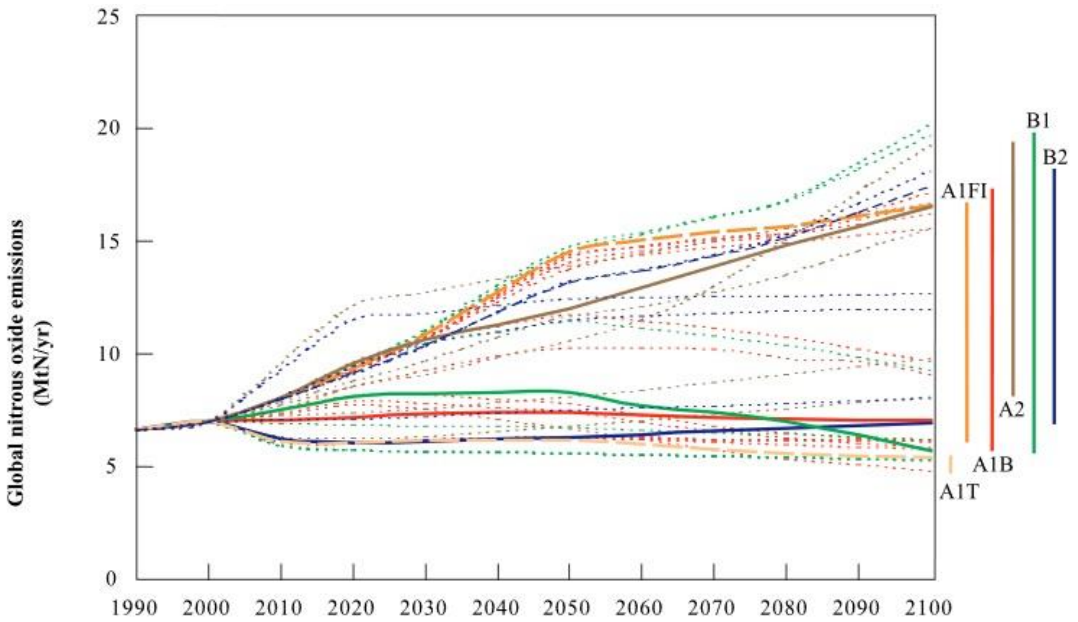
Global CO2 emissions related to energy and industry changes



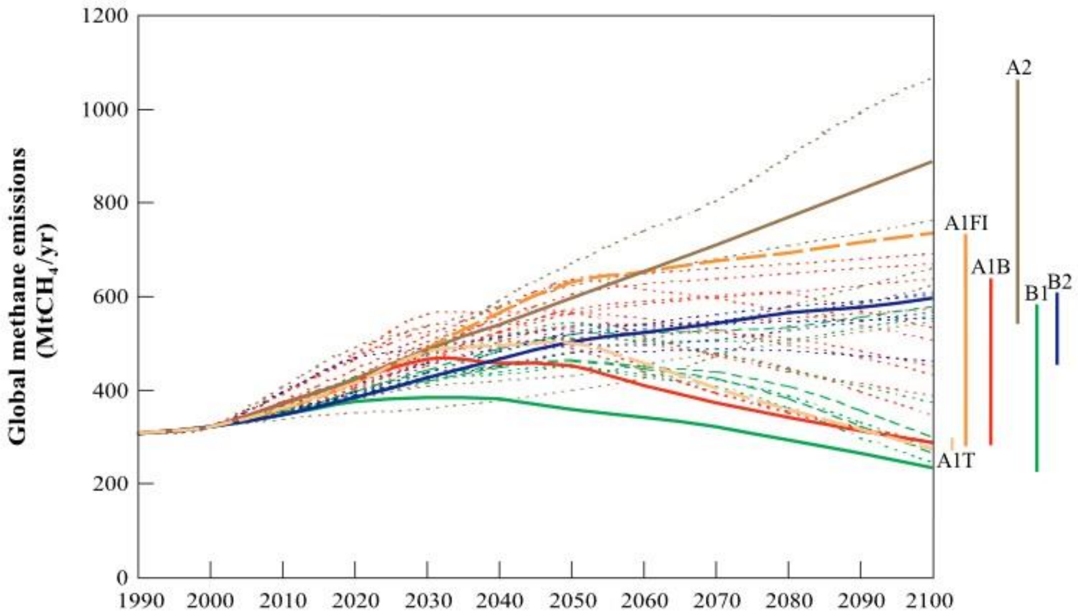
Global CO2 emissions related to land-use changes



Global nitrous oxide emission

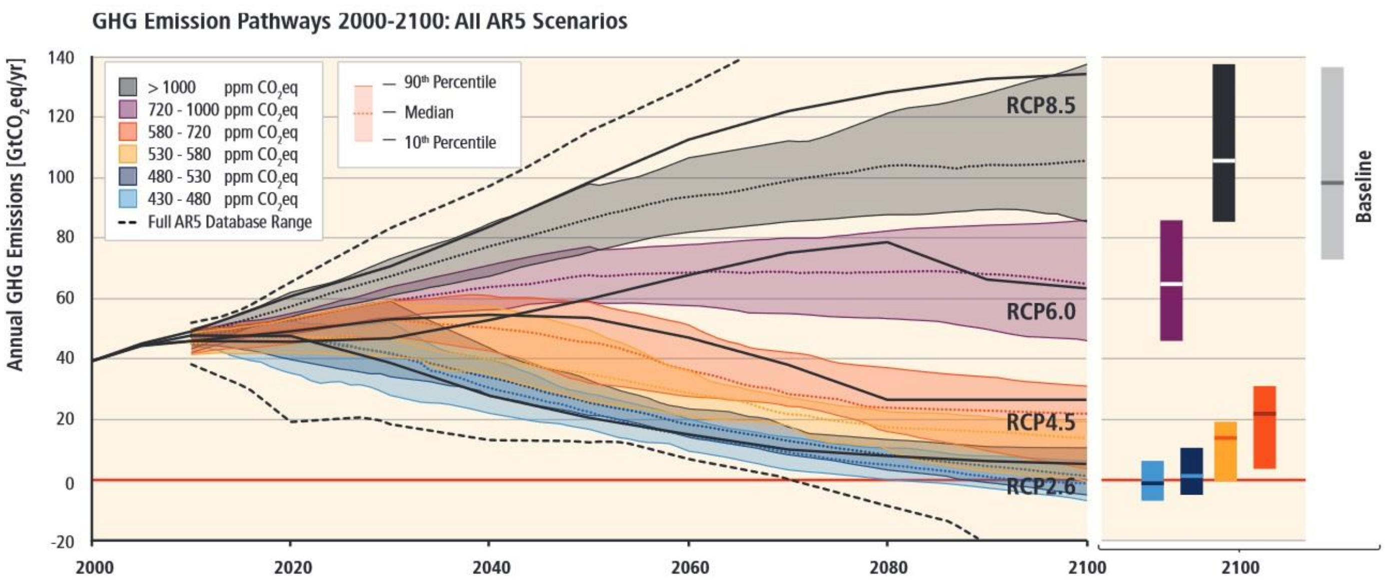


Global methane emissions

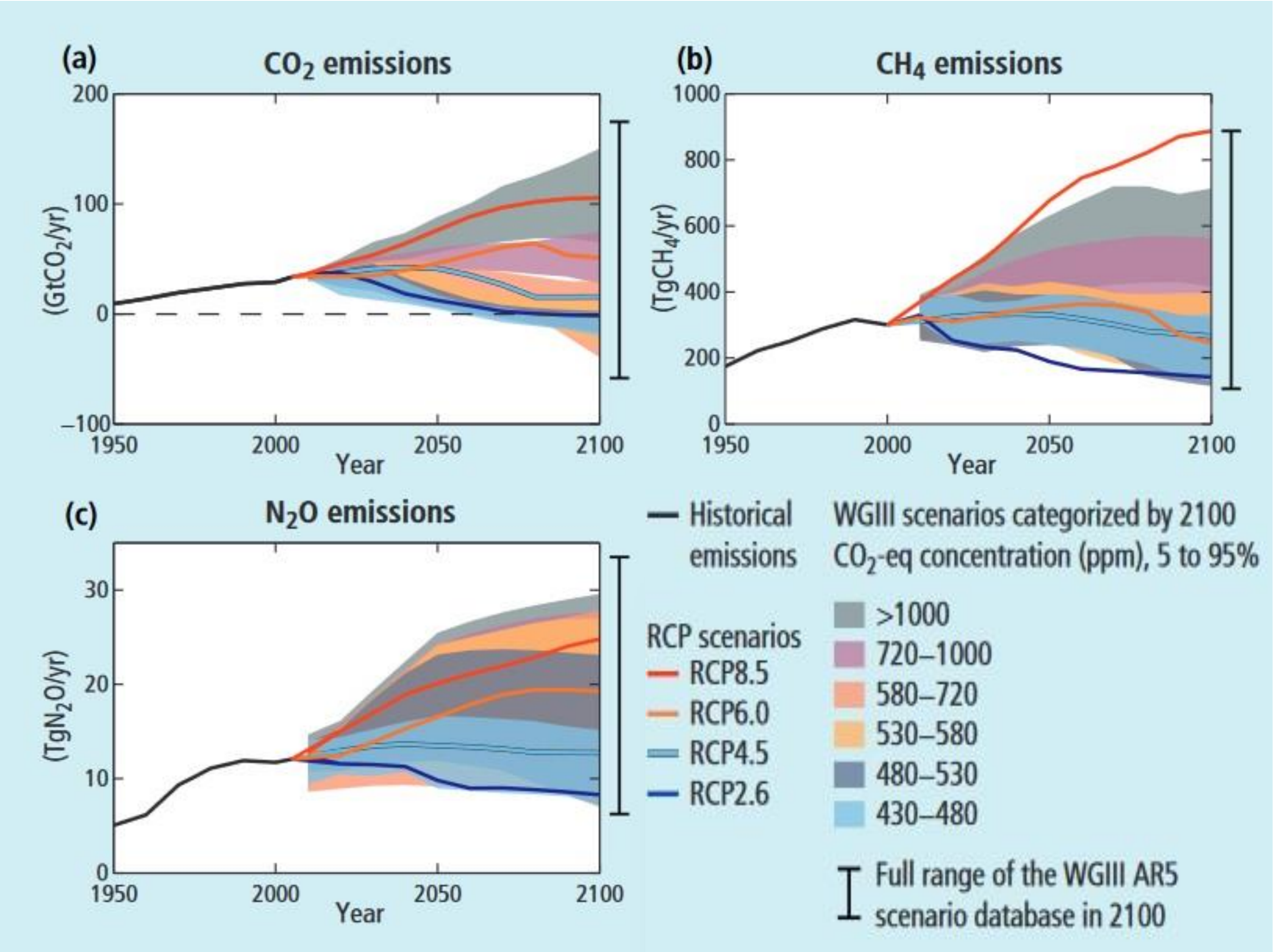


Representative Concentration Pathways (RCP)

- full, edited report was released online in 2014, it supresed SRES
- used in 5th IPCC report (AR5)
- described mitigation of climate change, mitigation options at different levels of governance and in different economic sectors, and the societal implications of different mitigation policies, renewable energy sources
- projections in AR5 were based on four climate-policy scenarios: RCP2.6, RCP4.5, RCP6, and RCP8.5

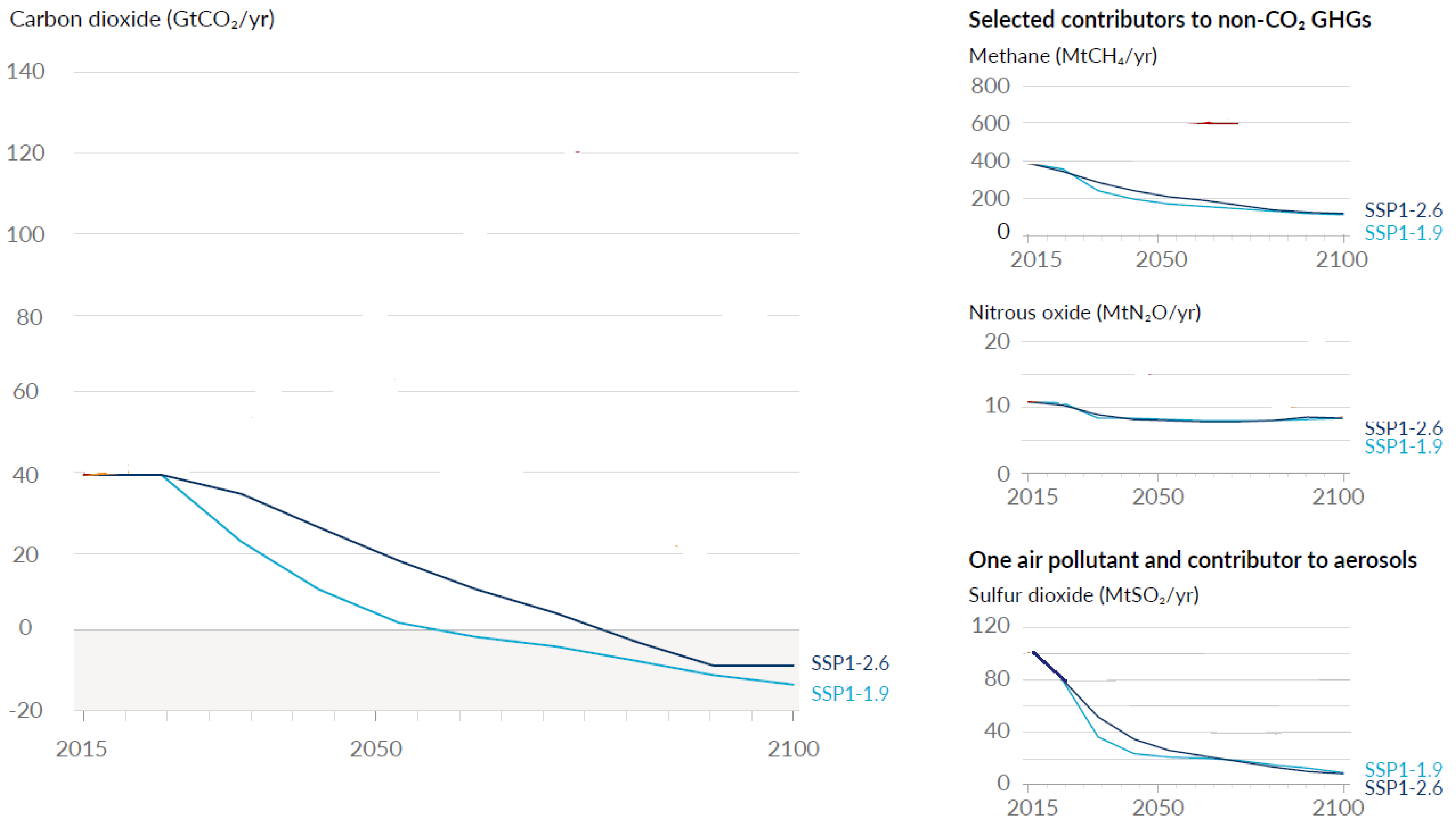


Concentration of GHG over 21st century

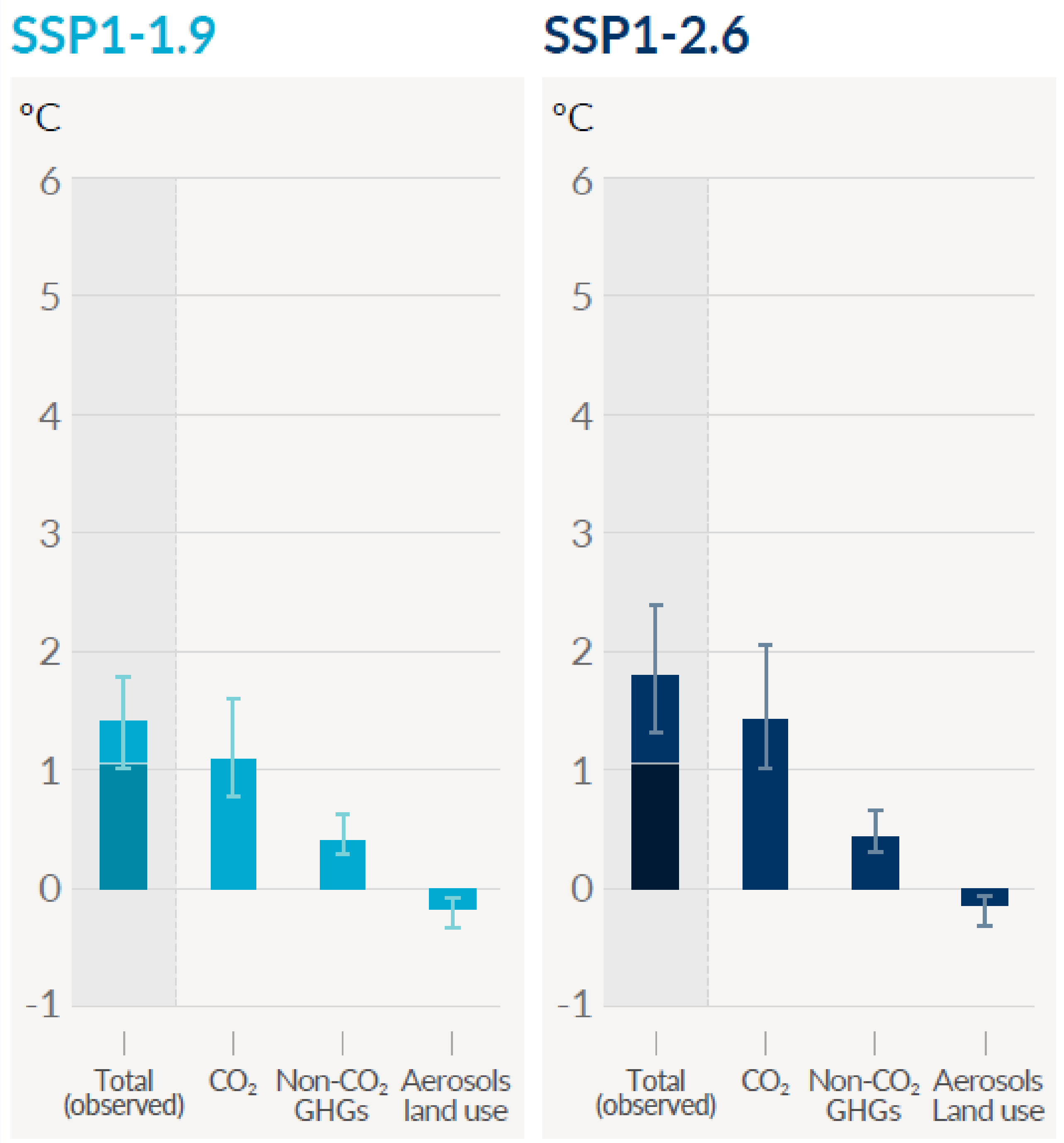


SSP1- 1.9
SSP1 – 2.6

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



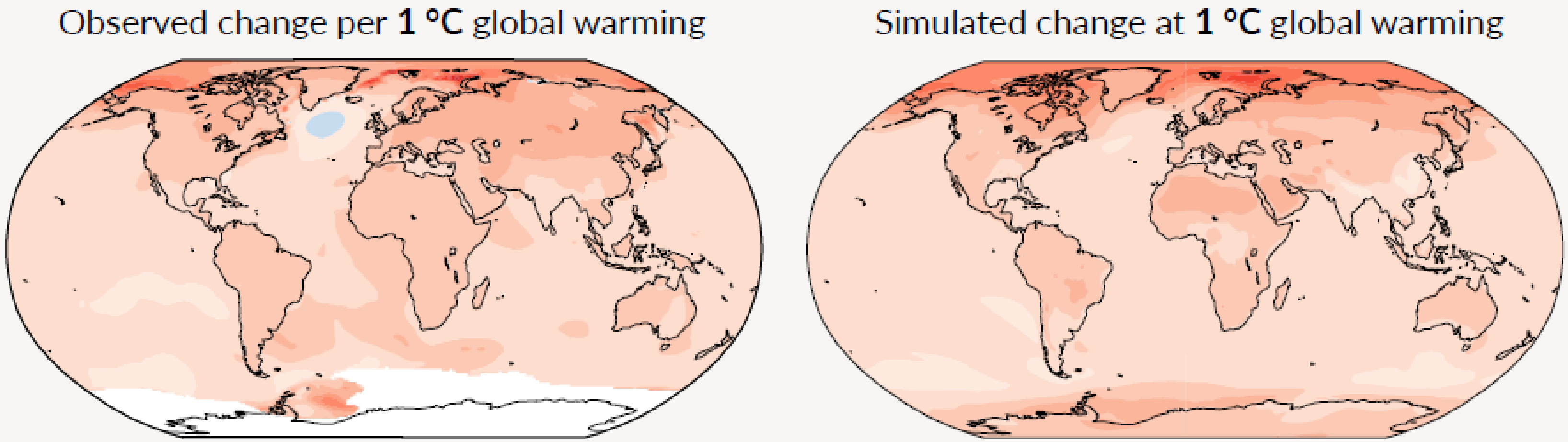
Change in global surface temperature in 2081–2100 relative to 1850–1900

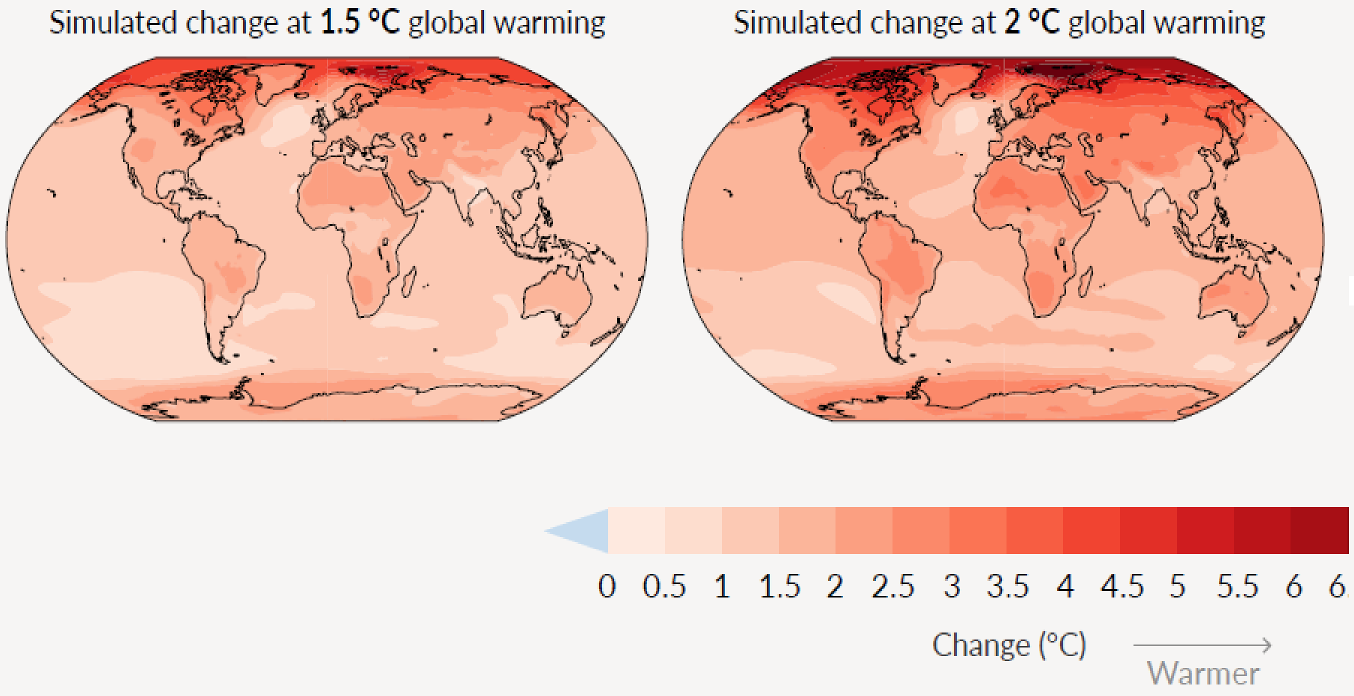


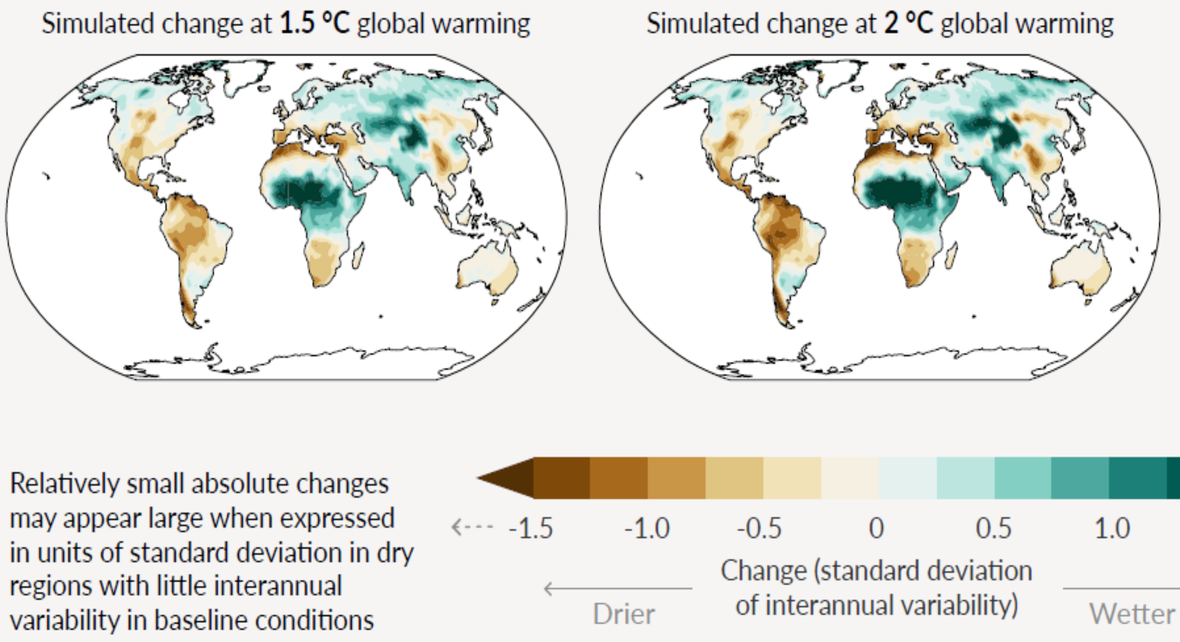
	SSP1-1.9	SSP1-2.6
Near term, 2021–2040	1.5 (1.2, 1.7)	1.5 (1.2, 1.8)
Mid-term, 2041–2060	1.6 (1.2, 2.0)	1.7 (1.3, 2.2)
Long term, 2081–2100	1.4 (1.0, 1.8)	1.8 (1.3, 2.4)
1.5°C	2025–2044 (2013–2032, n.c.)	2023–2042 (2012–2031, n.c.)
2°C	n.c. (n.c., n.c.)	n.c. (2031–2050, n.c.)
3°C	n.c. (n.c., n.c.)	n.c. (n.c., n.c.)
4°C	n.c. (n.c., n.c.)	n.c. (n.c., n.c.)

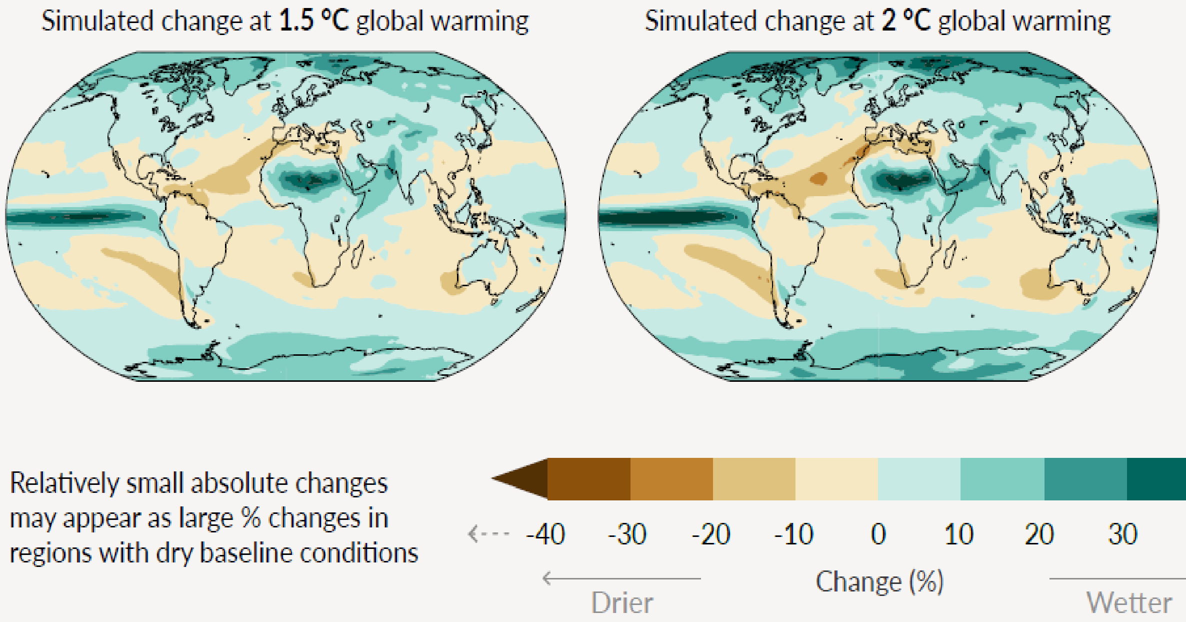
a) Annual mean temperature change (°C) at 1 °C global warming

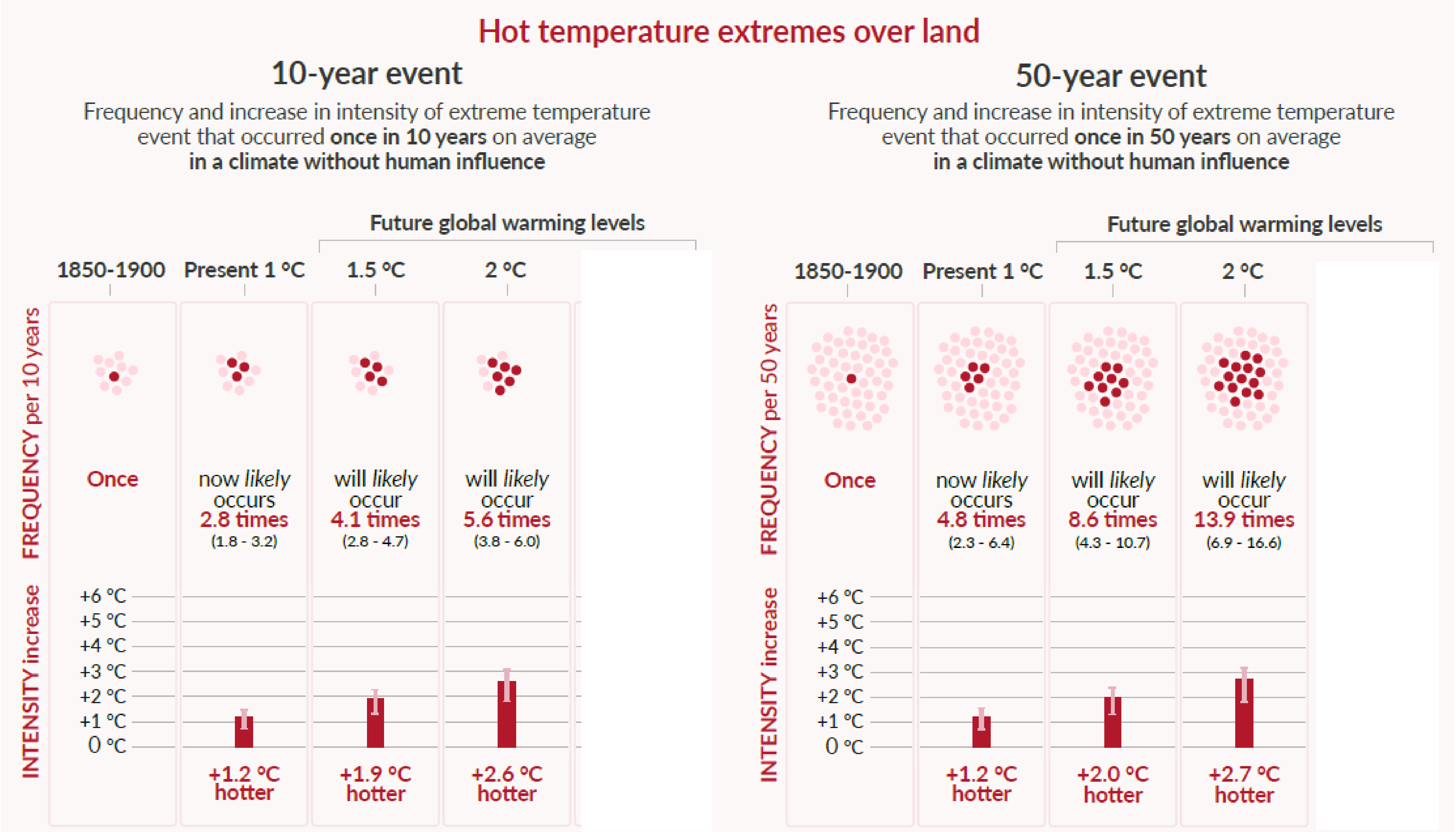
Warming at 1 °C affects all continents and is generally larger over land than over the oceans in both observations and models. Across most regions, observed and simulated patterns are consistent.

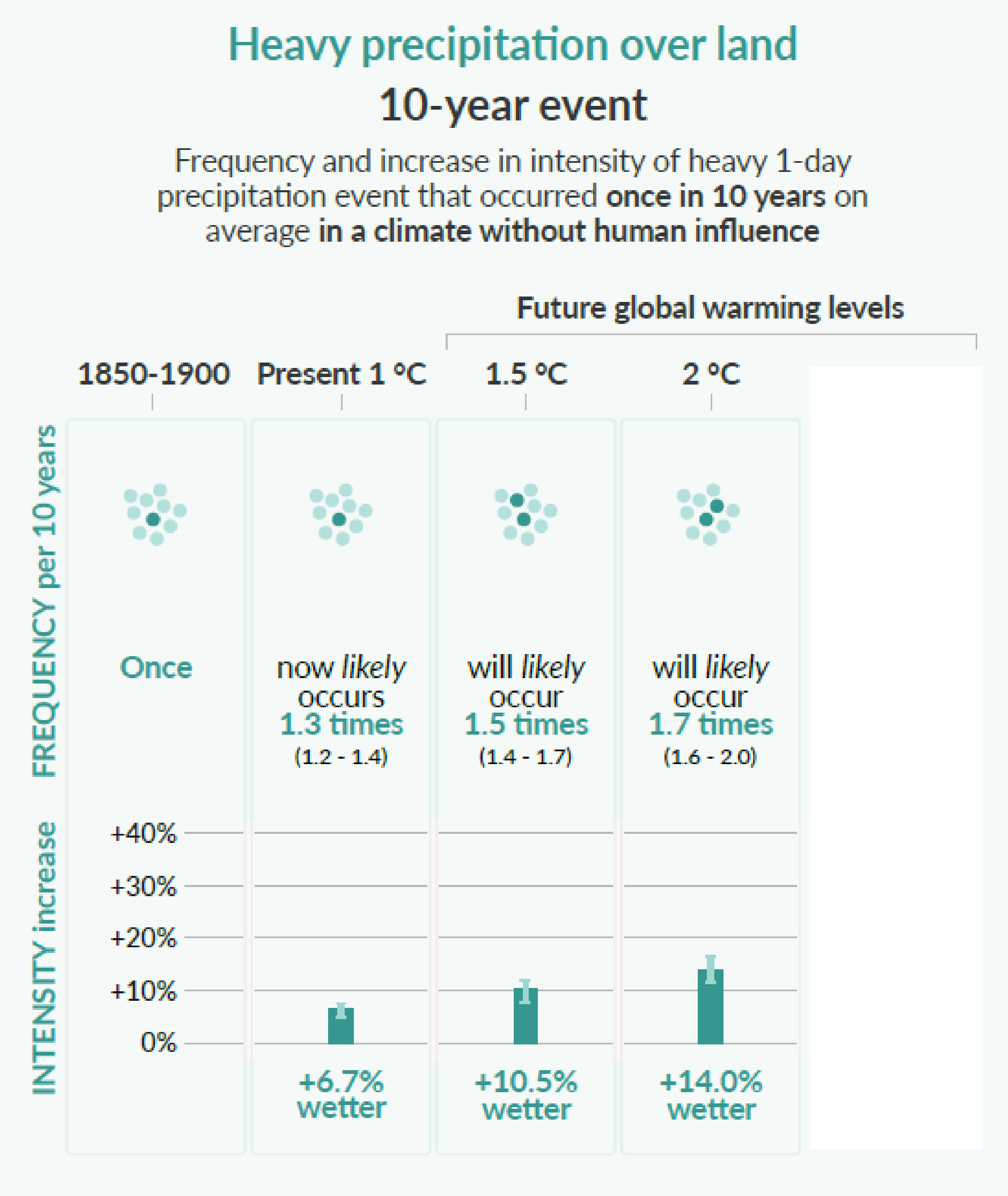



Simulated change at 1.5 °C global warming
Simulated change at 2 °C global warming
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6
Change (°C)
Warmer

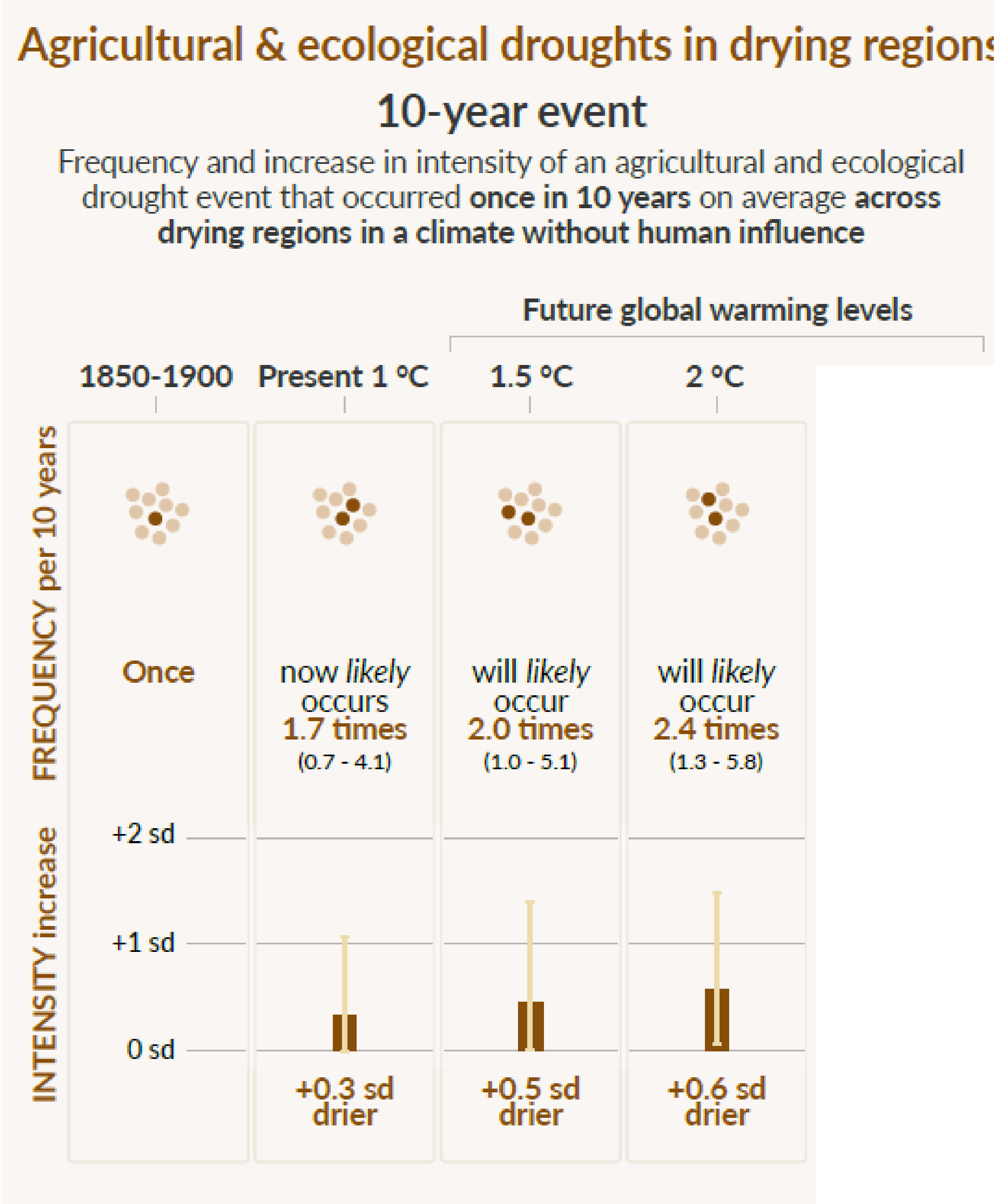

Simulated change at 1.5 °C global warming
Simulated change at 2 °C global warming
Relatively small absolute changes may appear large when expressed in units of standard deviation in dry regions with little interannual variability in baseline conditions
-1.5 -1.0 -0.5 0 0.5 1.0
Change (standard deviation of interannual variability)
Drier
Wetter


Simulated change at 1.5 °C global warming
Simulated change at 2 °C global warming
Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions
-40 -30 -20 -10 0 10 20 30
Change (%)
Drier
Wetter


Hot temperature extremes over land
10-year event
Frequency and increase in intensity of extreme temperature event that occurred once in 10 years on average in a climate without human influence
Future global warming levels
1850-1900
Present 1 °C
1.5 °C
2 °C
FREQUENCY per 10 years
Once
now likely occurs 2.8 times (1.8 - 3.2)
will likely occur 4.1 times (2.8 - 4.7)
will likely occur 5.6 times (3.8 - 6.0)
INTENSITY increase
+6 °C
+5 °C
+4 °C
+3 °C
+2 °C
+1 °C
0 °C
+1.2 °C hotter
+1.9 °C hotter
+2.6 °C hotter
50-year event
Frequency and increase in intensity of extreme temperature event that occurred once in 50 years on average in a climate without human influence
Future global warming levels
1850-1900
Present 1 °C
1.5 °C
2 °C
FREQUENCY per 50 years
Once
now likely occurs 4.8 times (2.3 - 6.4)
will likely occur 8.6 times (4.3 - 10.7)
will likely occur 13.9 times (6.9 - 16.6)
INTENSITY increase
+6 °C
+5 °C
+4 °C
+3 °C
+2 °C
+1 °C
0 °C
+1.2 °C hotter
+2.0 °C hotter
+2.7 °C hotter

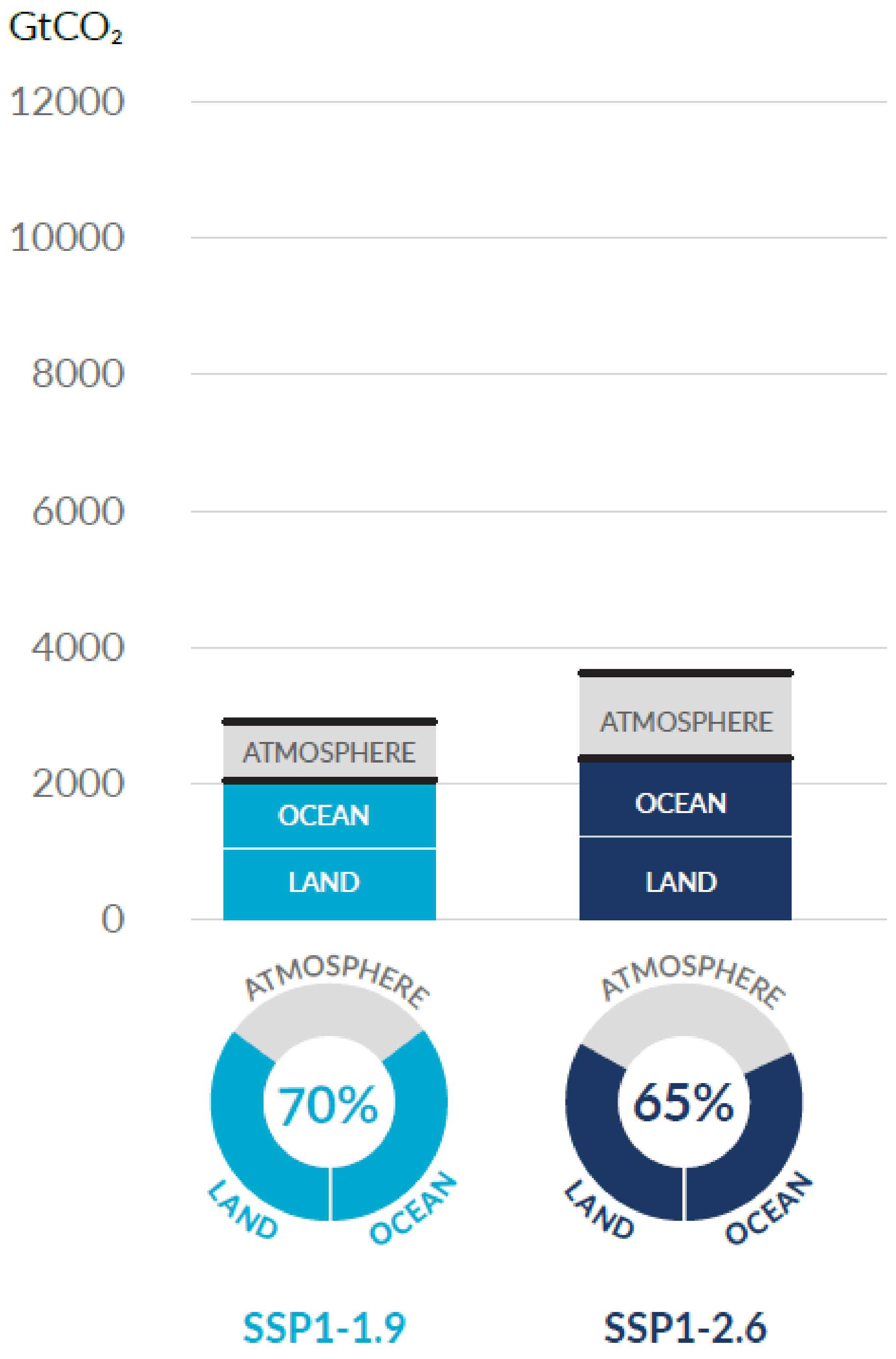


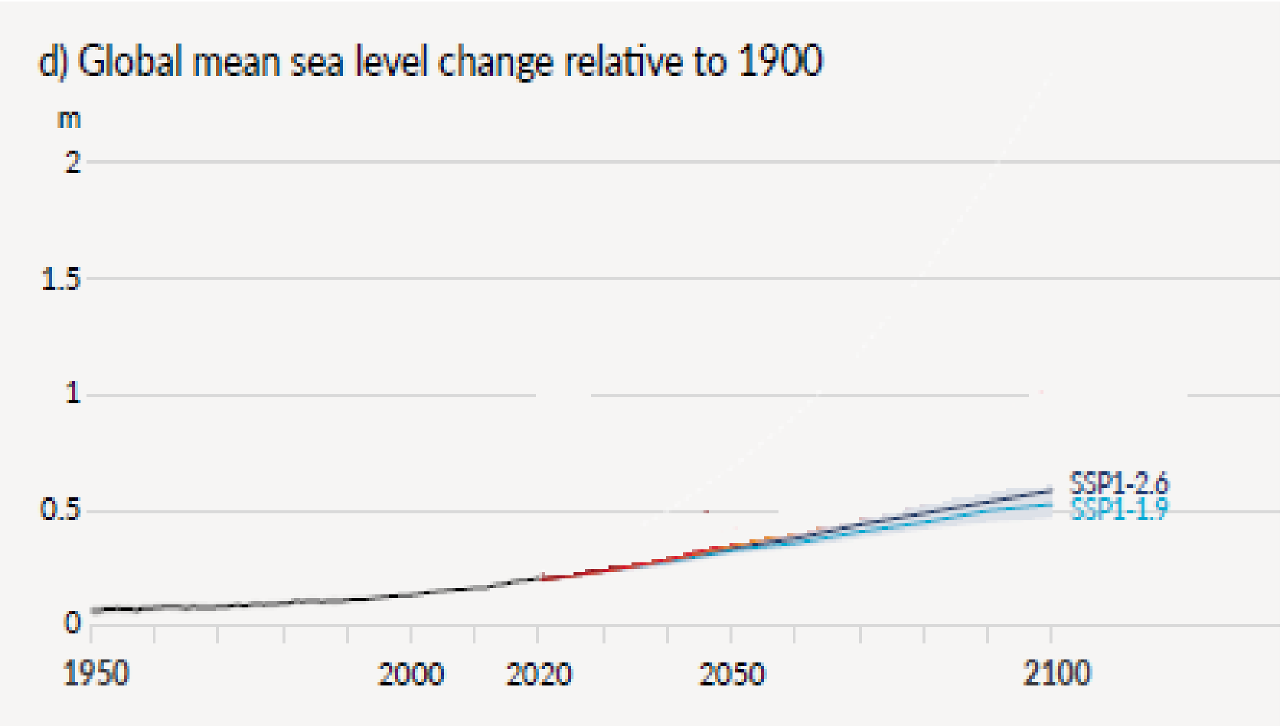
Heavy precipitation over land
10-year event
Frequency and increase in intensity of heavy 1-day precipitation event that occurred once in 10 years on average in a climate without human influence
Future global warming levels
1850-1900
Present 1 °C
1.5 °C
2 °C
FREQUENCY per 10 years
Once
now likely occurs 1.3 times (1.2 - 1.4)
will likely occur 1.5 times (1.4 - 1.7)
will likely occur 1.7 times (1.6 - 2.0)
INTENSITY increase
+40%
+30%
+20%
+10%
0%
+6.7% wetter
+10.5% wetter
+14.0% wetter

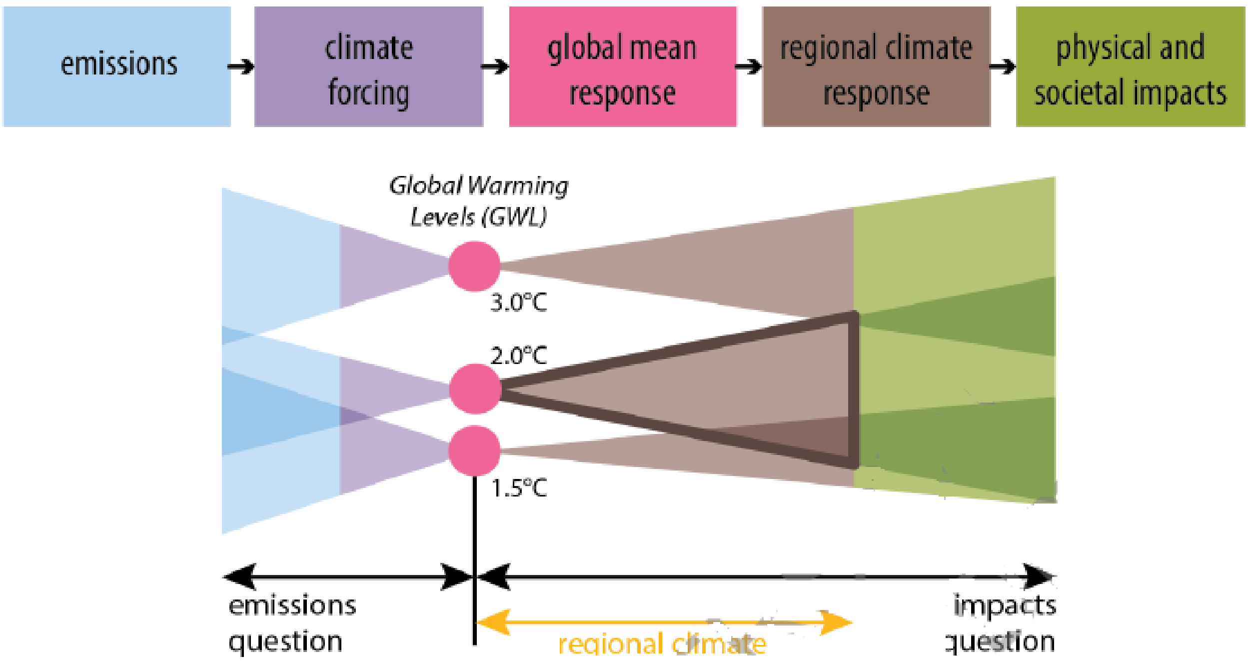


Agricultural & ecological droughts in drying regions
10-year event
Frequency and increase in intensity of an agricultural and ecological drought event that occurred once in 10 years on average across drying regions in a climate without human influence
Future global warming levels
1850-1900
Present 1 °C
1.5 °C
2 °C
FREQUENCY per 10 years
Once
now likely occurs 1.7 times (0.7 - 4.1)
will likely occur 2.0 times (1.0 - 5.1)
will likely occur 2.4 times (1.3 - 5.8)
INTENSITY increase
+2 sd
+1 sd
0 sd
+0.3 sd drier
+0.5 sd drier
+0.6 sd drier

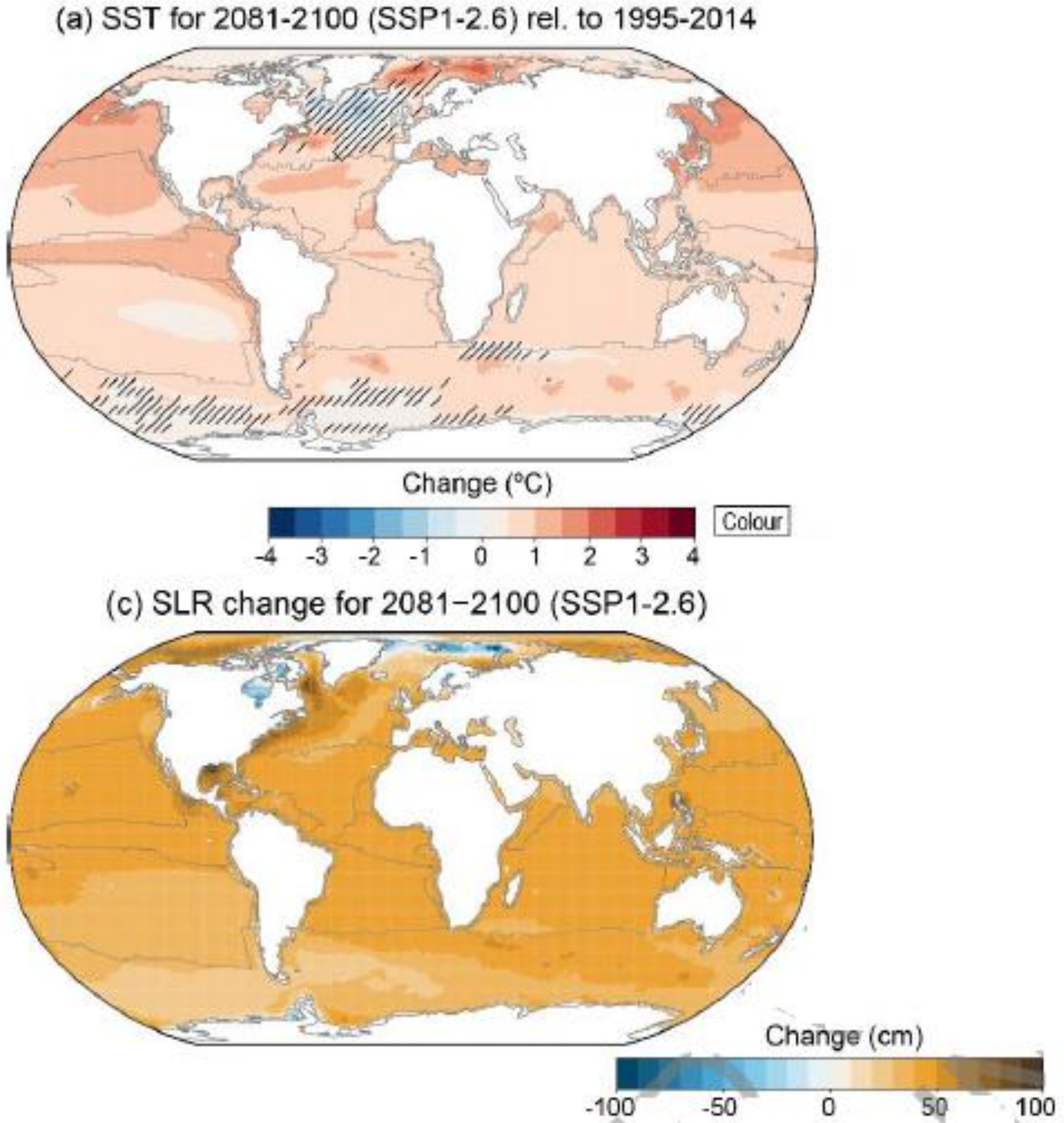
Land and ocean carbon sinks respond to past, current and future emissions, therefore cumulative sinks from 1850 to 2100 are presented here. During the historical period (1850-2019) the observed land and ocean sink took up 59% of the emissions.




d) Global mean sea level change relative to 1900
m
2
1.5
1
0.5
0
1950
2000
2020
2050
2100
SSP1-2.6
SSP1-1.9

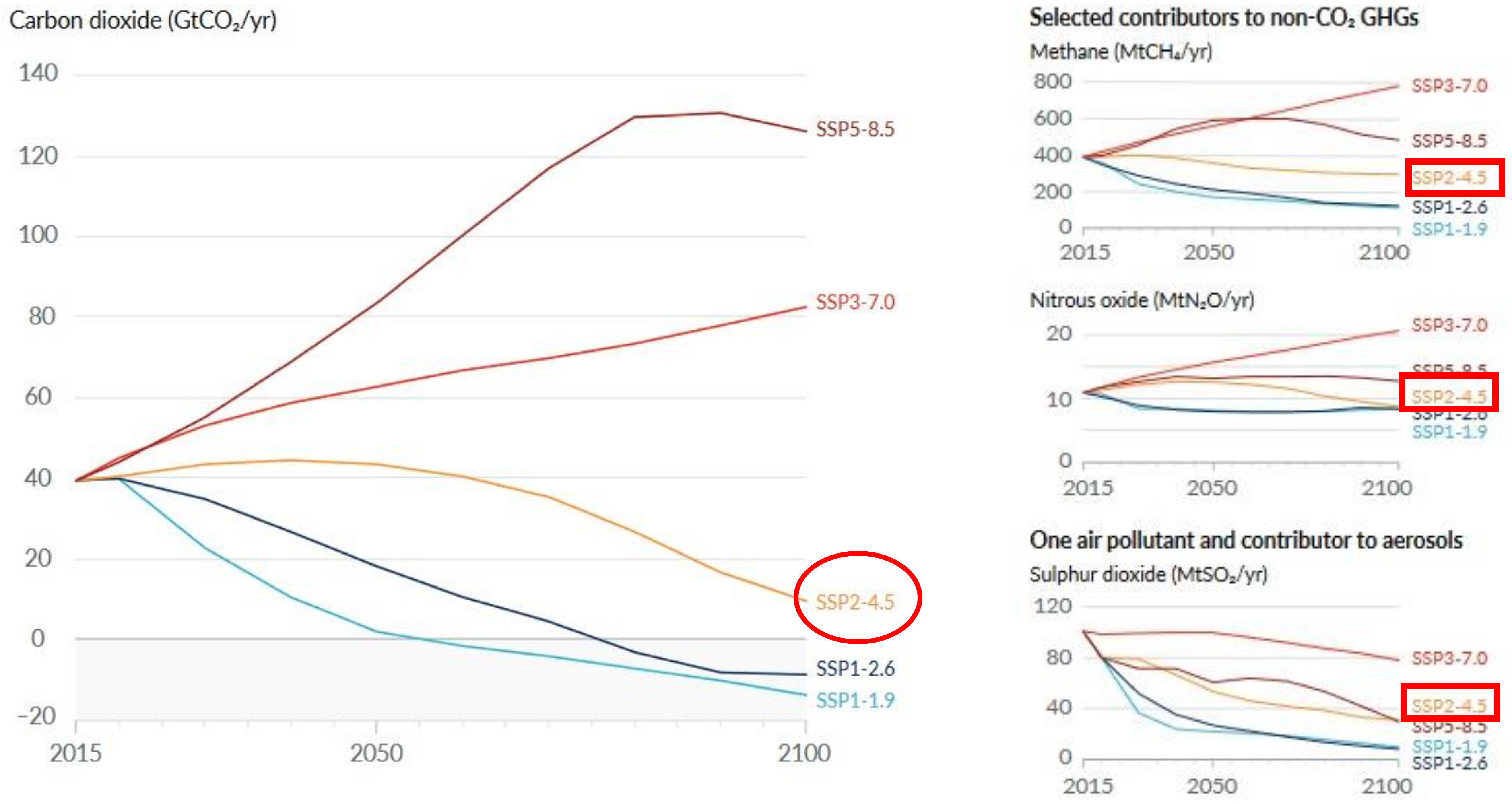

emissions
climate forcing
global mean response
regional climate response
physical and societal impacts
Global Warming Levels (GWL)
3.0°C
2.0°C
1.5°C
emissions question
regional climate
impacts question

Projected changes in sea surface temperature (top), sea level rise (bottom) for 2081–2100 under the SSP1-2.6 emission scenario compared to a 1995 - 2014 baseline



SSP2- 4.5

SSP2-4.5 – middle-of-the-road development



GSAT - Global Surface Air Temperature

- CMIP6 models show 5–95% range of GSAT change for 2081–2100, relative to 1995–2014, of 1.4°C–3.0°C, where CO2 concentrations increase to 2100
- general tendency toward larger long-term globally averaged surface warming than did the CMIP5 models, for nominally comparable scenarios
- 5–95% ranges have remained similar to the ranges in RCP2.6 and RCP4.5, respectively, but the distributions have shifted upward by about 0.3°C
- with regards to global warming levels of 1.5°C, 2.0°C, and 3.0°C, GSAT change relative to 1850–1900 will rise above 1.5°C

Units = °C	SSP2-4.5
Global: 2021–2040	
relative to 1995–2014	0.7 (0.4, 1.2)
relative to 1850–1900	1.6 (1.0, 2.3)
Global: 2041–2060	
relative to 1995–2014	1.3 (0.8, 1.9)
relative to 1850–1900	2.1 (1.5, 3.0)
Global: 2081–2100	
relative to 1995–2014	2.0 (1.4, 3.0)
relative to 1850–1900	2.9 (2.1, 4.0)
Land: 2081–2100 relative to 1995–2014	2.7 (1.7, 4.0)
Ocean: 2081–2100 relative to 1995–2014	1.8 (1.2, 2.7)
Tropics: 2081–2100 relative to 1995–2014	1.8 (1.2, 2.5)
Arctic: 2081–2100 relative to 1995–2014	5.4 (2.8, 10.0)
Antarctic: 2081–2100 relative to 1995–2014	1.9 (0.6, 3.2)

CMIP6 annual mean surface air temperature anomalies (°C). Displayed are multi-model averages and, in parentheses, the 5–95% ranges, for selected time periods, regions, and given SSP.

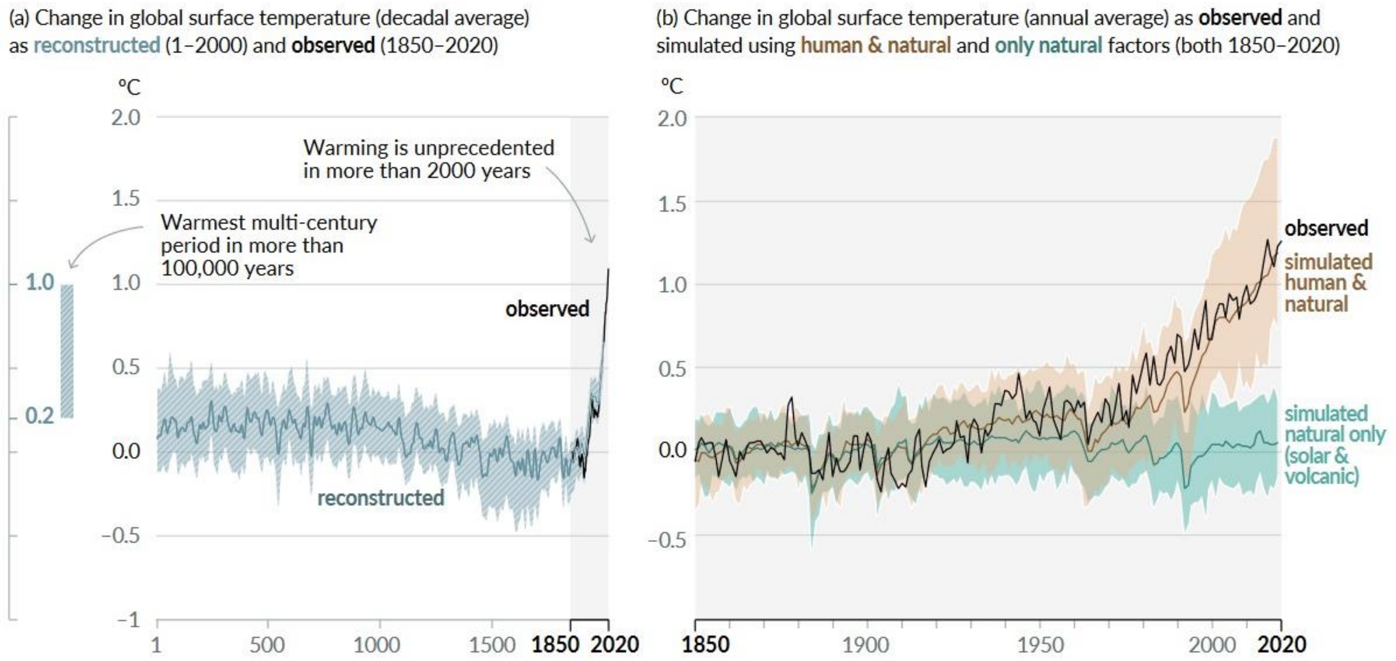
GSAT – Global Surface Air Temperature

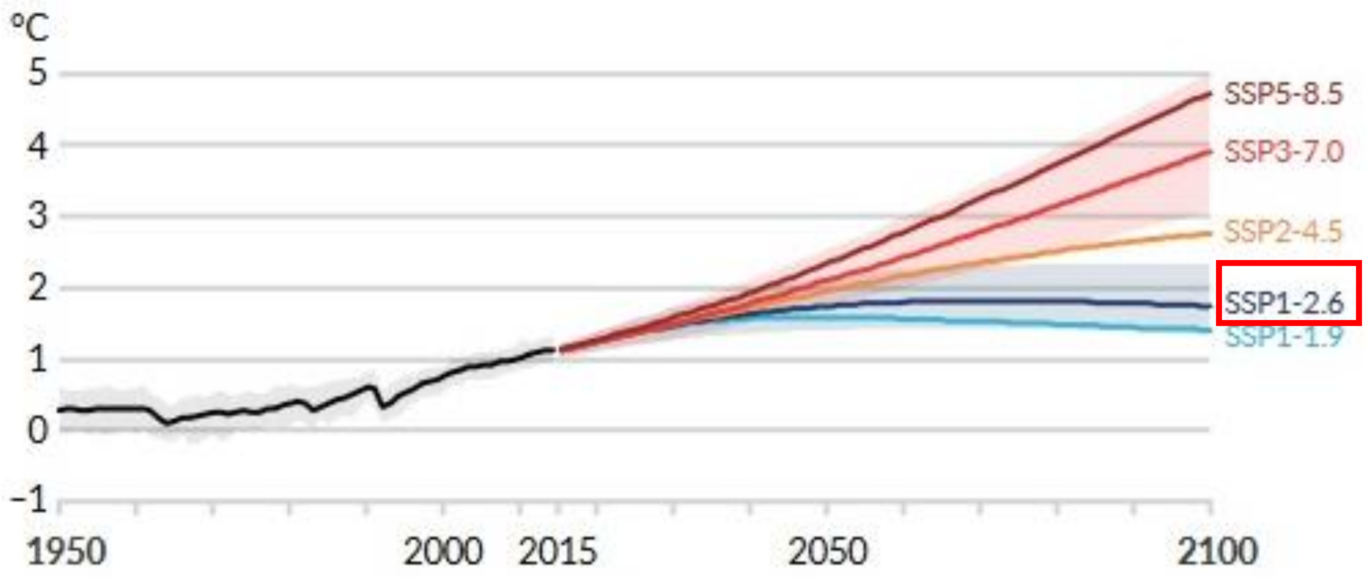
- averaged GSAT over the period 2081–2100 is very likely to be higher than in the recent past (1995–2014) by 1.3°C–2.5°C
- averaged GSAT over the period 2081–2100 is very likely to be higher than in the period 1850–1900 by 2.1°C–3.5°C
- during the near term (2021–2040), a 1.5°C increase in the 20-year average of GSAT, relative to the average over the period 1850–1900, is likely to occur in this scenario
- this scenario indicates that the central estimate of crossing the 1.5°C threshold lies in the early 2030s
- a warming level of 2°C in GSAT, relative to the period 1850–1900, is more likely than not to be crossed during the mid-term period under SSP2-4.5
- during the entire 21st century, a warming level of 2°C in GSAT, relative to the period 1850–1900, will extremely likely be crossed

	SSP2-4.5
Near term, 2021–2040 relative to 1995–2014 relative to 1850–1900	0.7 (0.4, 0.9) 1.5 (1.2, 1.8)
Mid-term, 2041–2060 relative to 1995–2014 relative to 1850–1900	1.1 (0.8, 1.6) 2.0 (1.6, 2.5)
Long term, 2081–2100 relative to 1995–2014 relative to 1850–1900	1.8 (1.2, 2.6) 2.7 (2.1, 3.5)
1.5°C, relative to 1850–1900	2021–2040 (2012–2031, 2037–2056)
2°C, relative to 1850–1900	2043–2062 (2028–2047, 2075–2094)
3°C, relative to 1850–1900	n.c. (2061–2080, n.c.)
4°C, relative to 1850–1900	n.c. (n.c., n.c.)

The change is displayed in °C relative to the 1995–2014 and 1850–1900 reference periods for selected time periods, and as the time when certain temperature thresholds are crossed, relative to the period 1850–1900. The entries give both the central estimate and, in parentheses, the very likely (5–95%) range, n.c. - the global warming threshold is not crossed during the period 2021–2100.

Changes in GSAT relative to 1850-1900





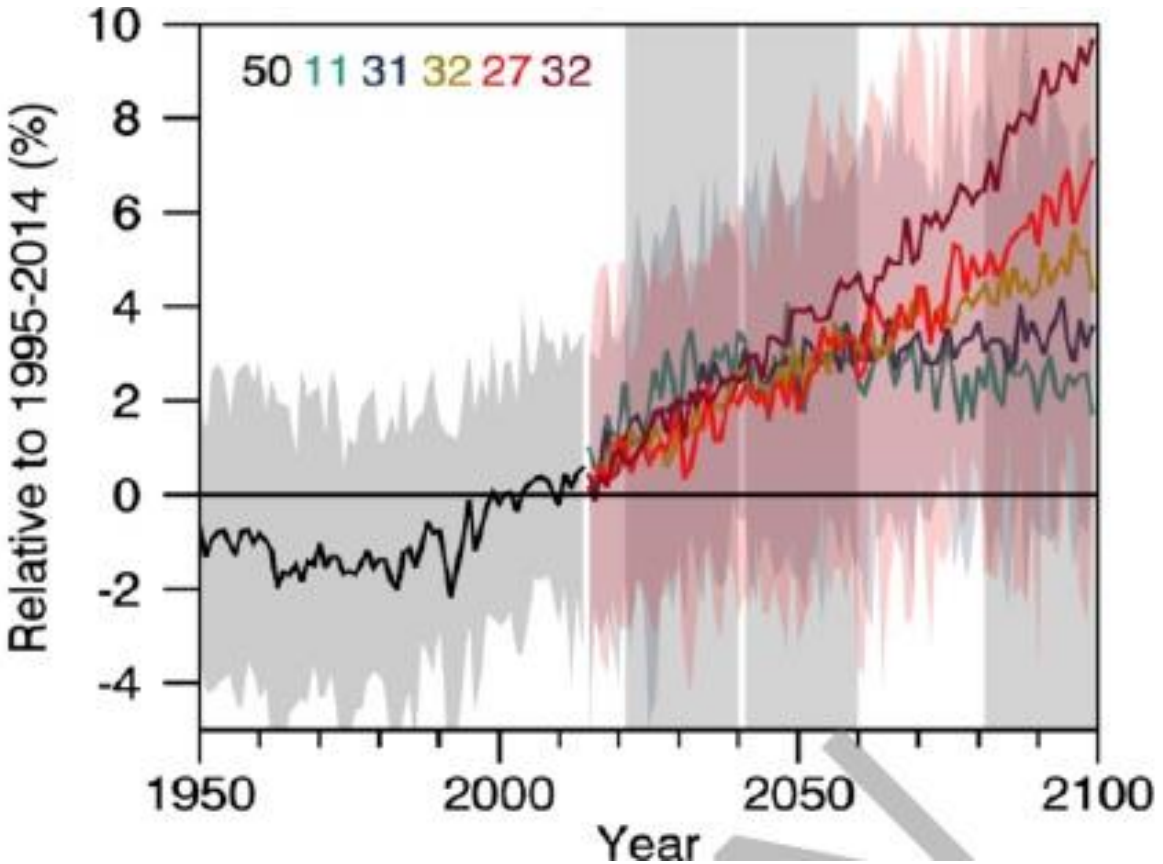
Units = %	SSP2-4.5
Land: 2021–2040	1.5 (–0.4, 3.6)
2041–2060	2.7 (0.3, 5.2)
2081–2100	4.6 (1.5, 8.3)
Global: 2081–2100	4.0 (2.3, 6.7)
Ocean: 2081–2100	3.8 (2.0, 6.8)
Land: ΔT > 1.5°C	1.7 (–2.9, 6.2) 100
ΔT > 2.0°C	2.8 (–2.2, 8.1) 97
ΔT > 3.0°C	4.9 (1.5, 9.6) 54
ΔT > 4.0°C	4.2 (1.3, 6.3) 9

Global land precipitation

- global land precipitation is larger during the period 2081–2100 than during the period 1995–2014
- global land precipitation for 2081–2100, relative to 1995–2014, shows a 5–95% range of 1.5–8.3%
- relative to 1995–2014, CMIP6 models show greater increases in precipitation over land than either globally or over the ocean

CMIP6 precipitation anomalies (%) relative to averages over 1995–2014 for selected future periods, regions and given SSP. Also shown are land precipitation anomalies at the time when global increase in GSAT relative to 1850–1900 exceeds 1.5°C, 2.0°C, 3.0°C, and 4.0°C, and the percentage of 2 simulations for which such exceedances are true (to the right of the parentheses).

Global land precipitation changes relative to the 1995-2014 average

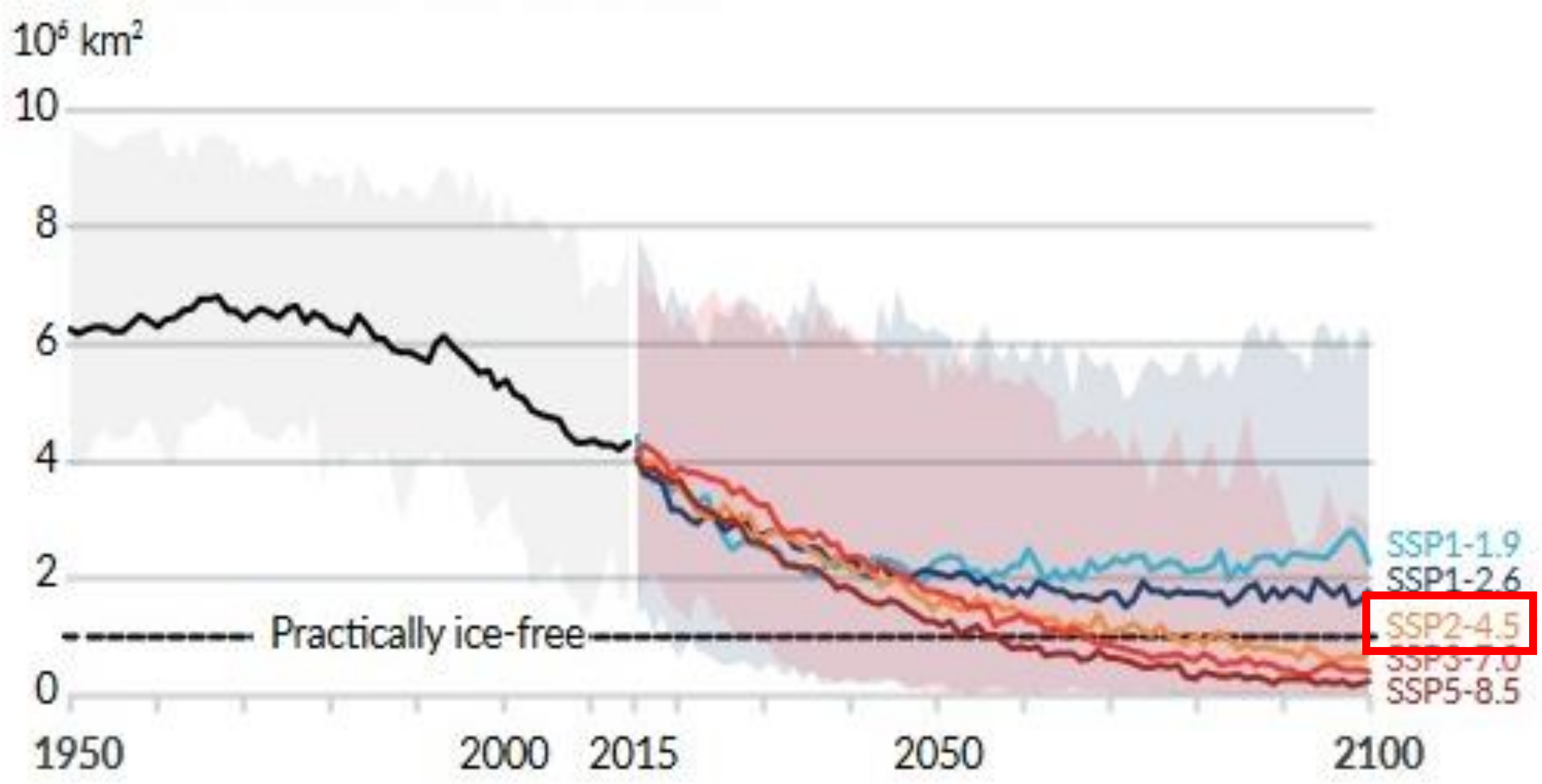


Arctic SIA – Sea Ice Area and GMSL – Global Mean Sea Level

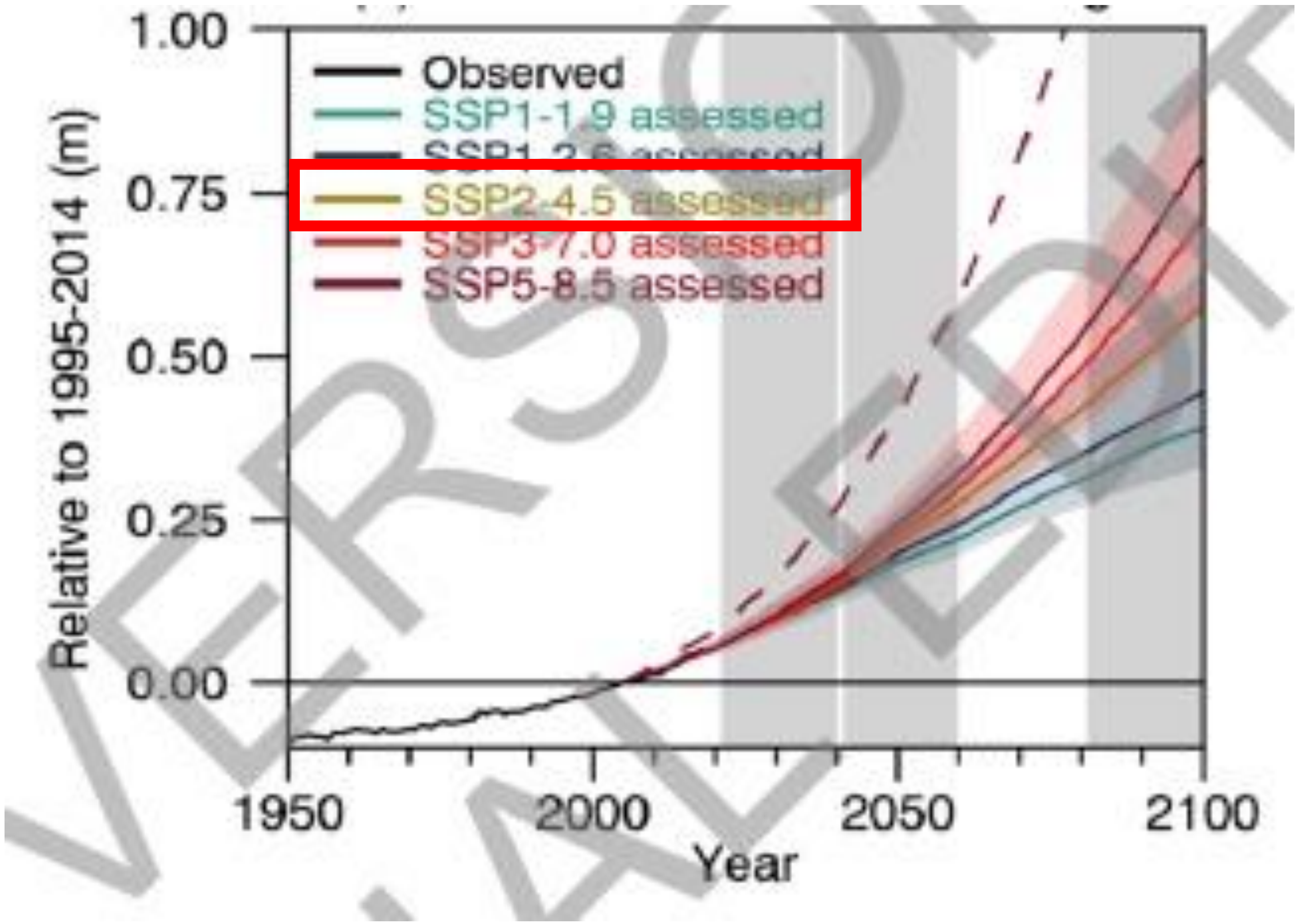
Units = $10^6 km^2$		SSP2-4.5
September:	2021–2040	2.8 (0.7, 6.4)
	2041–2060	1.7 (0.1, 5.6)
	2081–2100	0.8 (0.0, 4.6)
March:	2021–2040	14.9 (11.9, 23.5)
	2041–2060	14.3 (11.1, 23.3)
	2081–2100	13.1 (9.5, 22.2)

- on average the Arctic SIA will become practically ice-free in September by the end of the 21st century
- Arctic SIA in March decreases in the future, but to a much lesser degree than in September
- based on the assessment of the latest modelling information, the rise in GMSL is projected to accelerate over the 21st century
- under any one of the assessed SSPs, there will be continued rise in GMSL through the 21st century

September Arctic sea ice area



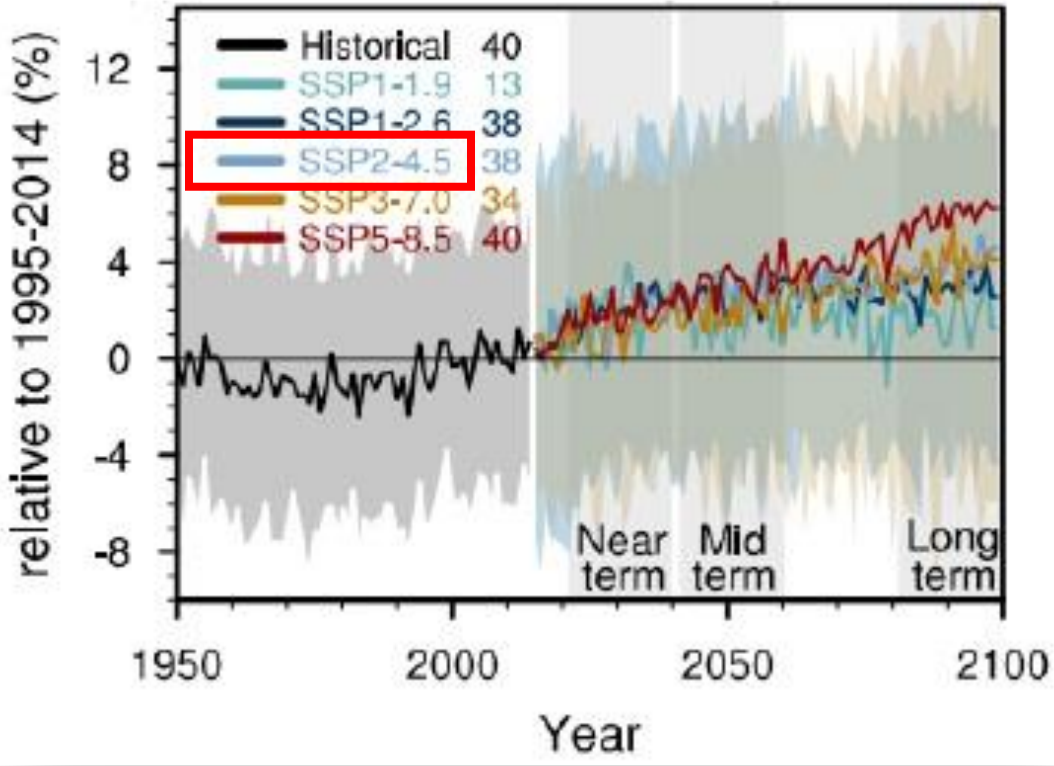
Global mean sea level change



Global Monsoon Precipitation and Circulation

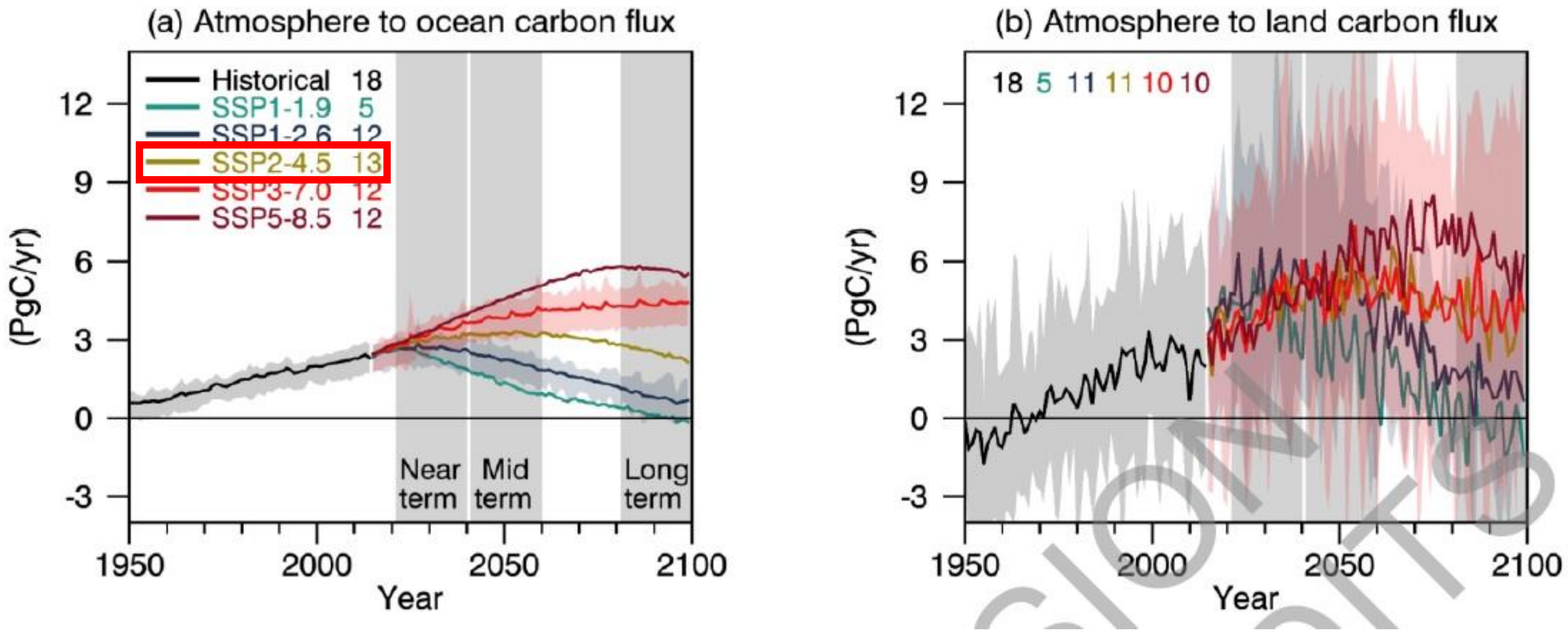
- the global land monsoon precipitation index, tends to increase in the near term, but changes are small compared to the intermodel spread in the historical period

- in the near-term, for CMIP6 projections, the multi-model mean (5–95% range) of global land monsoon precipitation change is 1.6%



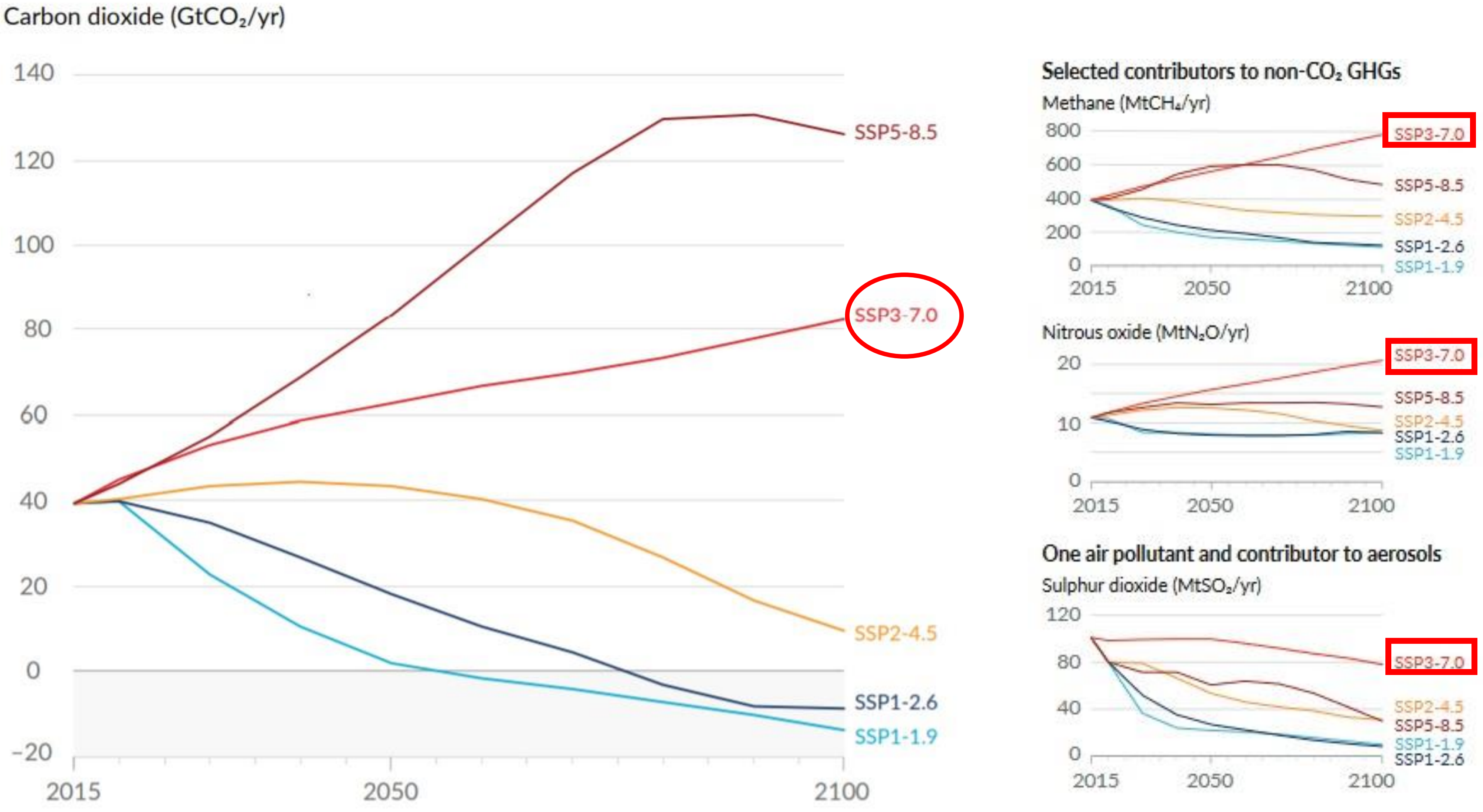
Ocean & Land Carbon flux

- SSP2-4.5 clearly lead to increasing 10-, 20-, and 30–37-year trends in ocean carbon flux over the near term

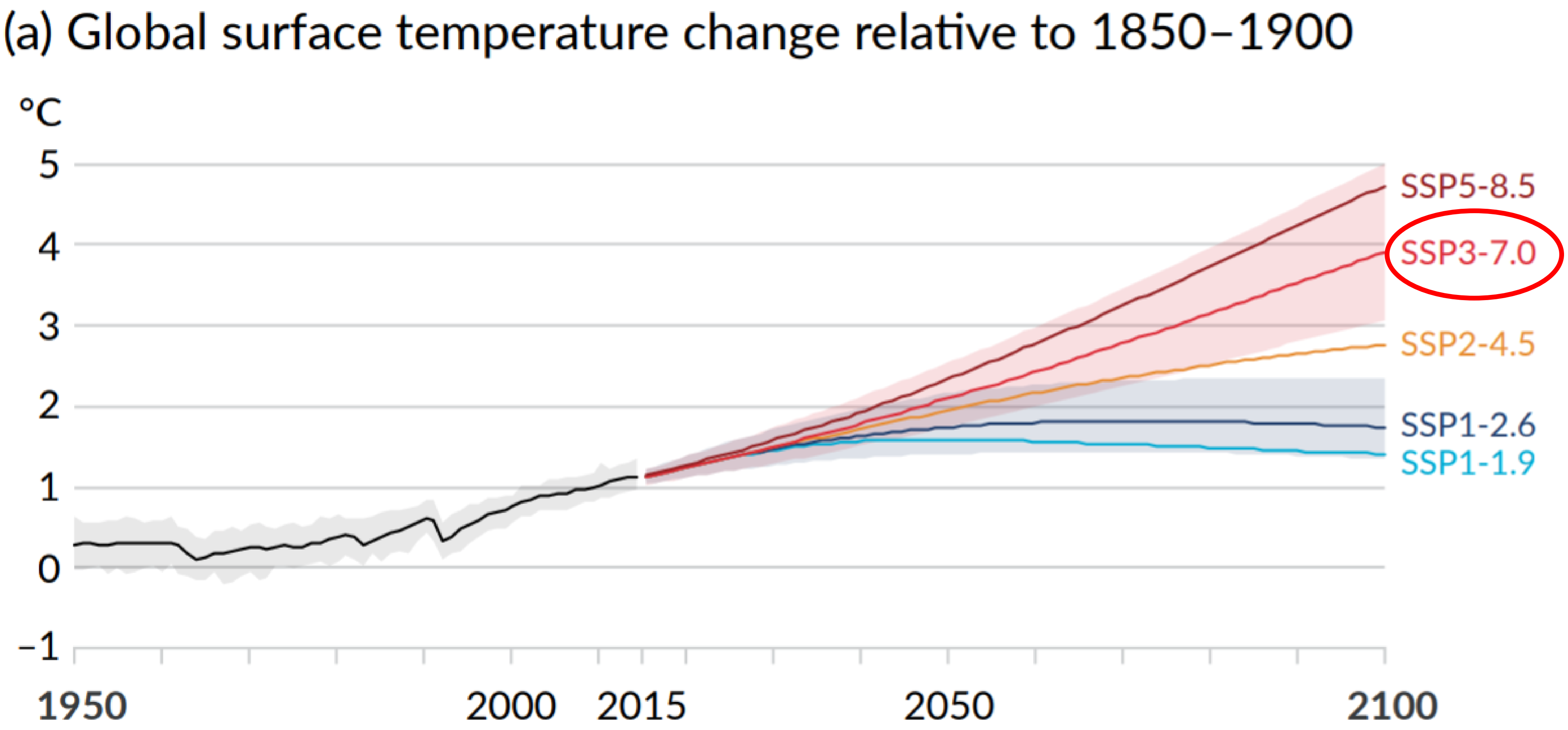


SSP3- 7.0

SSP3-7.0 – a Rocky Road



Changes in global surface temperature

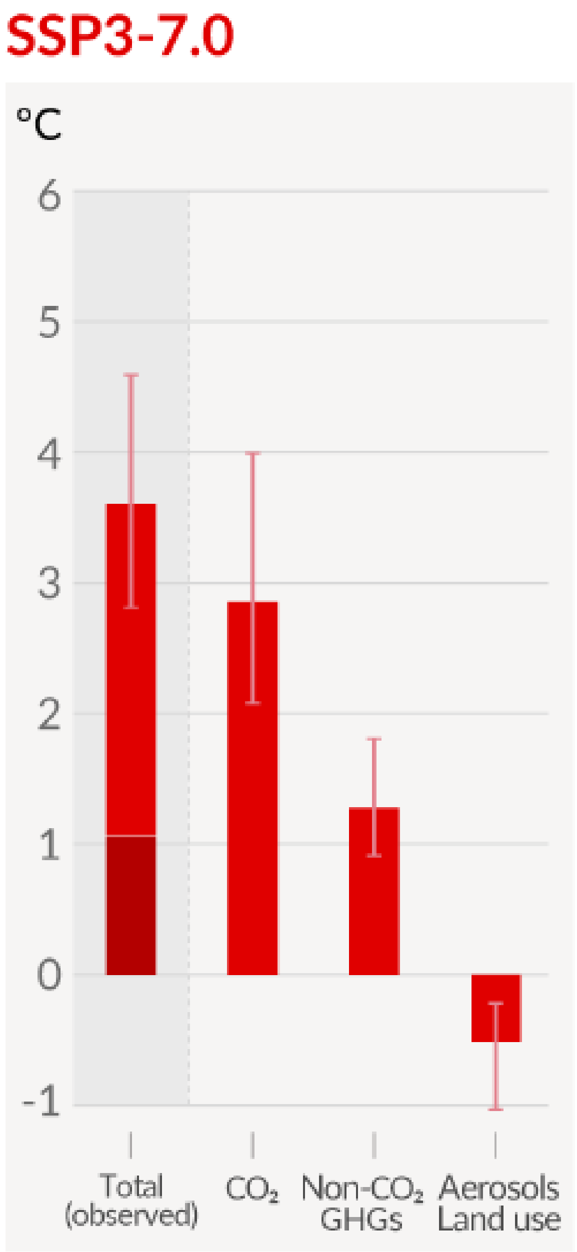


Changes in global surface temperature

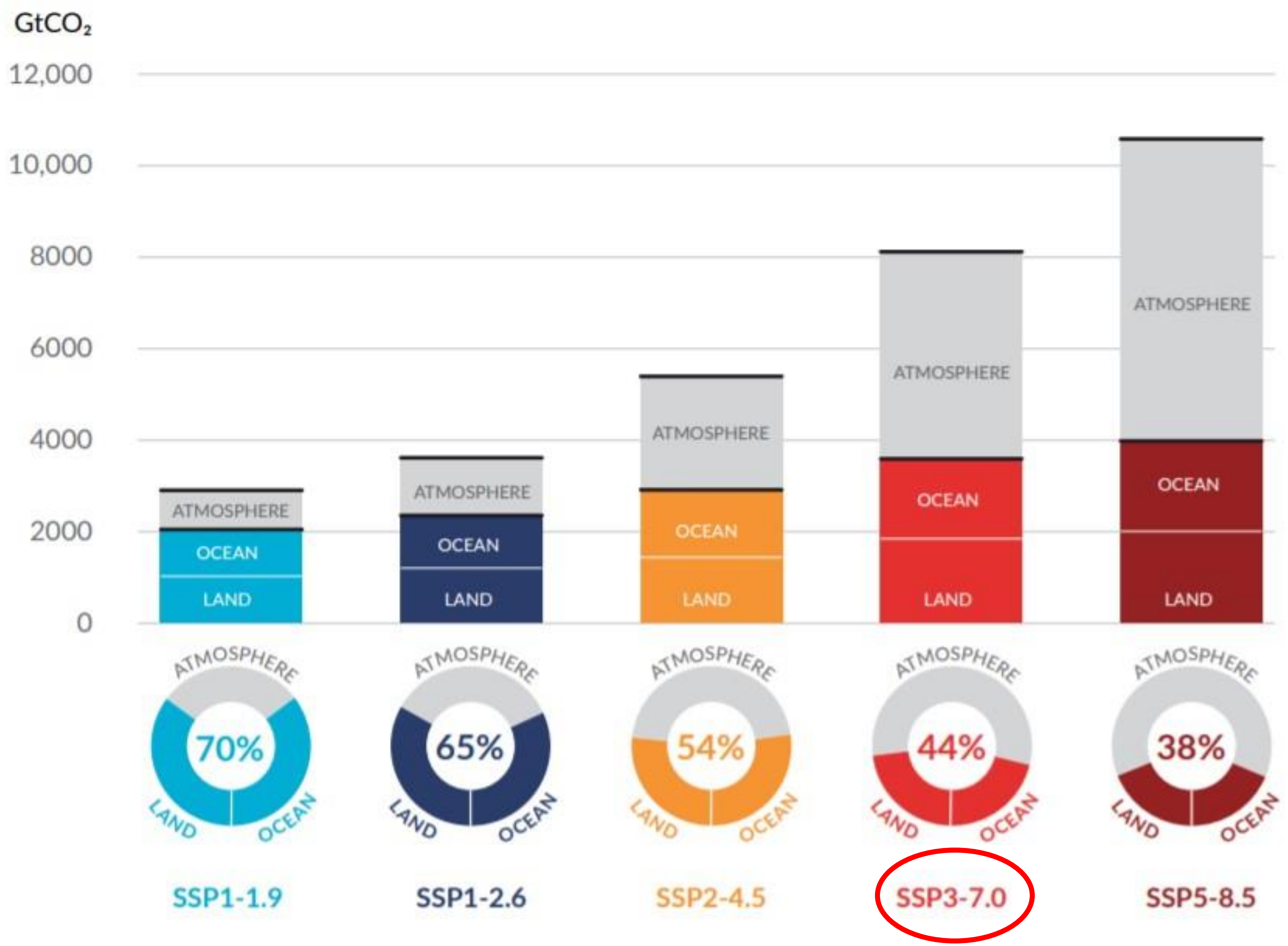
	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	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

Change in global surface temperature (in 2081–2100) & contribution to global surface temperature increase from different emissions

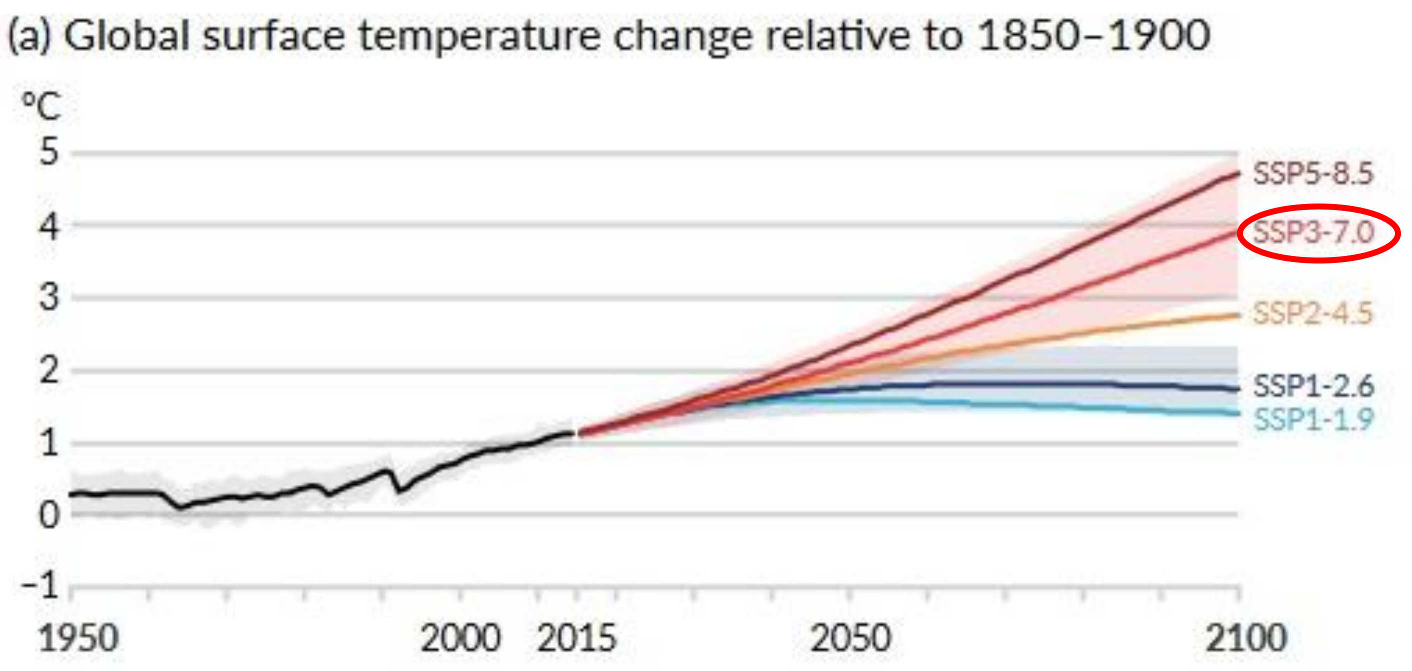
Units = °C	SSP3-7.0
Global: 2021–2040 relative to 1995–2014 relative to 1850–1900	 0.7 (0.5, 1.2) 1.6 (1.0, 2.4)
Global: 2041–2060 relative to 1995–2014 relative to 1850–1900	 1.4 (0.9, 2.3) 2.3 (1.6, 3.2)
Global: 2081–2100 relative to 1995–2014 relative to 1850–1900	 3.1 (2.2, 4.7) 3.9 (2.8, 5.5)
Land: 2081–2100 relative to 1995–2014	4.1 (3.0, 6.2)
Ocean: 2081–2100 relative to 1995–2014	2.7 (1.8, 4.0)
Tropics: 2081–2100 relative to 1995–2014	2.7 (2.0, 4.0)
Arctic: 2081–2100 relative to 1995–2014	7.7 (4.5, 13.4)
Antarctic: 2081–2100 relative to 1995–2014	2.8 (1.3, 4.5)



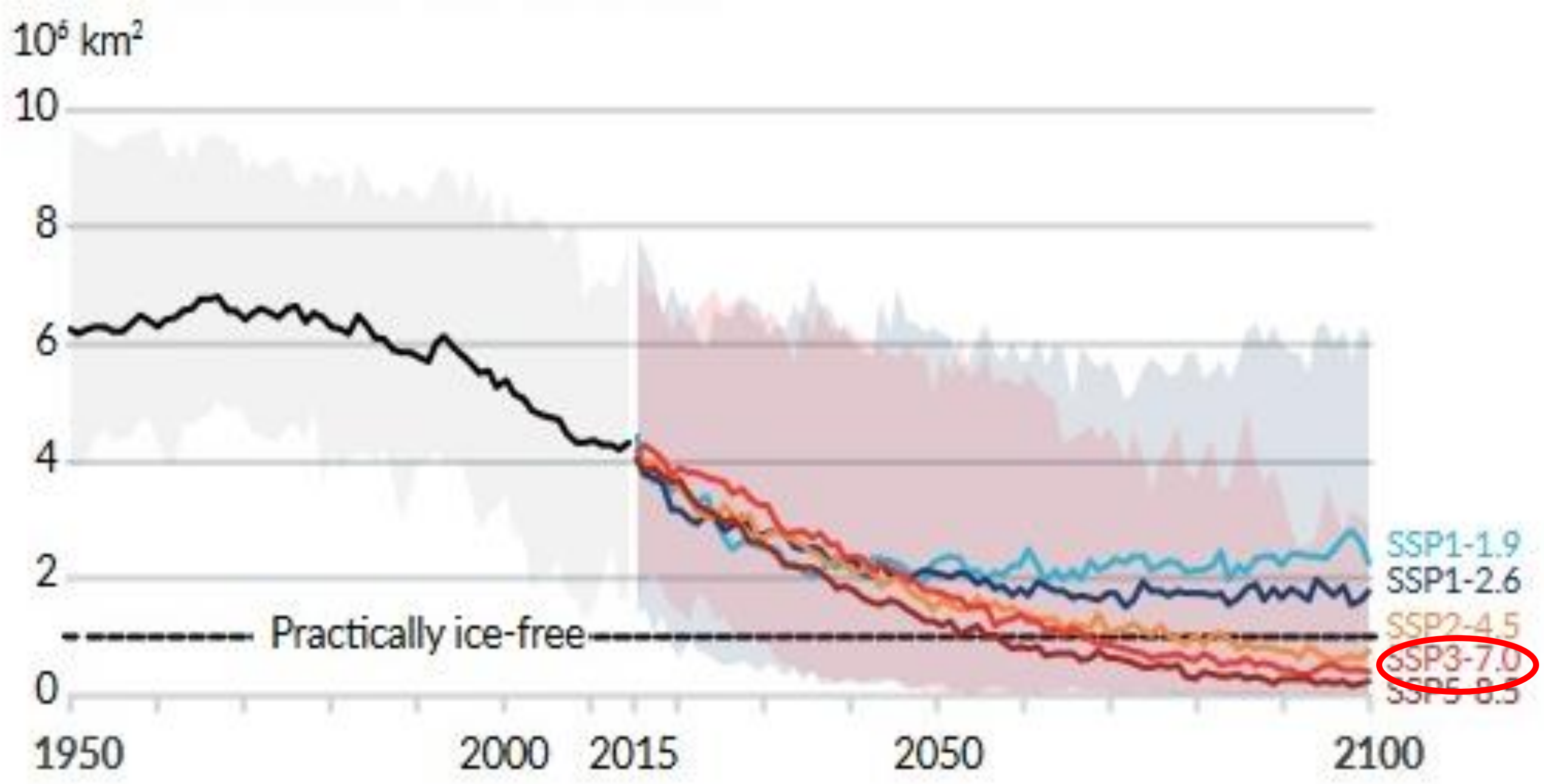
Total cumulative CO_2 emissions taken up by land and ocean and remaining in the atmosphere



Global mean sea level change (relative to 1900)

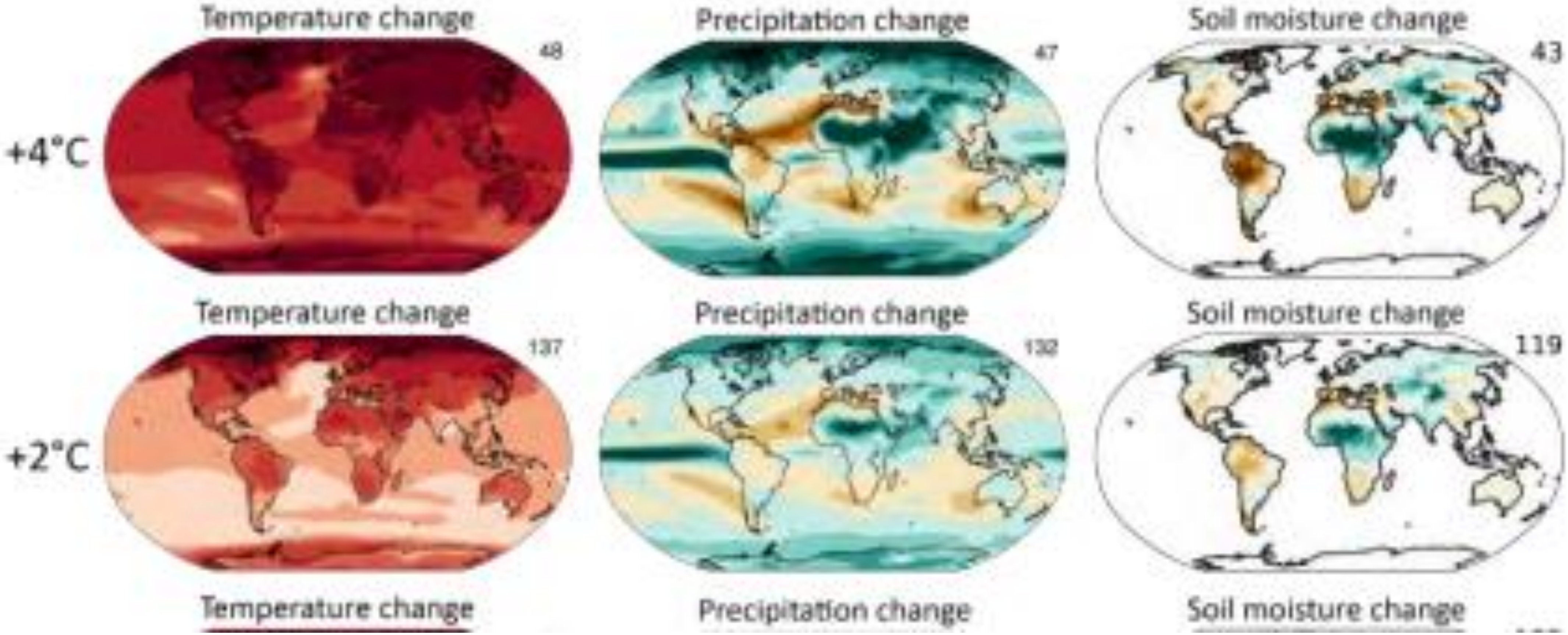


September Arctic sea ice area



The Arctic surface is projected to warm on annual average 10C, by 2081–2100 14 relative to 1995–2014

Climate Changes under SSP3

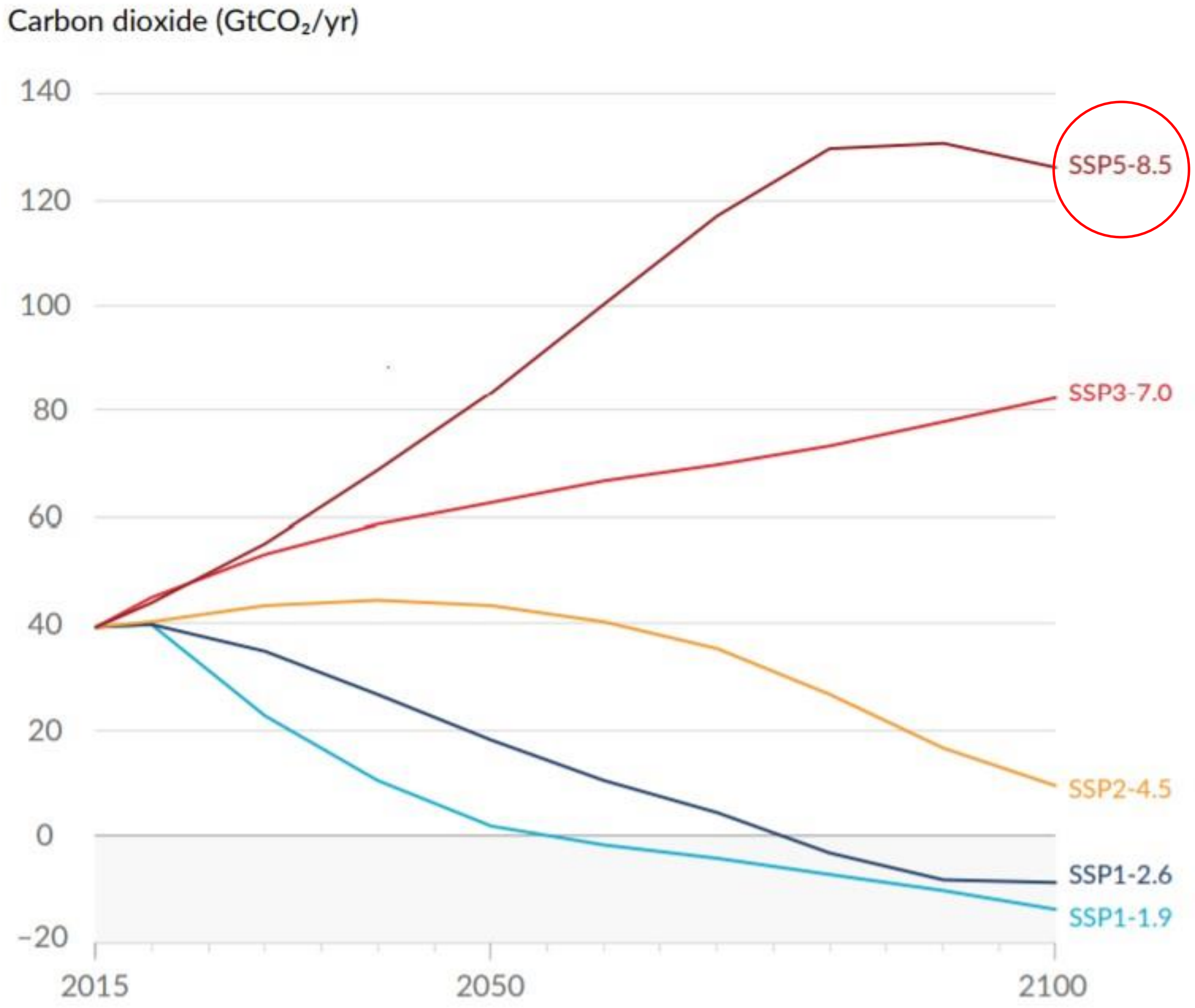


SSP3-7.0 – a Rocky Road

- The baseline scenario SSP3 was similar to that of SSP2, whereas **CO2 emissions** in SSP3 are higher than those in SSP2. This is mainly due to high **aerosol emissions** in SSP3.
- SSP3 has higher **climate mitigation costs**, due to combination of high greenhouse gas emissions in the baseline (no climate mitigation policy) scenario and low mitigative capacity.
- SSP3 has unique characteristics for **air pollutant** emissions and **land use** change. Weak implementation of **air quality legislation** and a high level of **coal dependency**, as well as forest area steadily decreases with a large **expansion of cropland and pasture** land.
- Global warming due to increases in methane, 39 tropospheric ozone and HFC levels. Large differences between Northern and Southern hemisphere **methane concentration**.
- **SSP3-7.0-lowNTCF** only reduced aerosol and ozone precursors compared to SSP3-7.0, not methane
- SSP3 shows high challenges to the adaptation in terms of **income and trade features.**
- By comparing SSP2 and SSP3, IAV analyses can clarify the influences of **socioeconomic elements** under similar climatic conditions.

SSP5- 8.5

SSP5-8.5
Worst Case
Scenario



Changes in global surface temperature for selected 20-year time periods

	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* 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
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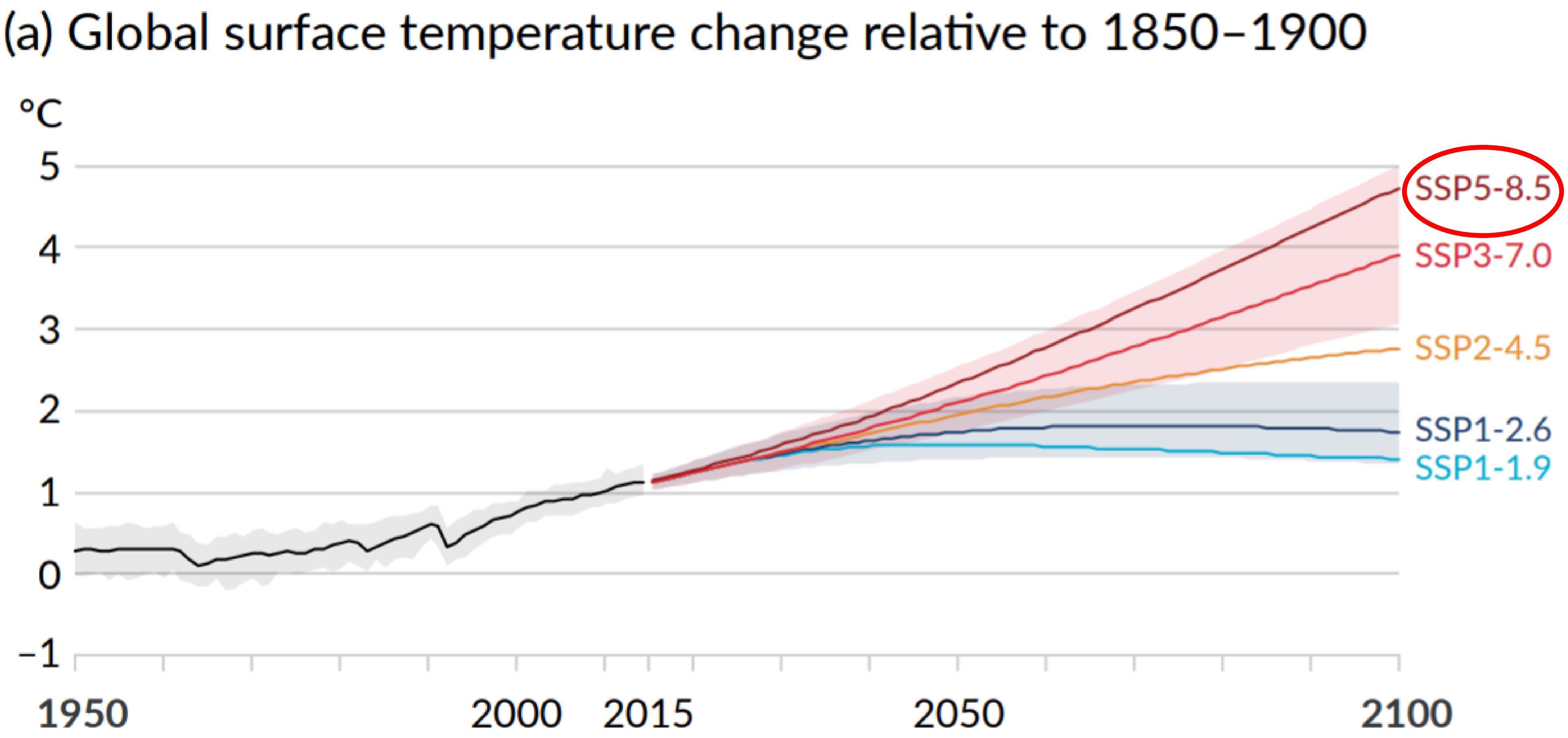
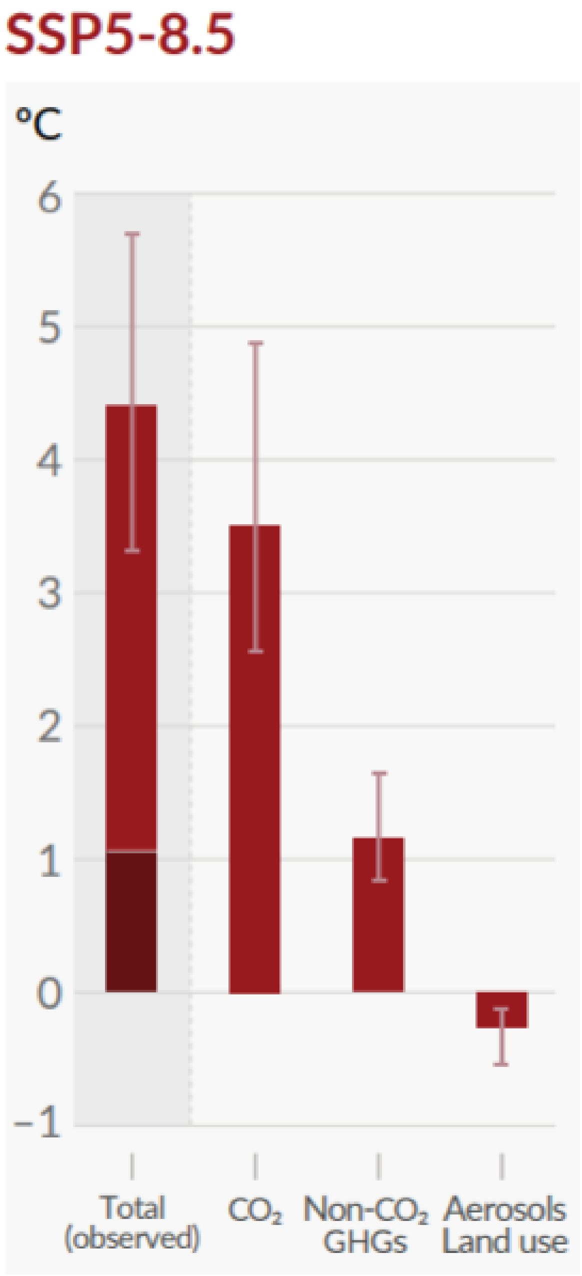
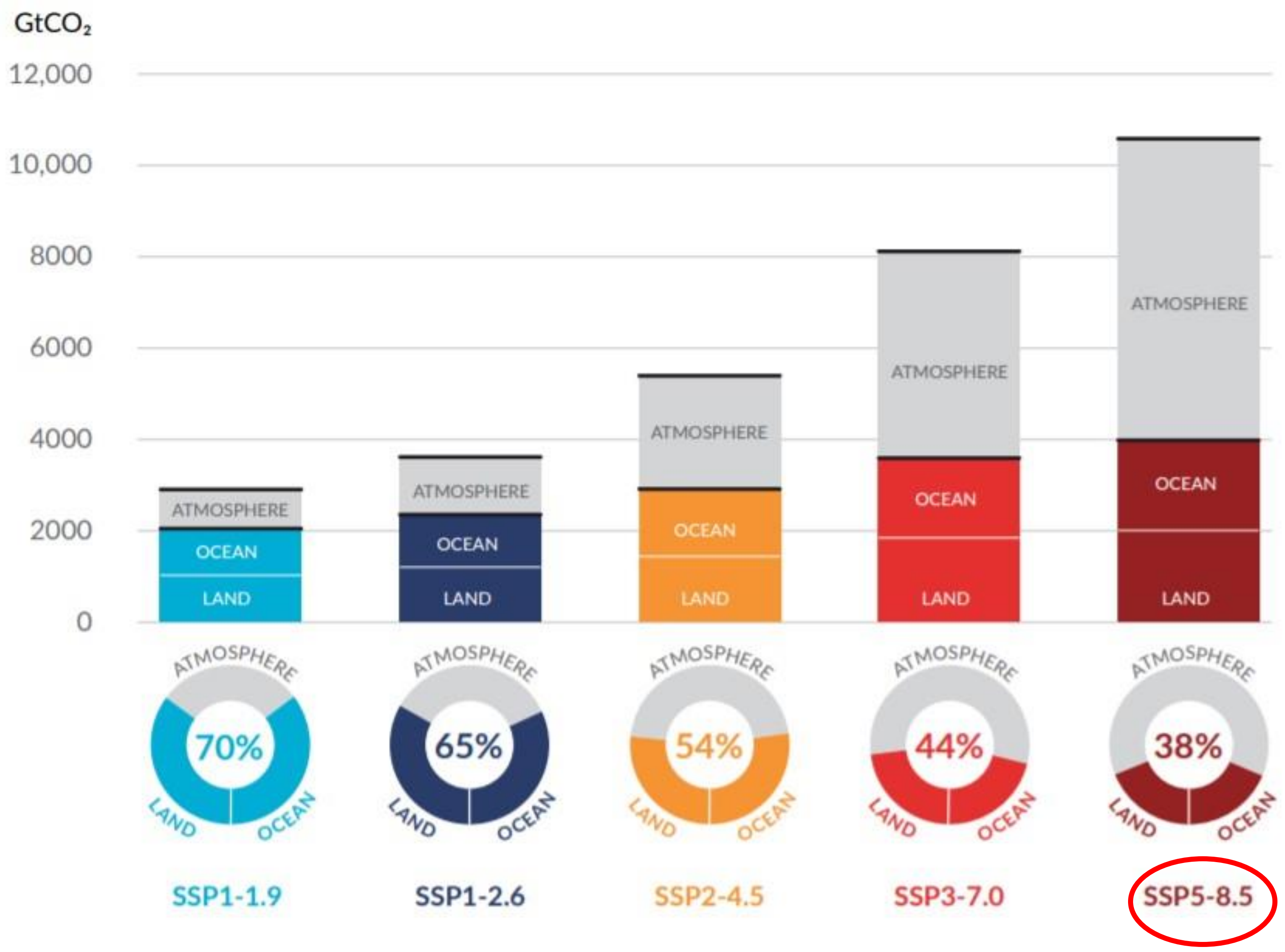
Changes in global surface temperature



Change in global surface temperature (in 2081–2100) & contribution to global surface temperature increase from different emissions

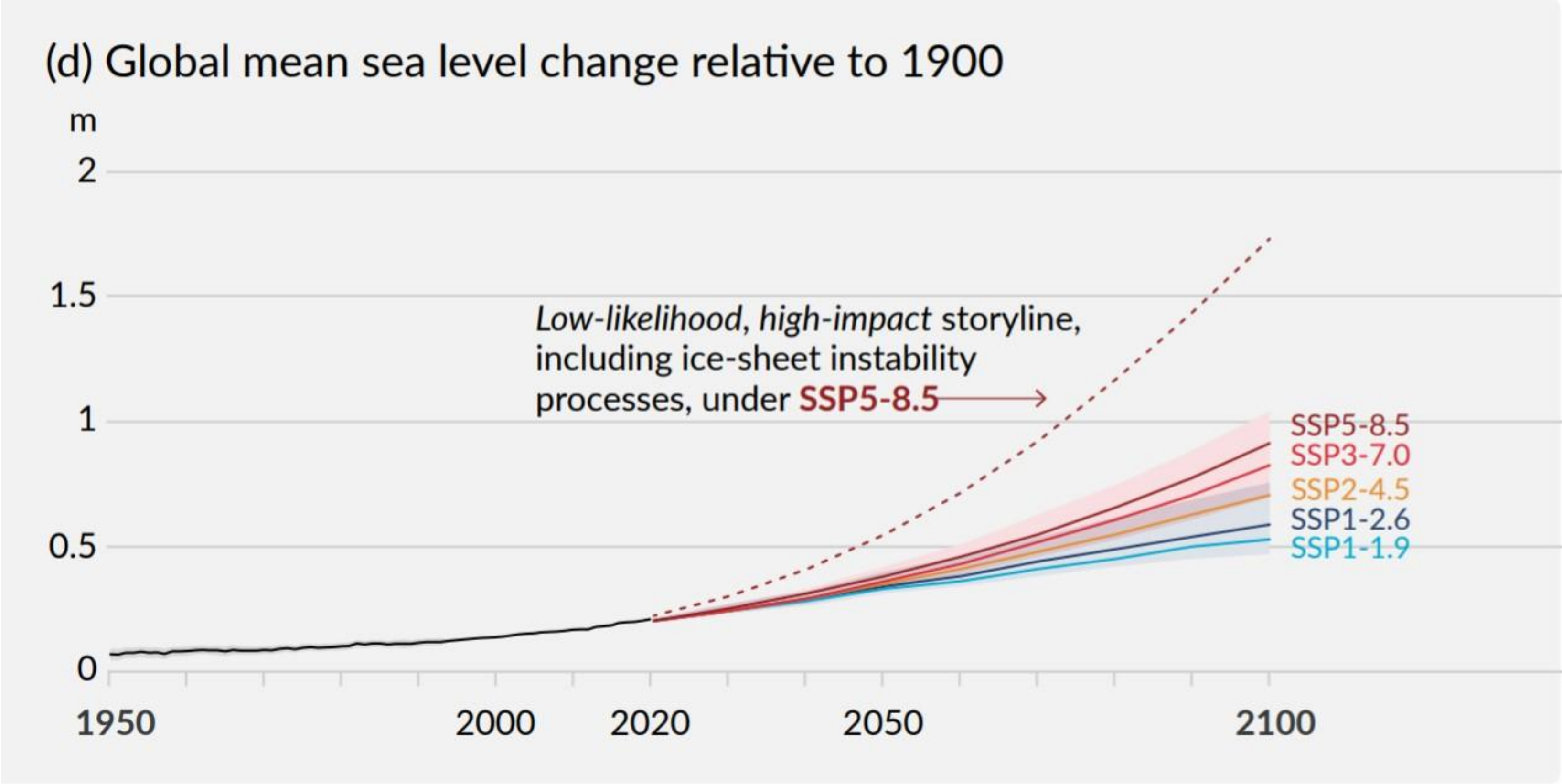


Total cumulative CO_2 emissions taken up by land and ocean and remaining in the atmosphere

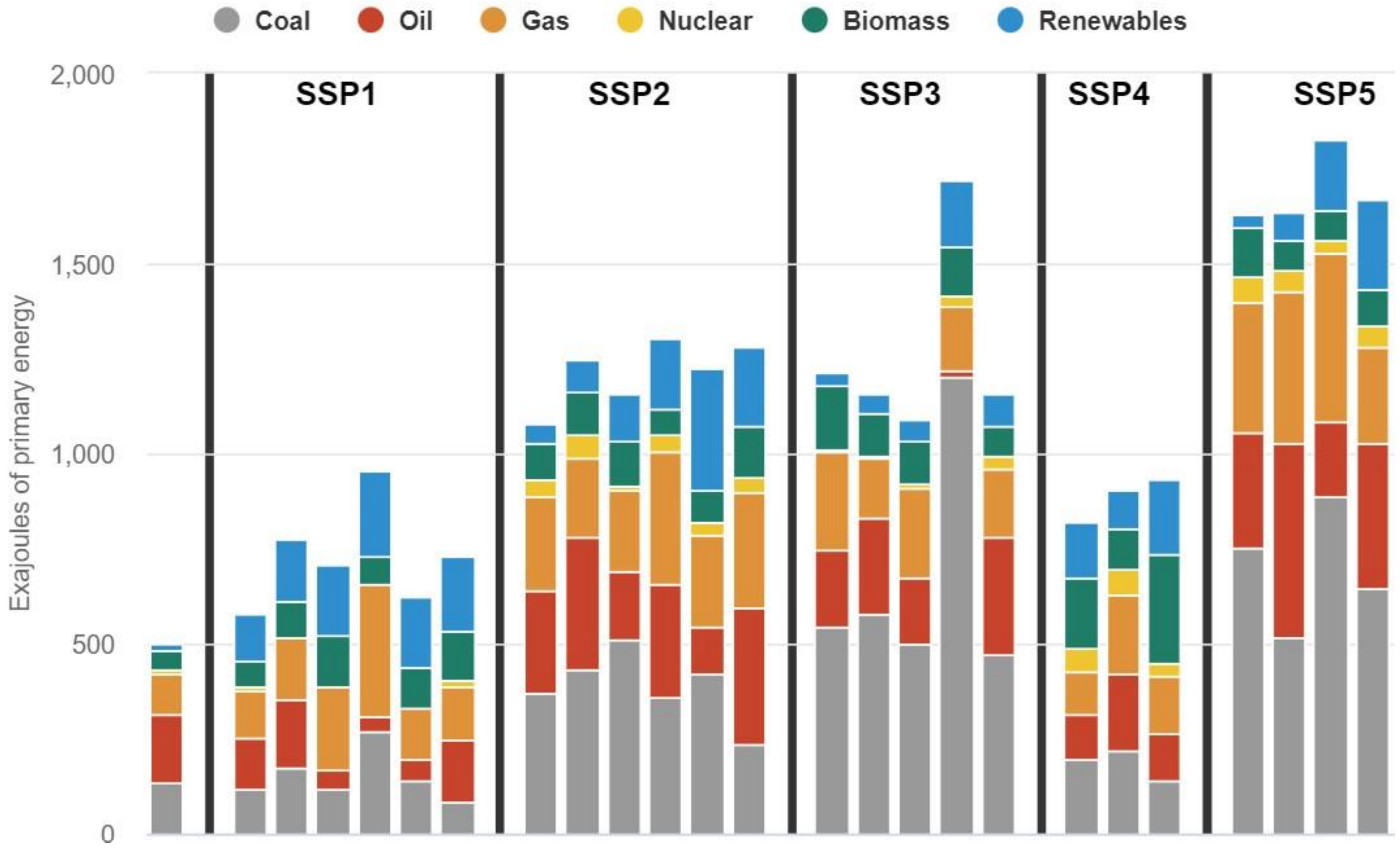


Global mean sea level change (relative to 1900)

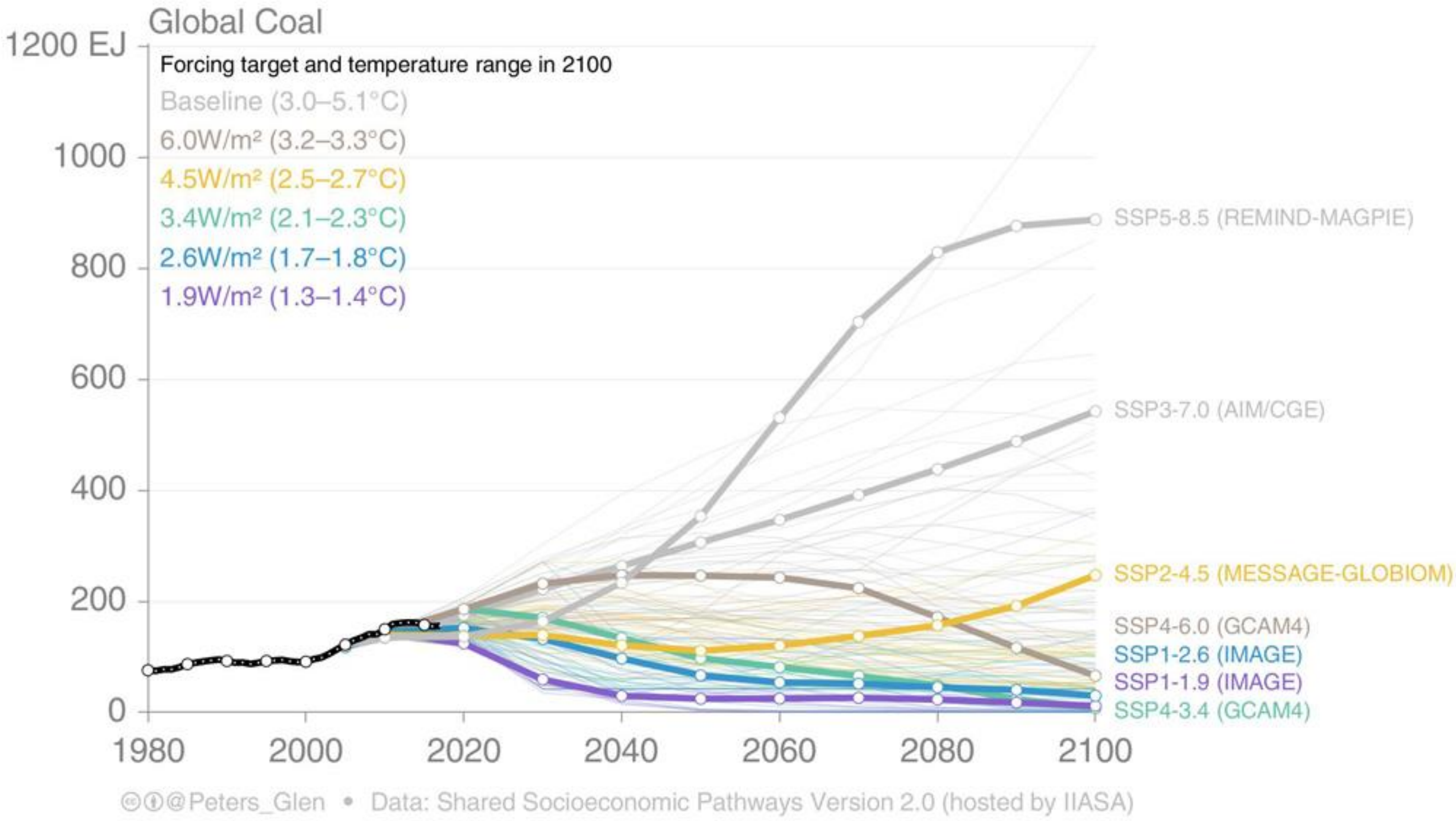
Sea level rise greater than 15 m by 2300 cannot be ruled out with high emissions scenario!



Primary energy in 2100 for SSP scenarios



Global coal use in exajoules (EJ)

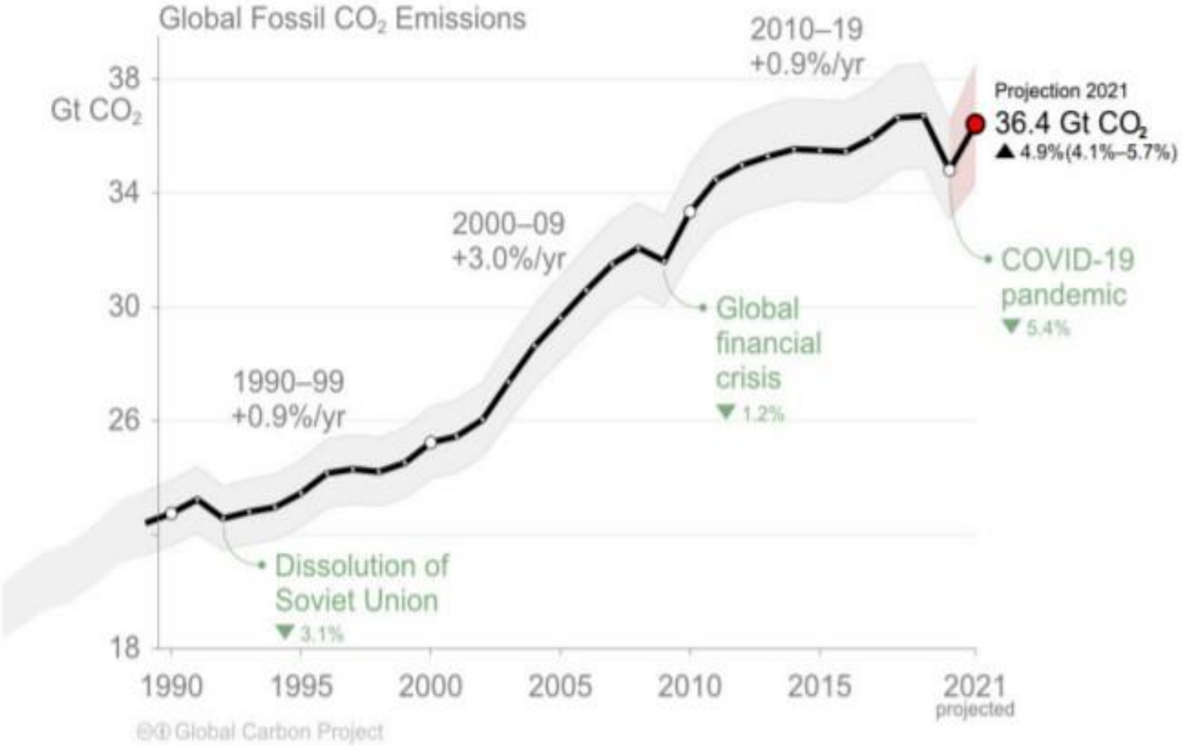


Global Carbon Budget 2021

Global Carbon Budget 2021

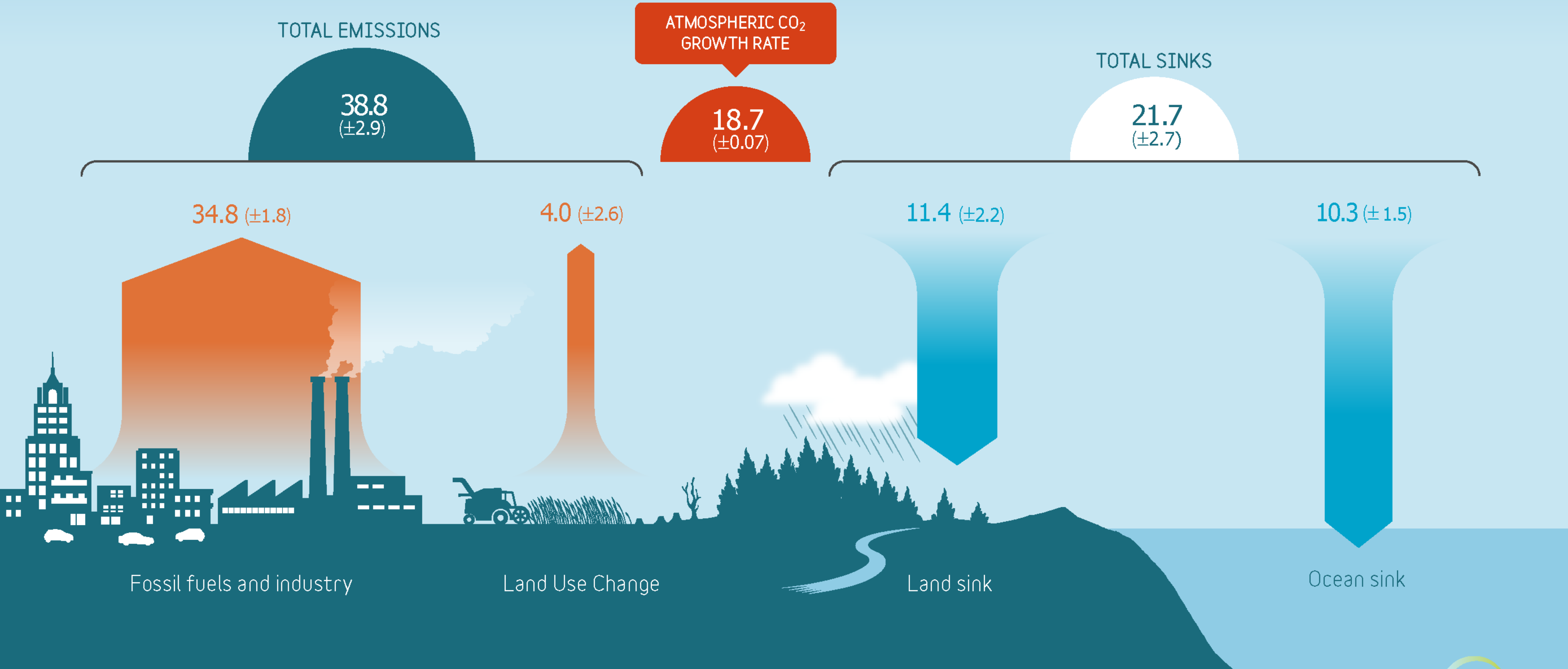
CO_2 emissions rebound towards pre-COVID levels

Global fossil CO_2 emissions in 2021 are set to rebound 4.9% after a record 5.4% drop in 2020.
This follows a decade of strong and growing energy decarbonisation which reduced the growth of emissions.



CO_2 emissions cuts of 1.4 billion tonnes are needed each year on average to reach net zero by 2050

GLOBAL CARBON BUDGET 2011-2020

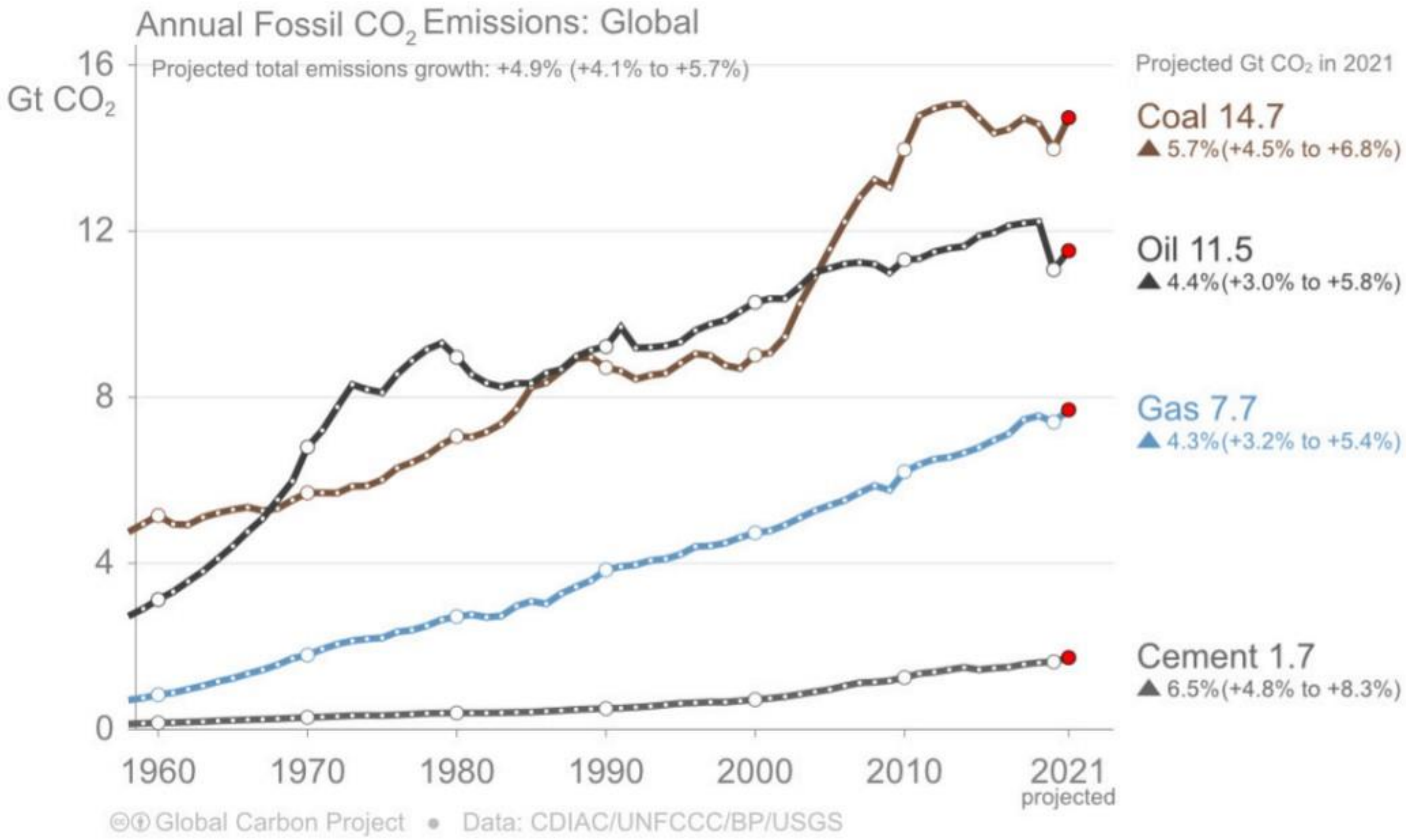


EMISSIONS AND SINKS

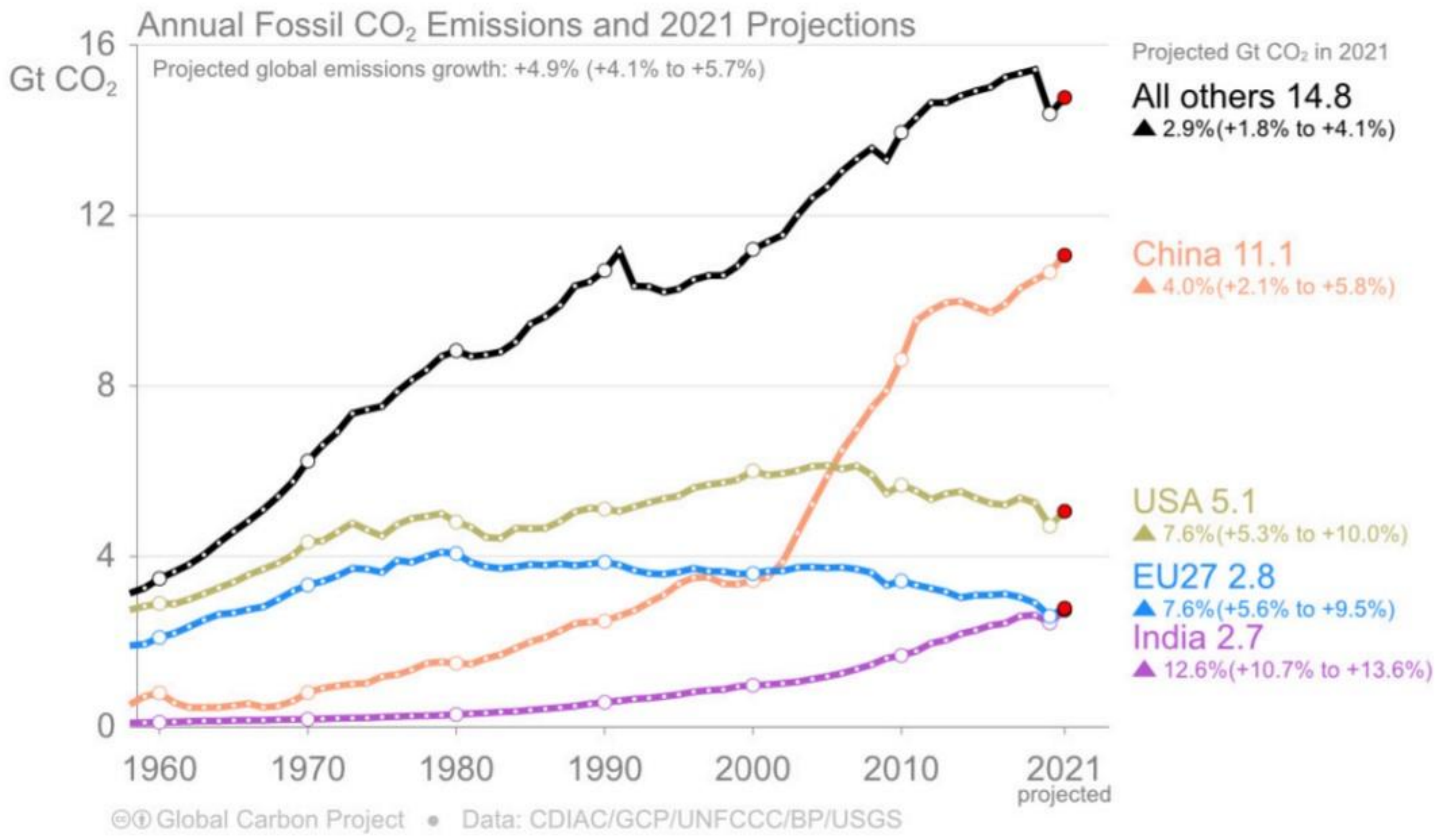
In billion-tons CO_2 per year (Pg CO_2 / yr), average 2011-2020

GLOBAL CARBON PROJECT

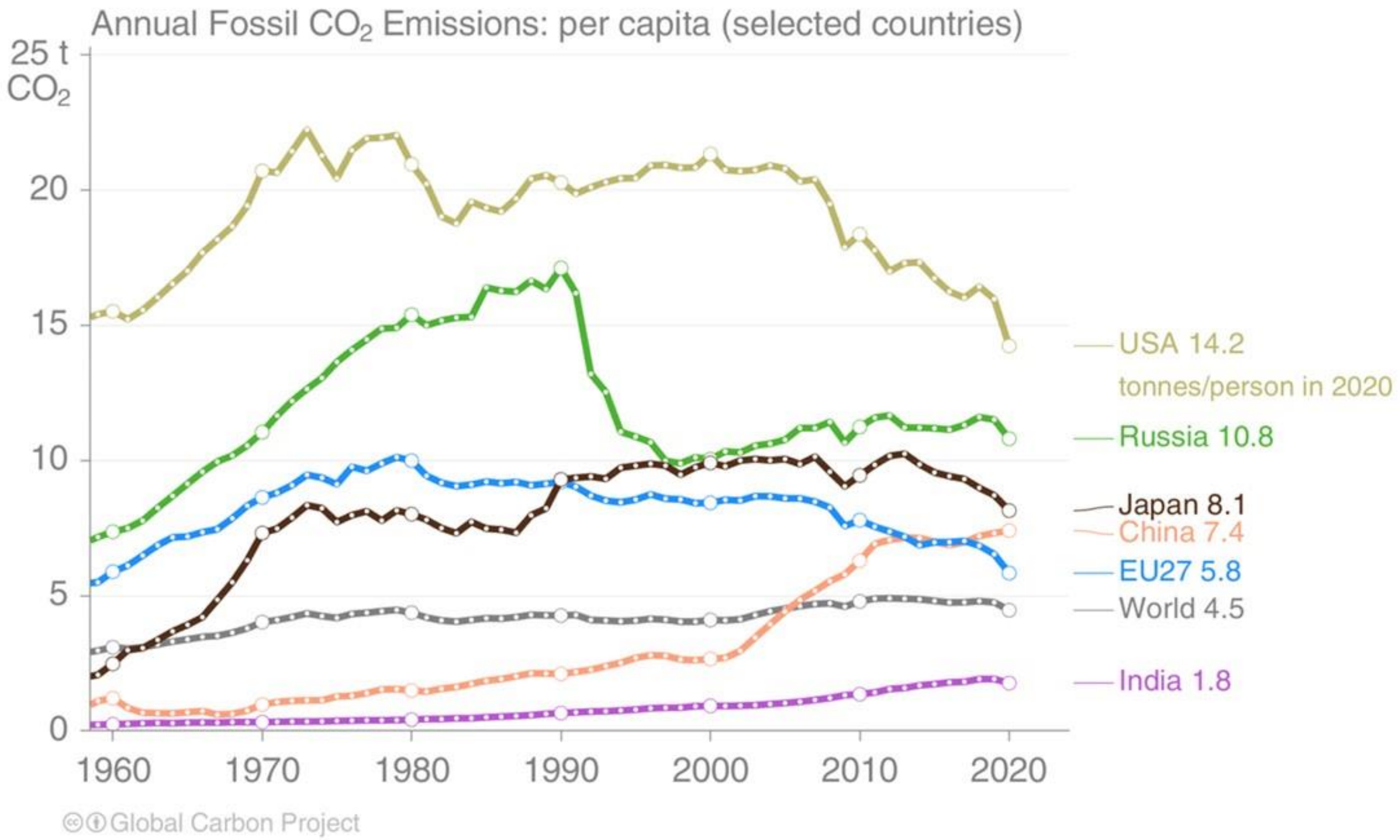
FONDATION

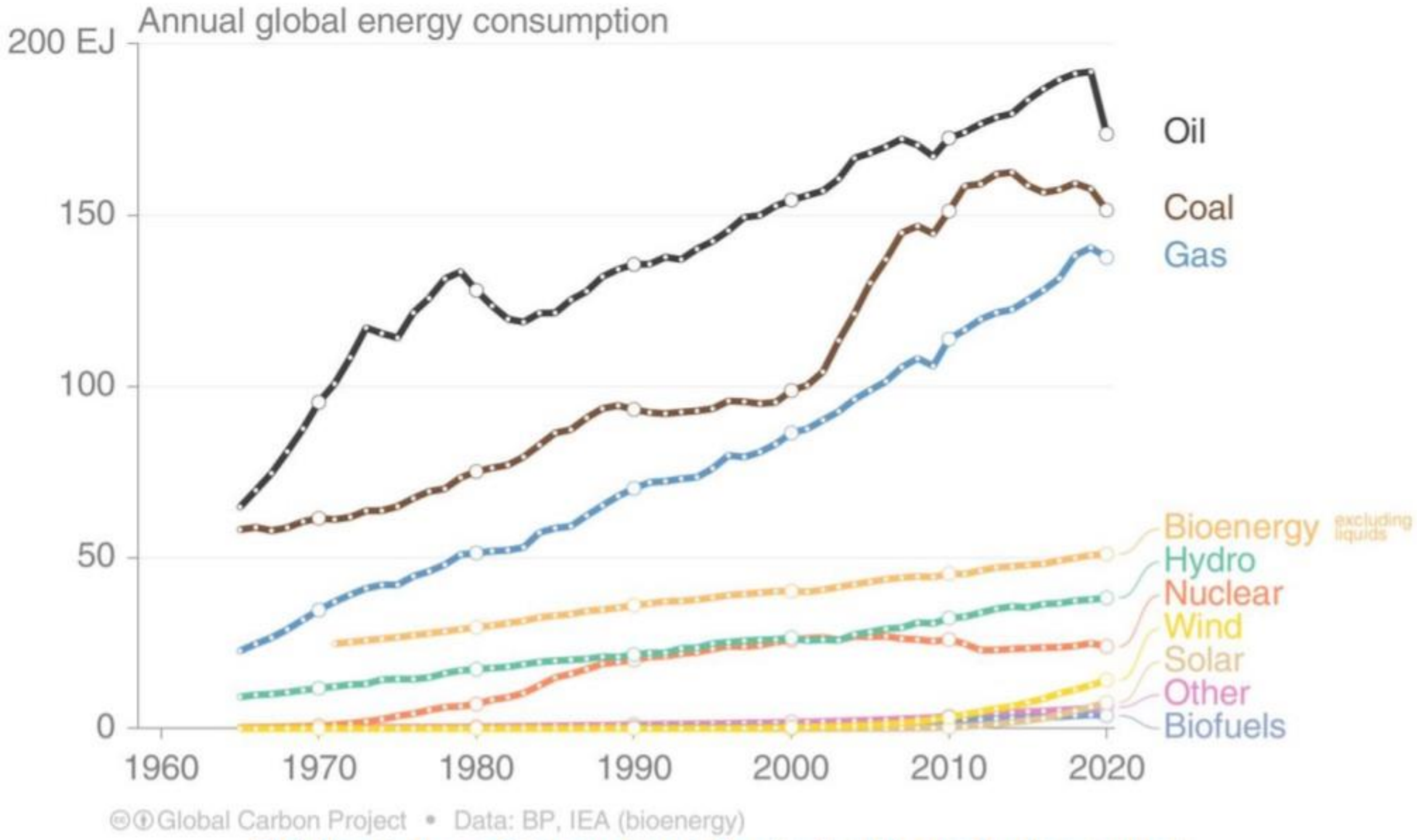


Annual Fossil CO2 Emissions: Global
16
Gt CO2
Projected total emissions growth: +4.9% (+4.1% to +5.7%)
Projected Gt CO2 in 2021
Coal 14.7
▲ 5.7%(+4.5% to +6.8%)
12
Oil 11.5
▲ 4.4%(+3.0% to +5.8%)
8
Gas 7.7
▲ 4.3%(+3.2% to +5.4%)
4
Cement 1.7
▲ 6.5%(+4.8% to +8.3%)
0
1960
1970
1980
1990
2000
2010
2021
projected
Global Carbon Project • Data: CDIAC/UNFCCC/BP/USGS



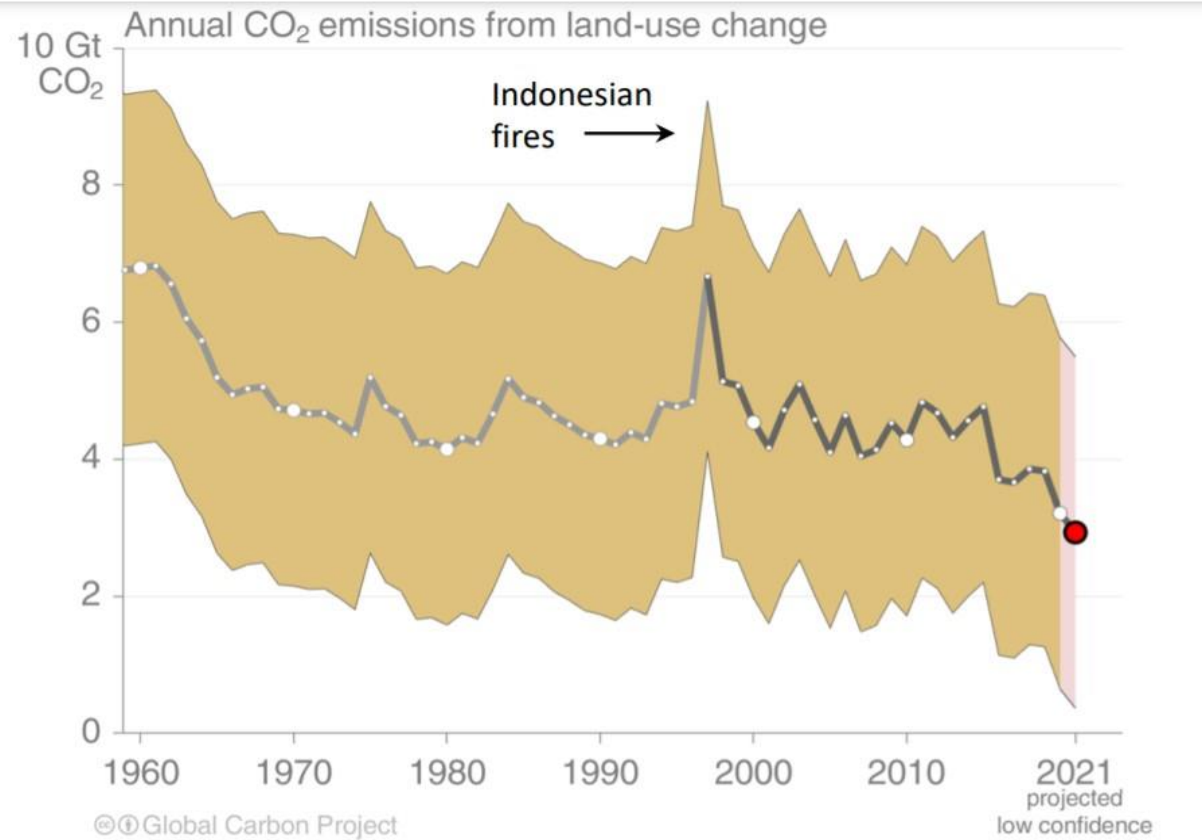
Annual Fossil CO2 Emissions and 2021 Projections
Projected global emissions growth: +4.9% (+4.1% to +5.7%)
16
Gt CO2
12
8
4
0
1960
1970
1980
1990
2000
2010
2021
projected
Projected Gt CO2 in 2021
All others 14.8
▲ 2.9%(+1.8% to +4.1%)
China 11.1
▲ 4.0%(+2.1% to +5.8%)
USA 5.1
▲ 7.6%(+5.3% to +10.0%)
EU27 2.8
▲ 7.6%(+5.6% to +9.5%)
India 2.7
▲ 12.6%(+10.7% to +13.6%)
Global Carbon Project • Data: CDIAC/GCP/UNFCCC/BP/USGS

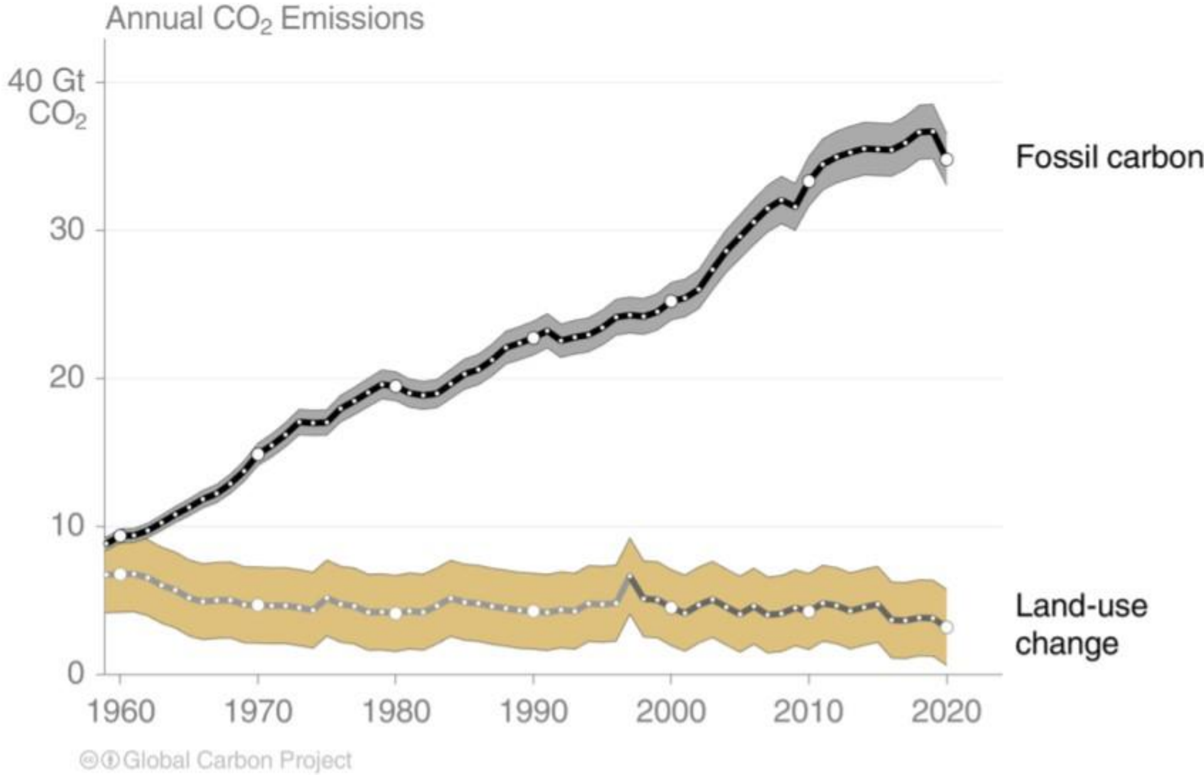

Annual Fossil CO_2 Emissions: per capita (selected countries)
25 t CO_2
20
15
10
5
0
1960
1970
1980
1990
2000
2010
2020
USA 14.2
tonnes/person in 2020
Russia 10.8
Japan 8.1
China 7.4
EU27 5.8
World 4.5
India 1.8
Global Carbon Project



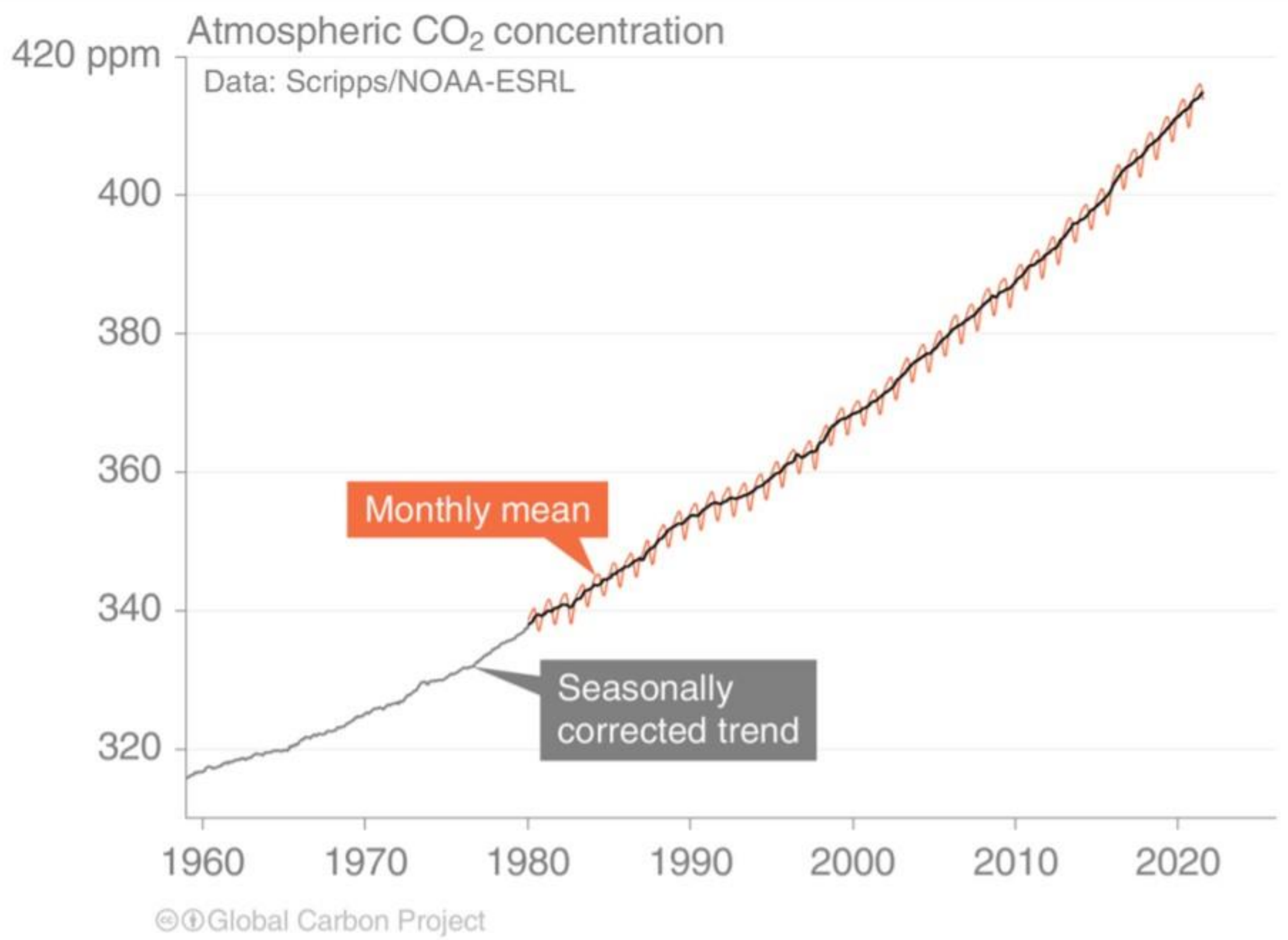
This figure shows “primary energy” using the BP substitution method
(non-fossil sources are scaled up by an assumed fossil efficiency of approximately 0.38)
Source: [BP 2021](); [Global Carbon Project 2021]()

Land-use change emission





The global CO2 concentration increased from ~277 ppm in 1750 to 415 ppm in 2021 (up 49%)



Progress since the Paris Agreement

- Decarbonization of energy showed a strong and growing signal in the decade 2010-2019 at the global level, pushing CO_2 emission down in the USA, EU27, and slowing their growth in China.
- Decarbonization of energy was not enough to compensate for the growing energy demand still largely met by fossil energy sources in many countries, despite the high deployment rate of renewables, resulting in continued growth in global emissions albeit at a slower rate.
- The rapid rebound in fossil CO_2 emissions as economies recover from the COVID-19 pandemic reinforces the need for immediate action and global coherence in the world's response to climate change.

Conclusion of Carbon Budget

- Global fossil CO_2 emissions in 2021 are set to rebound close to their pre-COVID levels.
- For major emitters, fossil CO_2 emissions in 2021 appear to return to pre-COVID trends.
- Global gross emissions due to land-use change remain at 14.1 $GtCO_2$ over the past decade. Global gross removals (eg, forest regrowth) have increased in the last two decades to 9.9 $GtCO_2$.
- Global gross emissions due to land-use change remain high, however the global gross removals (eg, forest regrowth) have increased in the last two decades.
- The land and ocean CO_2 sinks combined continued to take up around half (53% over the past decade) of the CO_2 emitted to the atmosphere
- The level of CO_2 continued to increase in the atmosphere in both 2020 and 2021 following long-term trends because of continued emissions.

Vote for the (according to you) most probable scenario through the link:

- https://forms.gle/PAvMfuX1S647w6FNA

List of references

- https://archive.ipcc.ch/ipccreports/sres/emission/index.php?idp=132
- https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/
- https://www.globalcarbonproject.org/carbonbudget/
- http://www.globalcarbonatlas.org/en/content/welcome-carbon-atlas
- https://www.ipcc.ch/site/assets/uploads/2018/03/sres-en.pdf
- https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_summary-for-policymakers.pdf
- https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_SPM_FINAL.pdf