EMISSION SCENARIOS, FUTURE CLIMATE

CLIMATE CHANGE.

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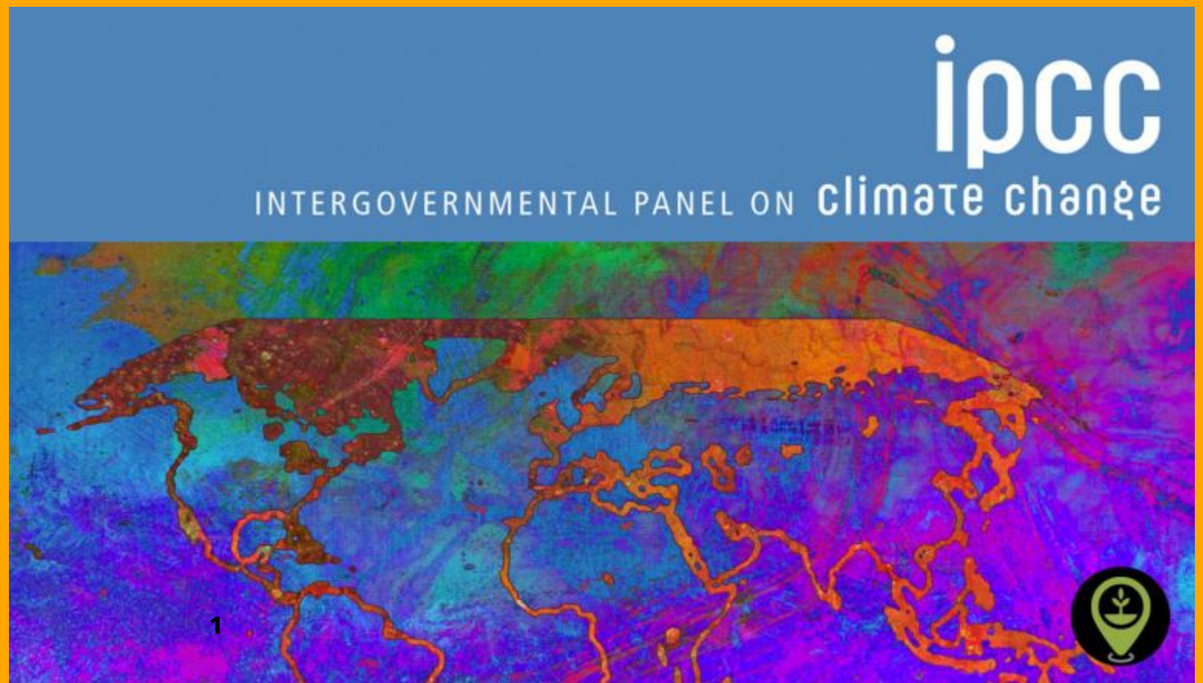

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1. INTRODUCTION: SCENARIOS AND METHODOLOGY.

1.1 SCENARIOS.

- A scenario is a description of how the future may develop based on coherent assumptions about key drivers, like : demography, socio-economic processes, lifestyle and relationships among this driving forces, for example.

- The scenarios can also be defined by geophysical driving forces: emissions or abundances of GHGs, aerosols and aerosol precursors or land-use patterns.

*"Scenarios are not predictions, they are **'what if'** investigations".*

1. INTRODUCTION: SCENARIOS AND METHODOLOGY.

1.1 SCENARIOS.

- **WHICH ARE THE SCENARIOS OF THE LAST IPCC REPORT?**

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

SSPX-Y (SSPX-RCPY)

X designates the socio-economic pathway:

1. sustainability
2. middle of the road
3. regional rivarly
4. inequality
5. fossil fuel-intensive

Y stands for the radiative forcing (energetic balance)

1. INTRODUCTION: SCENARIOS AND METHODOLOGY.

1.2 METHODOLOGY.

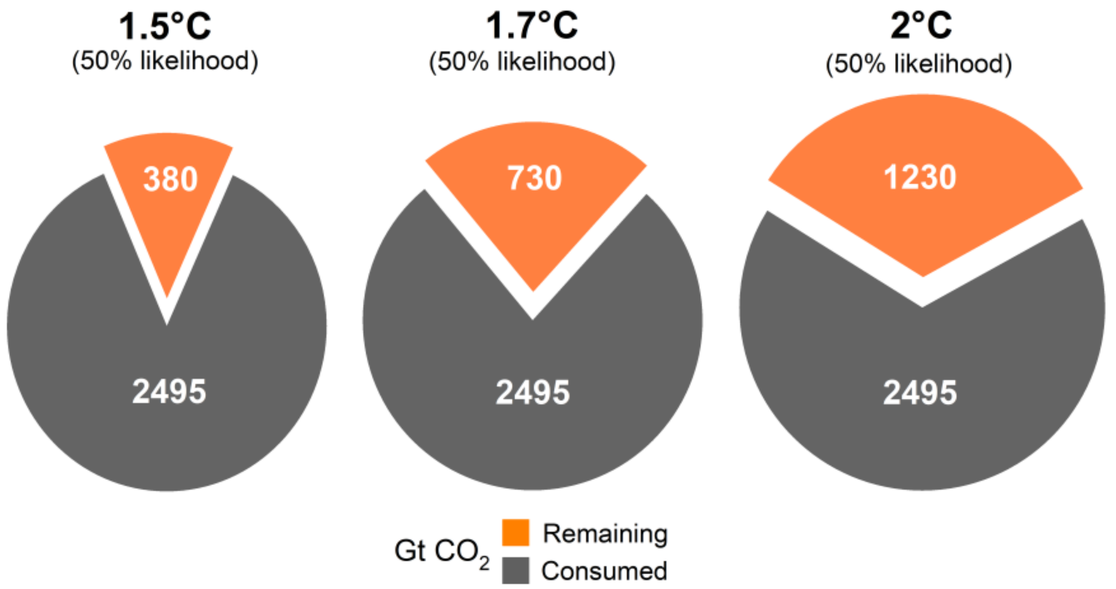
- **CMIP6- Coupled Model Intercomparison Project-6**: climate simulations that make use of atmosphere–ocean general circulation models, and Earth system models. Including representations of various biogeochemical cycles.

- This project produces a standard set of climate model simulations that can be scientifically exploited to address the three broad scientific questions:
  - How does the Earth system respond to forcing?
  - What are the origins and consequences of systematic model biases?
  - How can we assess future climate changes given internal climate variability, predictability and uncertainties in scenarios?

2. CARBON BUDGET AND EMISSIONS.

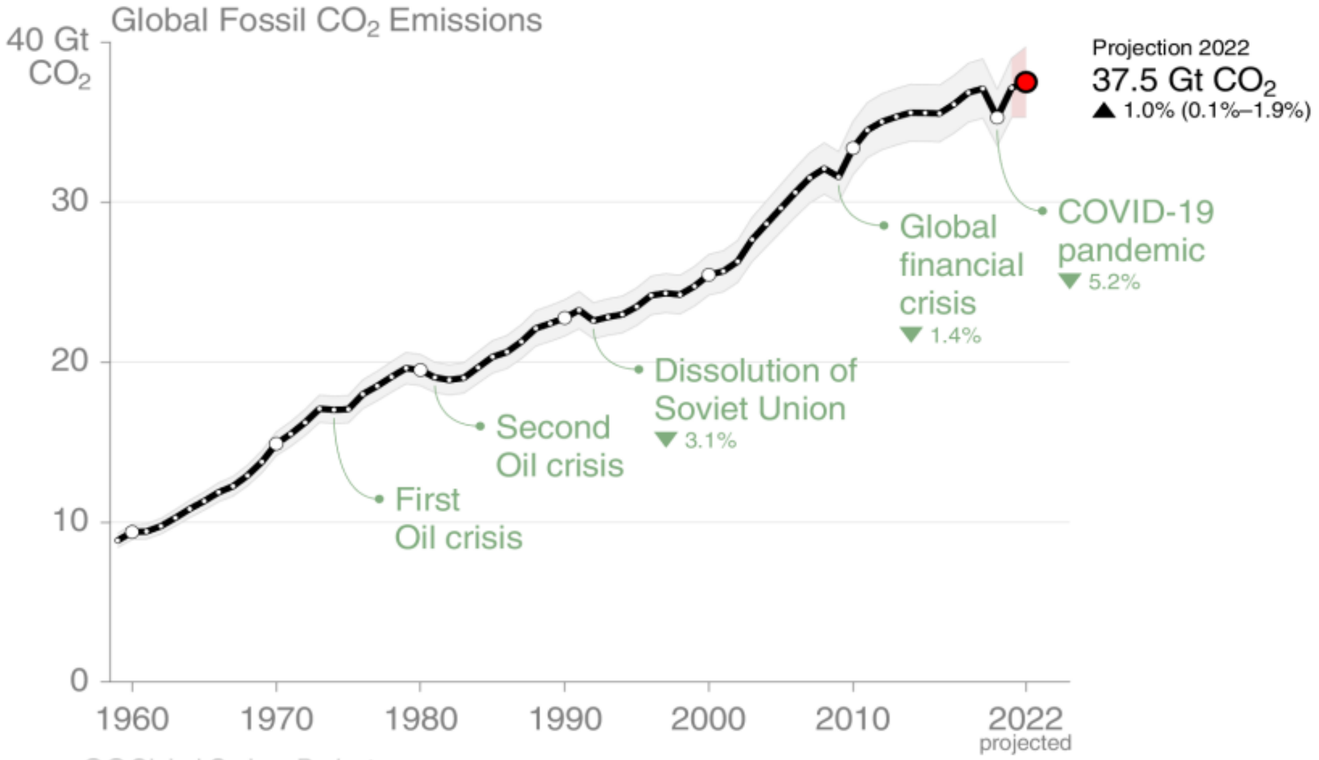
- The **carbon budget** is the upper limit of total CO2 emissions associated with staying below a specified global average temperature.

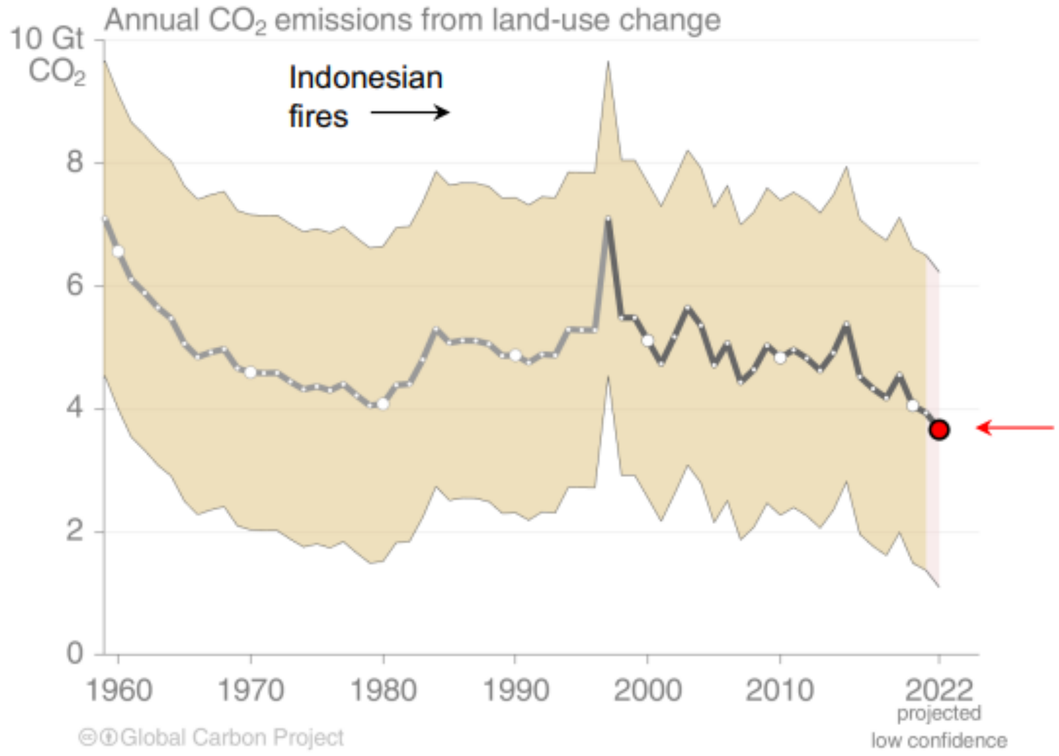
The remaining carbon budget for a 50% likelihood to limit global warming to 1.5°C , 1.7°C and 2°C has reduced to an equivalent of 9, 18 and 30 years from 2023 (at 2022 emissions levels).
2495 $GtCO_2$ have been emitted since 1850.



2. CARBON BUDGET AND EMISSIONS.

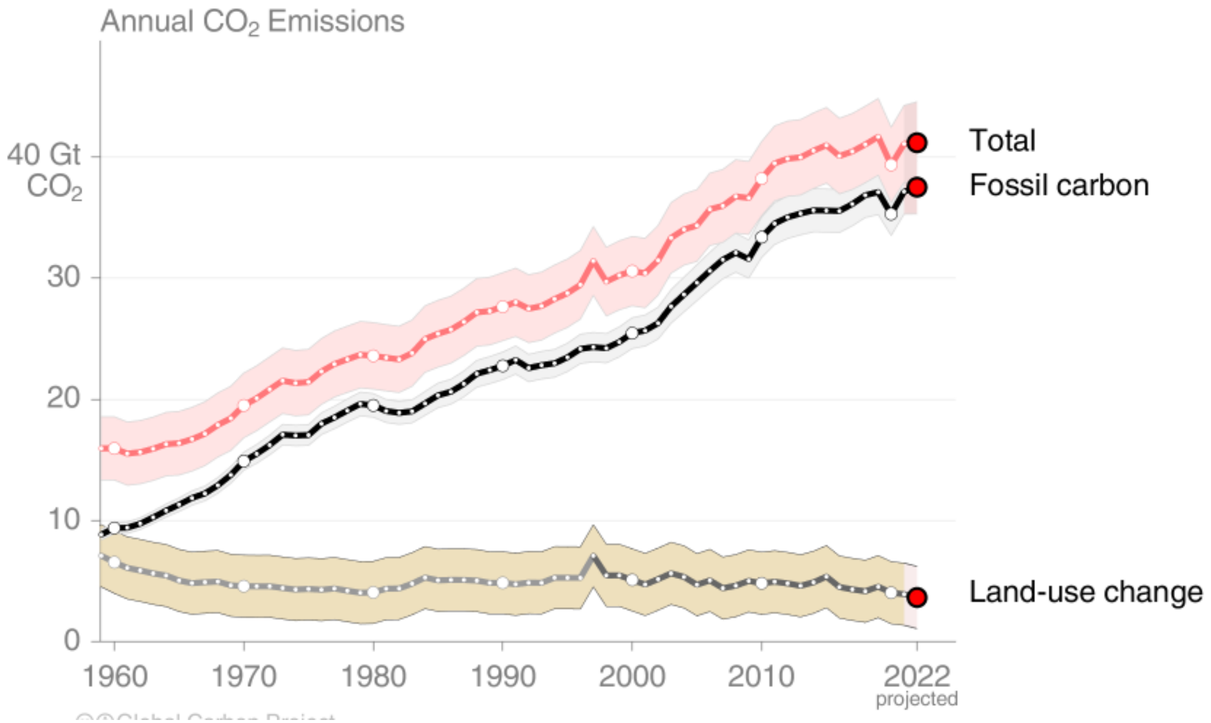
- GLOBAL FOSSIL CO_2 ANTHROPOGENIC EMISSION.



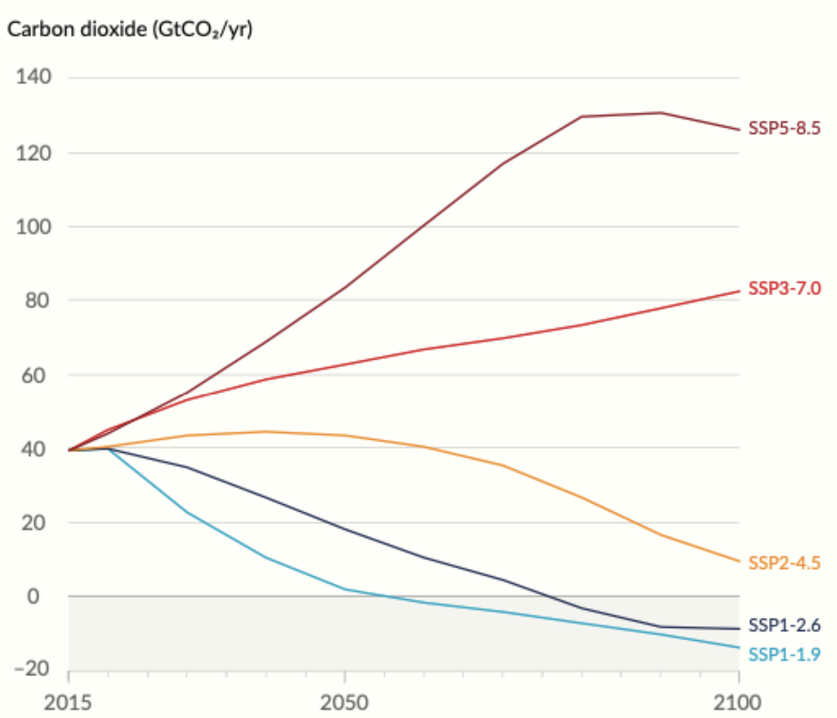


2. CARBON BUDGET AND EMISSIONS.

• ANUAL CO_2 EMISSIONS.



• CO_2 EMISSIONS ACORDING TO EACH SCENARIO.



3. FUTURE CHANGES IN GLOBAL CLIMATE.

3.1 ATMOSPHERE.

- **GLOBAL SURFACE AIR TEMPERATURE (GSAT)**

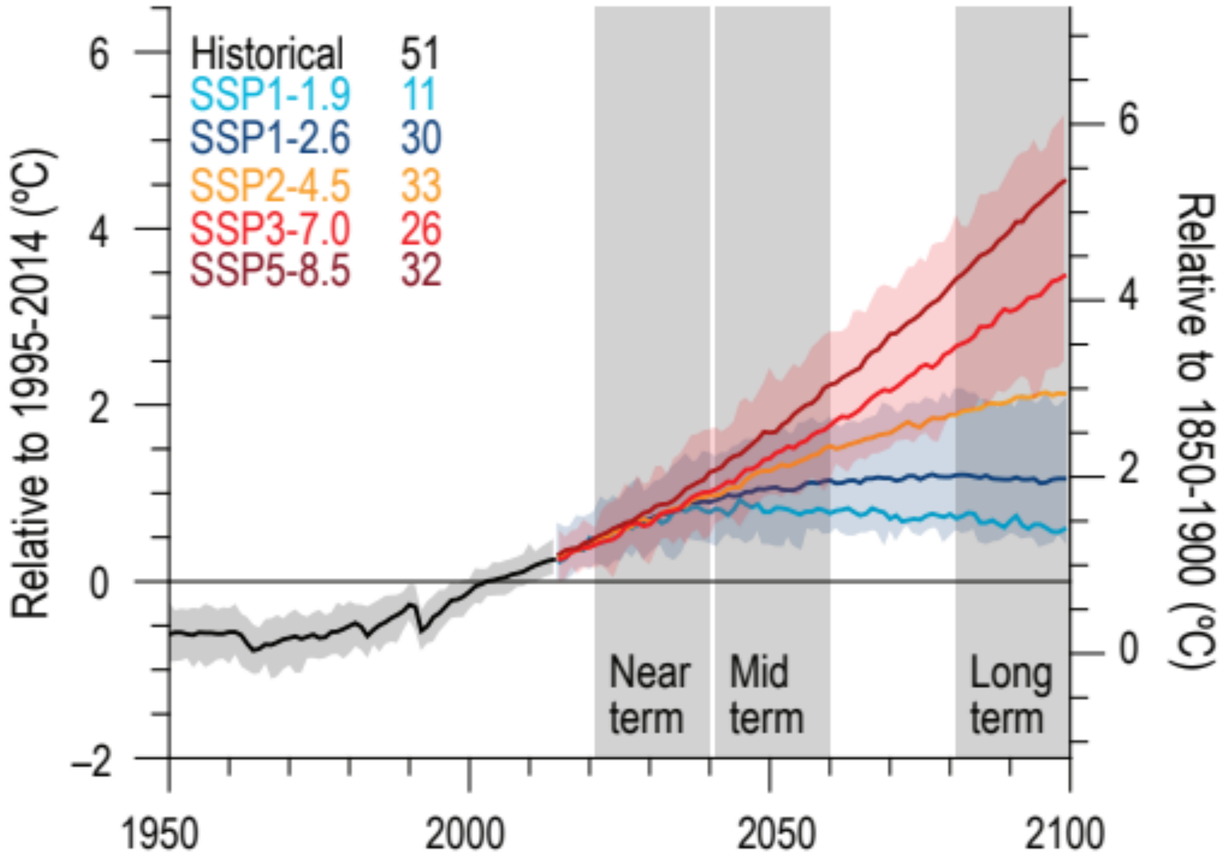
  - From CMIP5 simulations GSAT will continue to rise over the 21st century with the GHG increasing trend.

  - From CMIP6 models show the following LONG TERM (2081-2100), relative to 1995-2014:

    - (SSP1-1.9) very low GHG emissions: 0.2ºC-1.3ºC
    - (SSP1-2.6) low GHG emissions: 0.6ºC - 2.0ºC , where CO2 concentrations peak between 2040-2060
    - (SSP2-4.5) intermediate GHG emissions: 1.4ºC - 3ºC , where CO2 increases to 2100 and more.
    - (SSP3-7.0) high GHG emissions: 2.2ºC - 4.7ºC
    - (SSP5-8.5) very high GHG emission: 2.7ºC - 5.7ºC

- When will the GSAT rise 1.5°C, 2°C or 3°C?
  - 1.5°C following SSP2-4.5, SSP3-7.0 by 2030.
  - 2.0°C following either SSP3-7.0 or SSP5-8.5 by 2043.
  - 3.0°C following SSP5-8.5 by 2062.

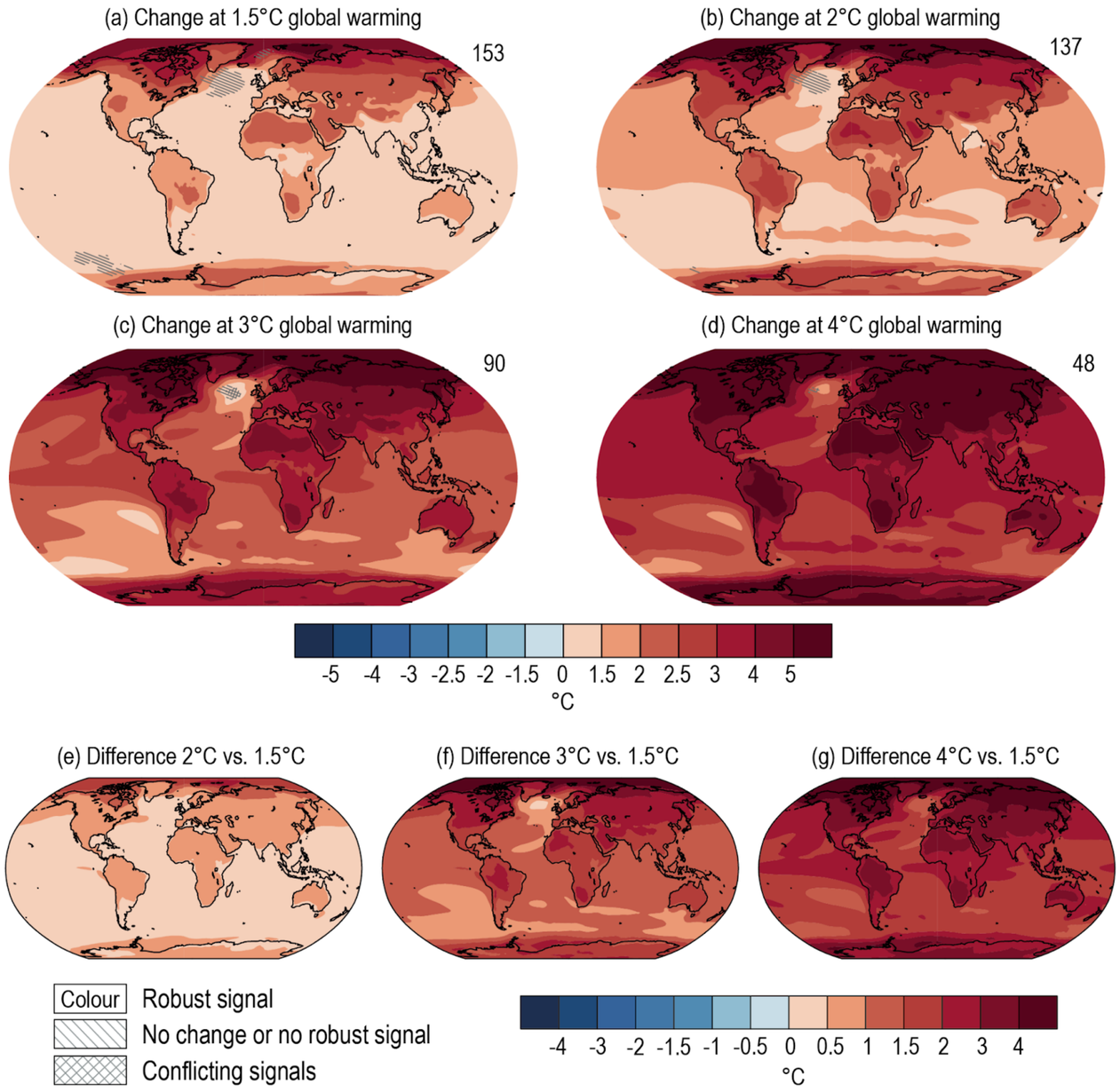
GLOBAL TEMPERATURE CAHNGE



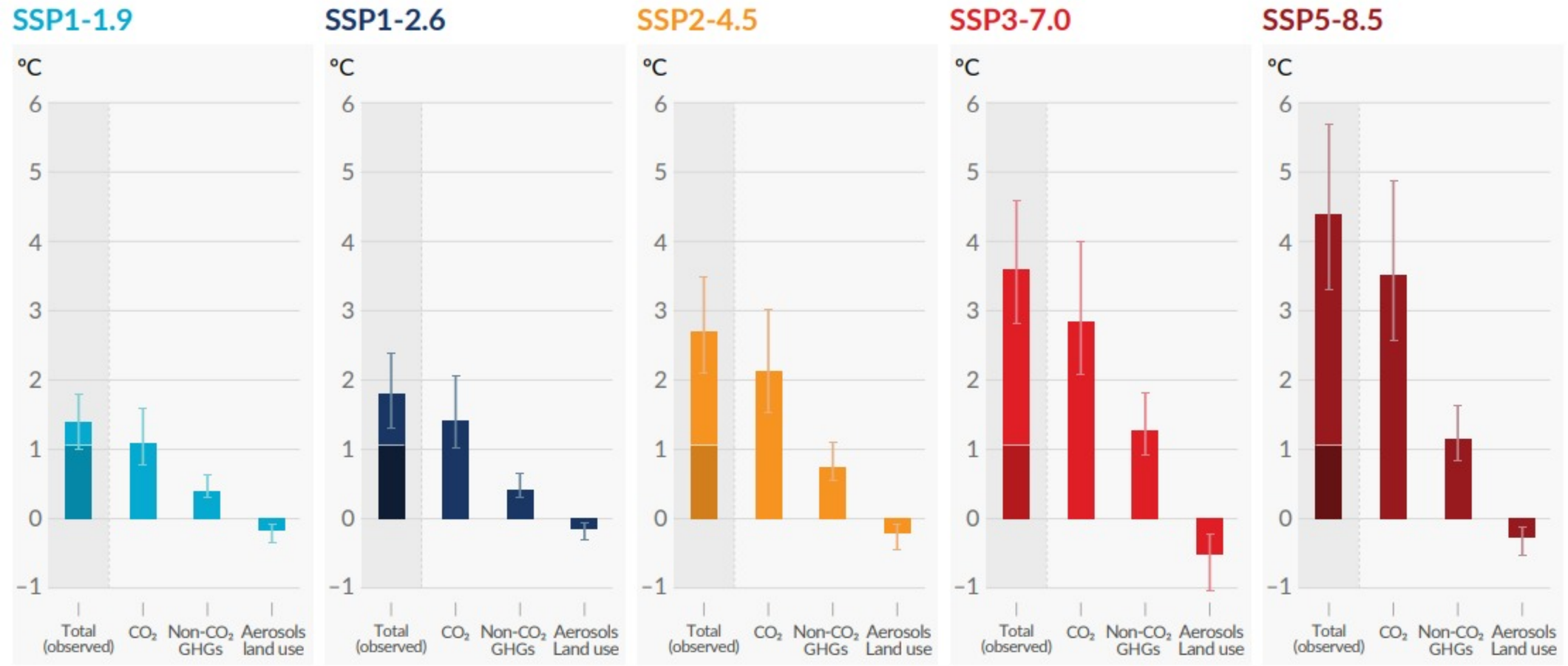
- Projected spatial patterns of change in annual average near-surface temperature (°C) at different levels of global warming.

- CMIP6 models project that annual average surface air temperature will warm about 50% more over land than over the ocean, and that the Arctic will warm about more than 2.5 times the global average.

- For 2081-2100 relative to 1995-2014:.
  - (SSP1-1.9)
    - Land: 0.3ºC-2.0ºC
    - Artic: 0.5ºC-6.6ºC
  - (SSP5-8.5)
    - Land: 3.5ºC-7.6ºC
    - Artic: 6.2ºC-15.2ºC



- **CONTRIBUTION TO GLOBAL SURFACE TEMPERATURE INCREASE FROM DIFFERENT EMISSIONS. (Long term compared with 1850-1900)**



3. FUTURE CHANGES IN GLOBAL CLIMATE.

3.1 ATMOSPHERE.

- **PRECIPITATION.**

  - CMIP5 projections that global mean precipitation over the 21st century will increase by more than 0.05 mm day–1 (about 2% of global precipitation) and 0.15 mm day–1 (about 5% of global precipitation) under the RCP2.6 and RCP8.5 scenarios, respectively..

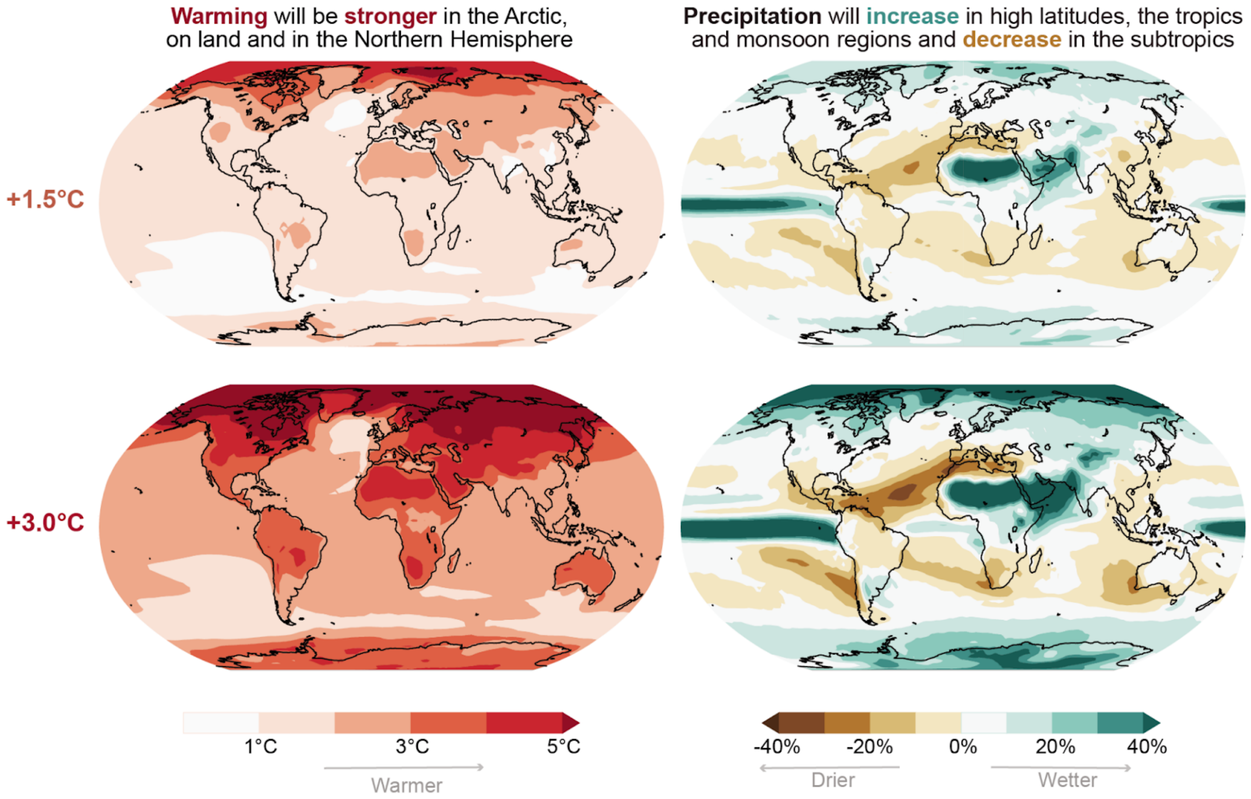
  - In the CMIP6 simulations about global land precipitation for 2081–2100, relative to 1995–2014, shows :

    - (SSP1-1.9) 0.2% to 4.7%
    - (SSP1-2.6) 0.0% to 6.6%
    - (SSP2-4.5) 1.5% to 8.3%
    - (SSP3-7.0) 0.5% to 9.6%
    - (SSP5-8.5) 0.9% to 12.9%

CLIMATE CHANGE AND REGIONAL PATTERNS.

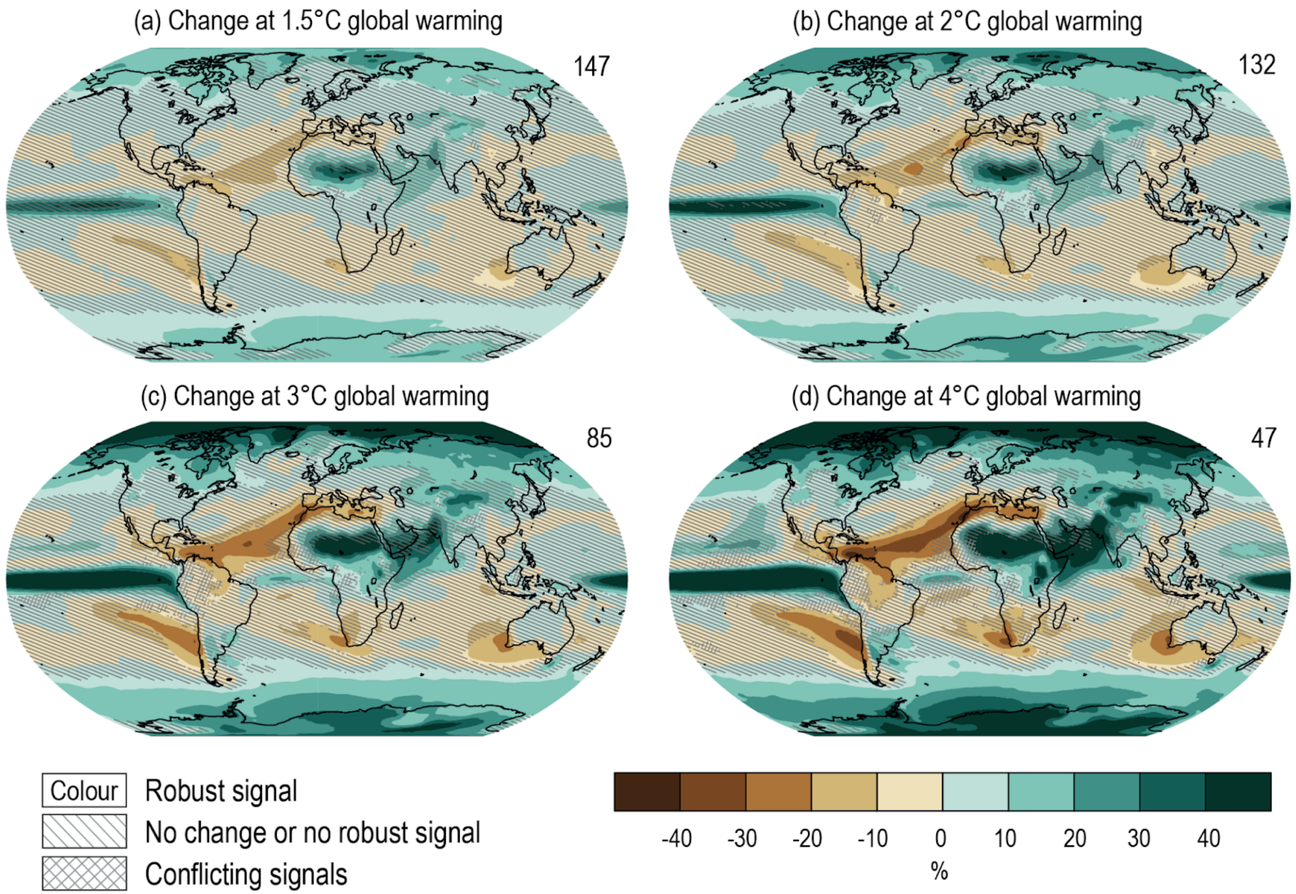
- For scenarios that relative to 1850-1900 GSAT rise 1.5ºC (SSP2-4.5, SSP3-7.0, or SSP5-8.5) the ensemble-mean change in global land precipitation is on average about 1.6%

- For scenarios that relative to 1850-1900 GSAT rise 3ºC (SSP5-8.5) the ensemble-mean change in global land precipitation is on average about 4.9%.



- For scenarios with unanimous global warming above 2.0°C (SSP3-7.0, or SSP5-8.5) the ensemble-mean increase in global land precipitation is on average about 2.6%

- On average under SSP1-1.9 and SSP1-2.6, the global land precipitation change for simulations where global warming exceeds 1.5°C and 2.0°C will be about 1.9% and 3.0%, respectively.



"Relative to 1995–2014, and across all of the scenarios considered here, CMIP6 models show greater increases in precipitation over land than either globally or over the ocean (high confidence)".

3. FUTURE CHANGES IN GLOBAL CLIMATE.

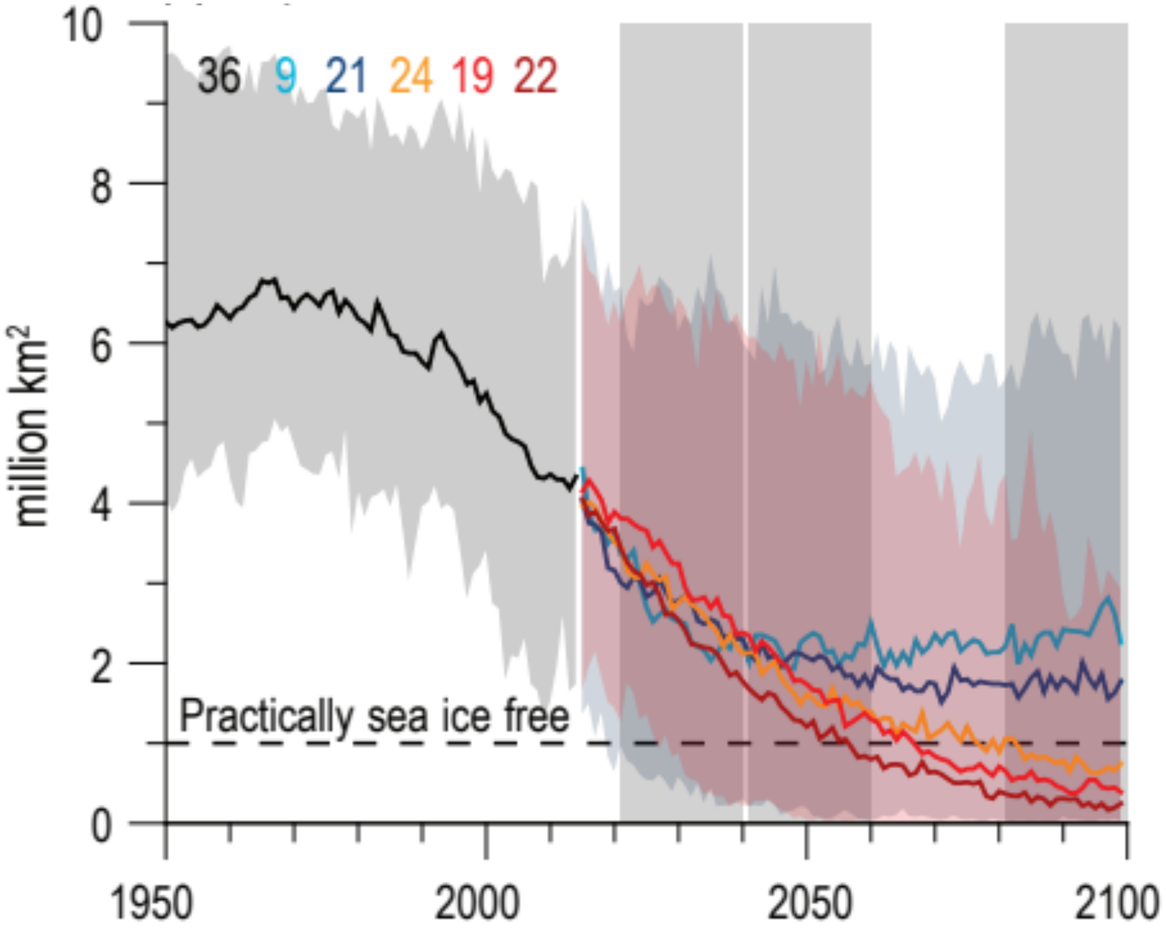
3.1 CRYOSPHERE, OCEAN AND BIOSPHERE.

- **ARTIC SEA ICE.**
  - CMIP5 simulations that there will be year- round reductions of Arctic sea ice coverage by the end of this century. The ranges are:
    - September:
      - RCP2.6: 43%
      - RCP8.5: 94%
    - March:
      - RCP2.6: 8%
      - RCP8.5: 34%
  - Based on a five-member selection of CMIP5 models, AR5 further assessed that for RCP8.5, Arctic sea ice coverage in September will drop below 1 million km^2 and be practically ice free at some point between 2040 and 2060.

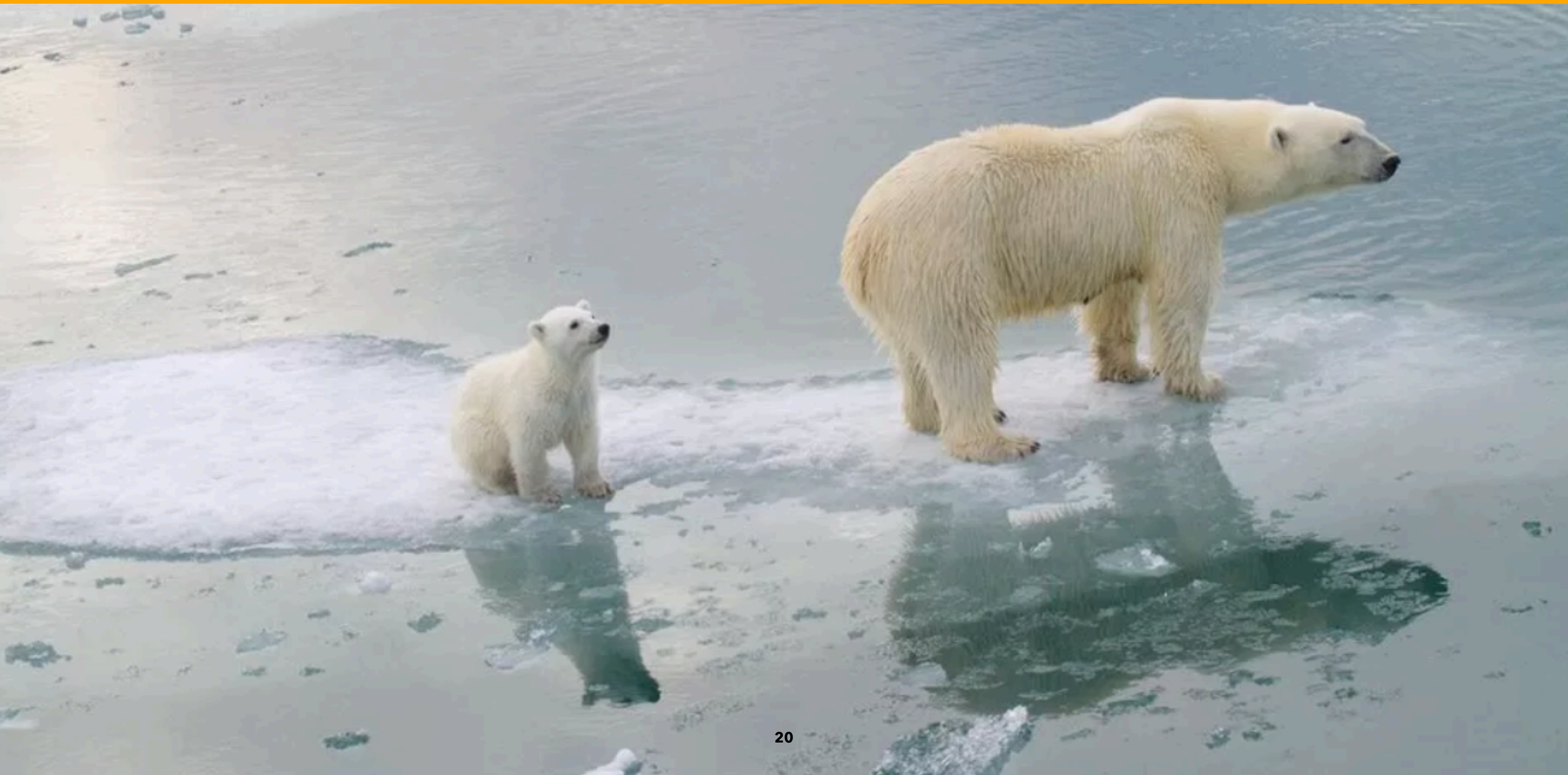
- FIPCC 2019: for an stabilized global warming of 1.5ºC is approximately 1% but for 2ªC GSAT is 10-35% respectively.

- CMIP6 models conclude that ni average the Arctic will become practically ice-free in September by the end of the 21st century under SSP2-4.5, SSP3-7.0, and SSP5-8.5 (*high confidence*)

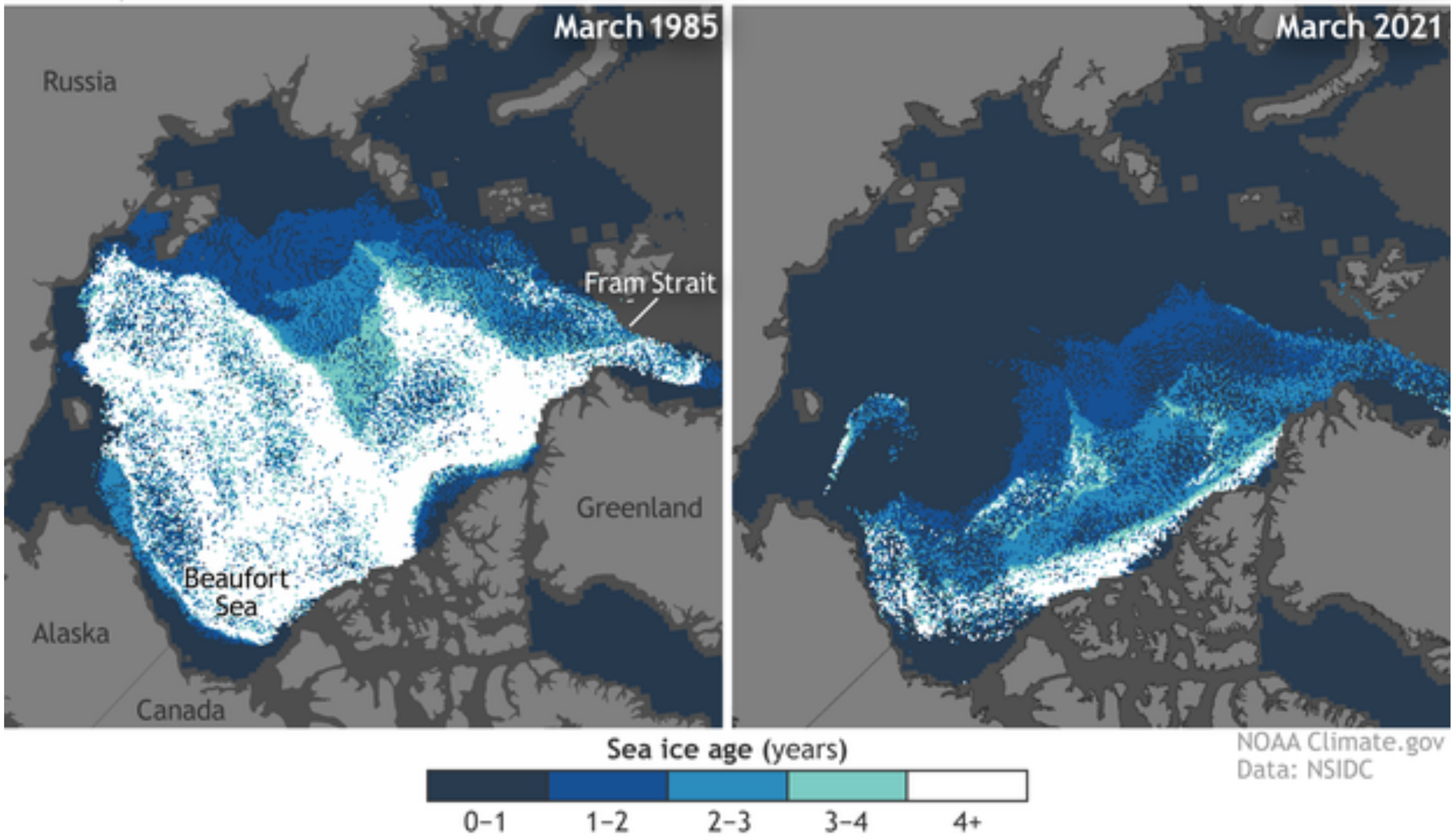
SEPTEMBER ARTIC SEA ICE AREA.



"Polar bears could be lost by 2100." BBC report.



Month and Time Period		SSP1-1.9 (10^6 km^2)	SSP1-2.6 (10^6 km^2)	SSP2-4.5 (10^6 km^2)	SSP3-7.0 (10^6 km^2)	SSP5-8.5 (10^6 km^2)
September	2021–2040	2.6 (1.1, 6.5)	2.7 (0.6, 6.4)	2.8 (0.7, 6.4)	3.1 (1.1, 6.4)	2.5 (0.4, 5.8)
	2041–2060	2.2 (0.3, 6.5)	2.0 (0.2, 6.1)	1.7 (0.1, 5.6)	1.7 (0.1, 5.7)	1.2 (0.0, 5.2)
	2081–2100	2.4 (0.2, 6.2)	1.7 (0.0, 6.0)	0.8 (0.0, 4.6)	0.5 (0.0, 3.3)	0.3 (0.0, 2.2)
March	2021–2040	14.0 (11.4, 18.7)	14.9 (11.9, 25.8)	14.9 (11.9, 23.5)	15.0 (11.7, 27.3)	14.9 (11.9, 24.7)
	2041–2060	13.8 (10.9, 18.3)	14.5 (10.9, 25.7)	14.3 (11.1, 23.3)	14.2 (10.5, 27.1)	13.9 (10.2, 24.5)
	2081–2100	13.7 (10.9, 18.5)	14.2 (10.6, 25.7)	13.1 (9.5, 22.2)	11.8 (5.4, 25.5)	9.7 (3.1, 21.6)


March 1985
March 2021
Russia
Fram Strait
Greenland
Beaufort Sea
Alaska
Canada
Sea ice age (years)
0–1
1–2
2–3
3–4
4+
NOAA Climate.gov
Data: NSIDC

3. FUTURE CHANGES IN GLOBAL CLIMATE.

3.1 CRYOSPHERE, OCEAN AND BIOSPHERE..

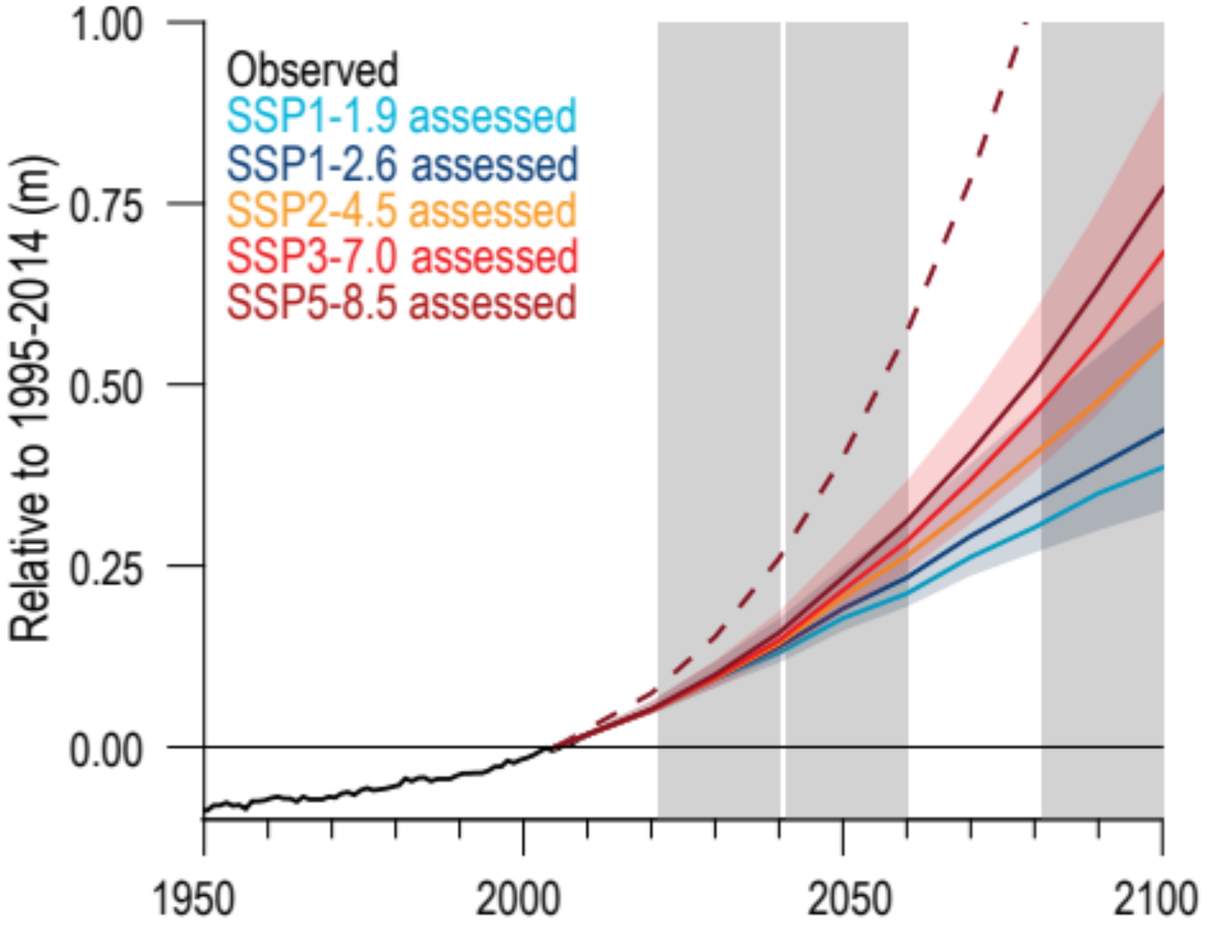
- **GLOBAL MEAN SEA LEVEL.**

  - The AR5 assessed from CMIP5 process-based simulations that the rate of GMSL rise during the 21st century will *very likely* exceed the rate observed during 1971–2010 for all RCP scenarios due to increases in ocean warming and loss of mass from glaciers and ice sheets.

  - Based on the assessment of the latest modelling information the *likely* range of GMSL change averaged over 2081–2100 relative to 1995–2014 is:
    - (SSP1-2.6) 0.30–0.54 m
    - (SSP2-4.5) 0.46–0.74 m
    - (SSP3-7.0) the rise in GMSL is projected to accelerate over 21st century
    - (SSP5-8.5) the rise in GMSL is projected to accelerate over 21st century

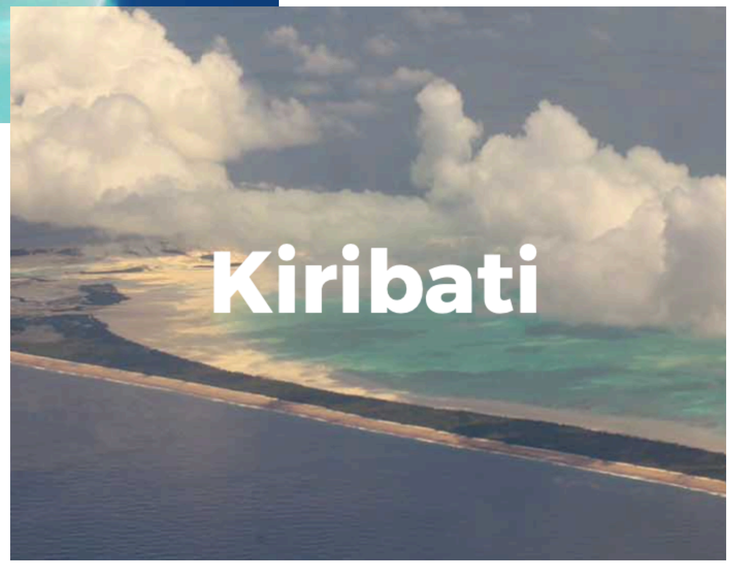
- From Sea Level Projection Tool - NASA Sea Level Change Portal

GLOBAL MEAN SEA LEVEL CHANGE



- Acording to the Union of Concerned Scientists (UCS), the Maldives is the flatest country on Earth, which an average elevation of just 1m. If they experience a sea level rise on the order of just 45cm they will lose around 77% of the land.

- Kiribati coutry is around 1.8m above sea level. They could lose two-third parts of their land if sea level rises 90cm approximately.



3. FUTURE CHANGES IN GLOBAL CLIMATE.

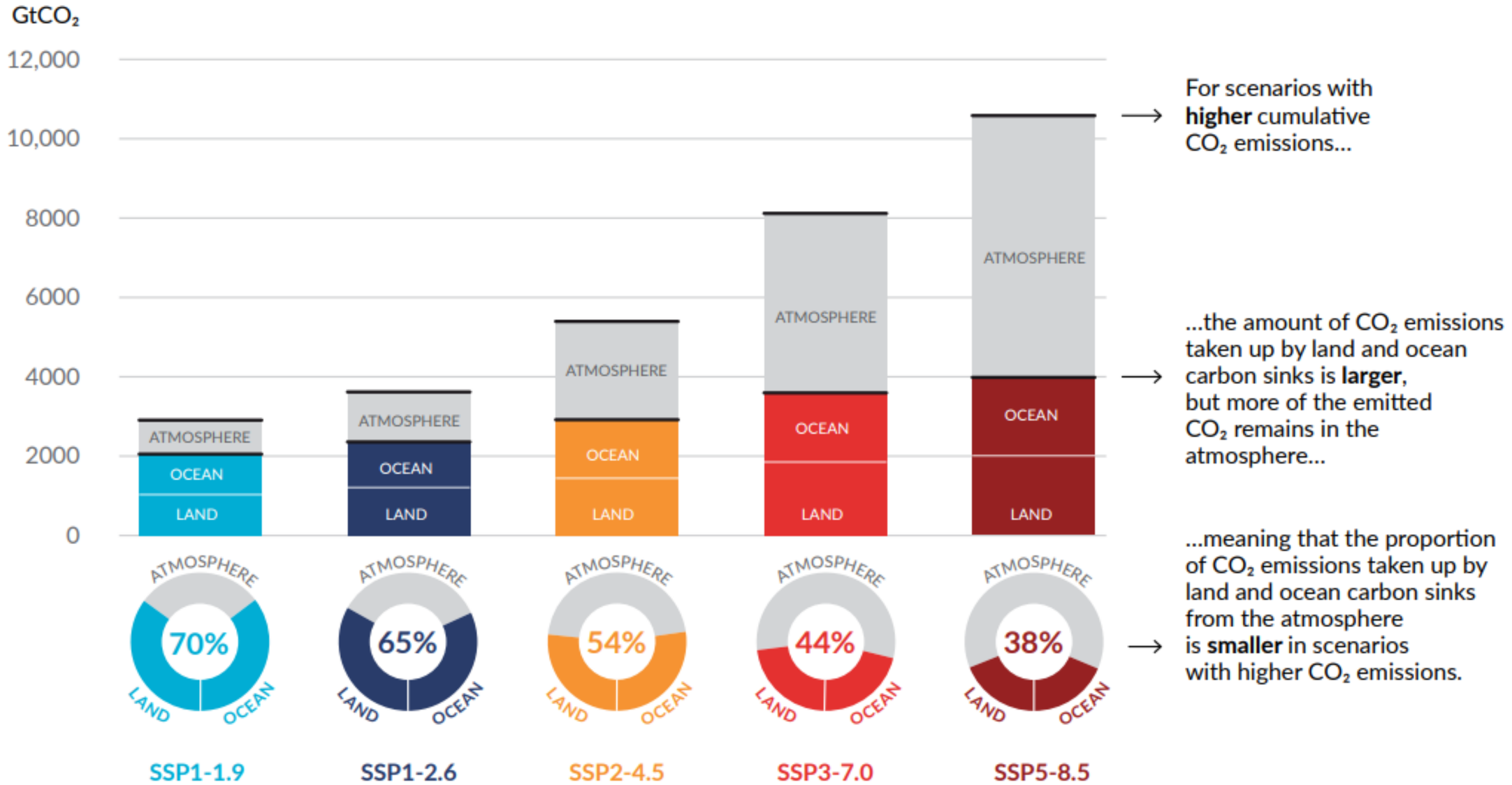
3.1 CRYOSPHERE, OCEAN AND BIOSPHERE..

- **OCEAN AND LAND CARBON UPTAKE.**

  - The AR5 concluded with *very high confidence* that ocean carbon uptake of anthropogenic CO_2 will continue increasing under all RCPs scenarios through the 21st century, with higher uptake corresponding to higher concentration pathways.

  - Based on results from the CMIP6 models:
    - The flux of carbon from the atmosphere into the ocean increases continually through most of 21st century in the two highest emissions and decreases continually under the other emissions scenarios
    - The flux of carbon from the atmosphere to land shows a similar 21st century behaviour across the scenarios but with much higher year-to-year variation than ocean carbon flux.

"Under scenarios with increasing CO2 emissions, the ocean and land carbon sinks are projected to be less effective at slowing the accumulation of CO2 in the atmosphere".



3. FUTURE CHANGES IN GLOBAL CLIMATE.

3.1 CRYOSPHERE, OCEAN AND BIOSPHERE..

- **SURFACE OCEAN pH.**

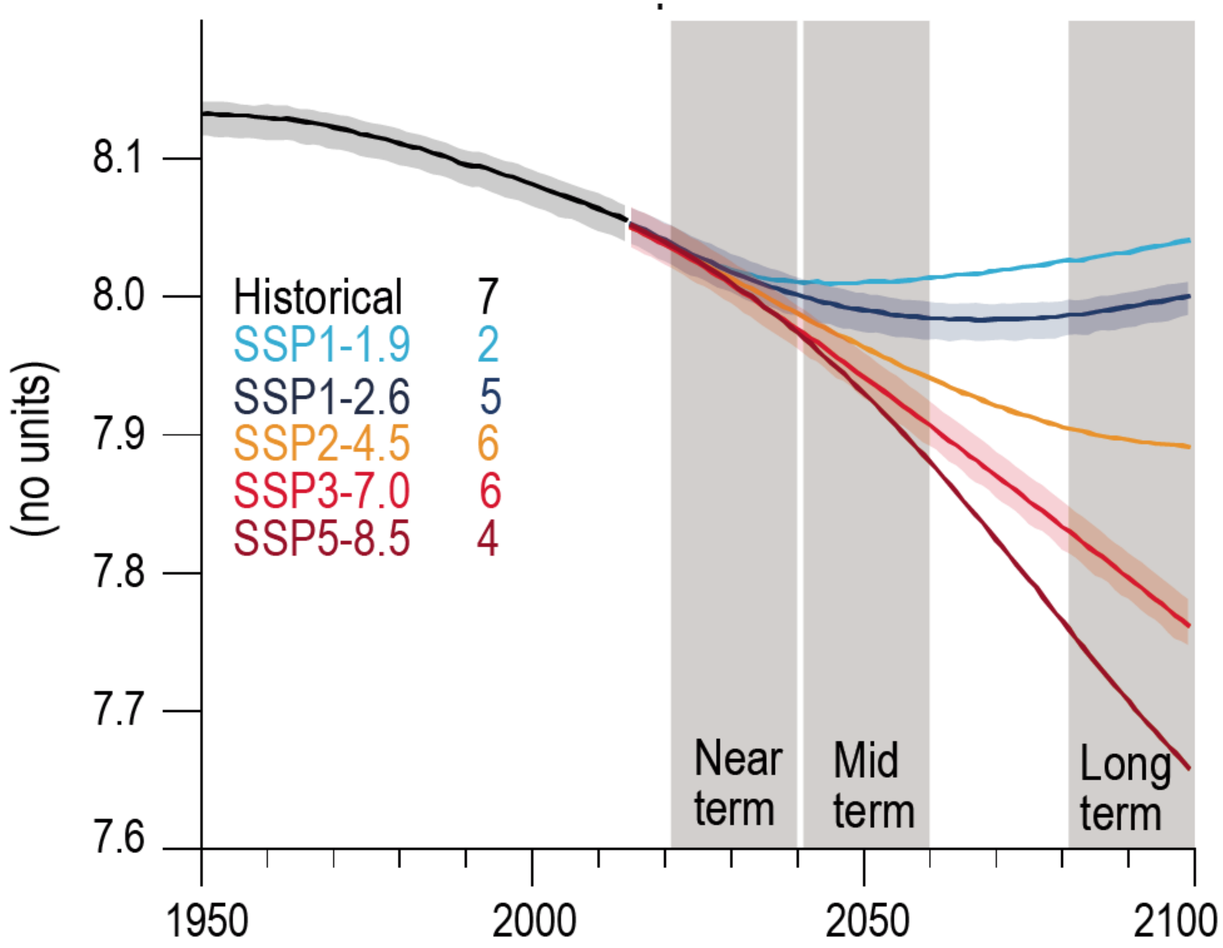
  - The AR5 assessed from CMIP5 simulations that it is *virtually certain* that increasing storage of carbon by the ocean under all four RCPs through to 2100 will increase ocean acidification in the future.

  - The decrease in surface ocean pH from 1986–2005 to 2081–2100 (long term) would be:

    - RCP2.6: 0.065
    - RCP4.5: 0.145
    - RCP6.0: 0.203
    - RCP8.5: 0.31

- Based on results from the CMIP6 models we conclude that, except for the lower emissions scenarios SSP1-1.9 and SSP1-2.6, ocean surface pH decreases monotonically through the 21st century (high confidence)

GLOBAL SURFACE OCEAN pH



- The acidification of the ocean means the death and loss of the coral reef all around the world. The species that suffer the most from this ocean acidification are corals, molluscs and crustaceans, etc. And that also affects the whole food chain.(CATASTROPHIC)

4. OVERALL SITUATION - IRREVERSIBLE AND REVERSIBLE

- A loss of carbon stored in permafrost into the atmosphere.
- An increase in ocean temperatures.
- An increase in global sea level, which is linked to coastal flooding.
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- An increase in global sea level, which is linked to coastal flooding.

4. OVERALL SITUATION - IRREVERSIBLE AND REVERSIBLE

- Many of the scenarios aimed at reaching the Paris Agreement target of less than 1.5 C of warming by 2100 involve a concept called "overshoot."

- Overshoot acknowledges that the average global temperature will rise above 1.5 C temporarily, due to our inability to reduce emissions fast enough. Once we finally stop emitting CO2, it will stabilize at a temperature higher than 1.5 C

4. OVERALL SITUATION - IRREVERSIBLE AND REVERSIBLE

- The IPCC report says there's high confidence that human intervention has the potential to remove CO2 from the atmosphere and store it in reservoirs for the long term, a technology known as carbon capture and storage.

- The reversible changes are directly related to the amount of CO2 in the atmosphere, and respond "relatively quickly" to changes in that amount.

- Some of the current warming is due to methane, a greenhouse gas that is much more short-lived than CO2 – albeit more powerful in terms of trapping heat. It has a lifetime of just 12 years, compared to hundreds of years for CO2.

4. OVERALL SITUATION - IRREVERSIBLE AND REVERSIBLE

- It will take much more time to remove CO2 already in the atmosphere, enough to lower the global temperature.

- "Any processes that involve the ocean or glaciers or permafrost are processes that have a much longer timescale associated with them – much more inertia,.

- "The sea level will continue to rise because large ice sheets, especially, take a long time to come into equilibrium with a new temperature," he said. "And the deep ocean takes a long time to warm up to a level that is consistent with the surface."

4. OVERALL SITUATION - IRREVERSIBLE AND REVERSIBLE

- The temperature of the ocean is "still responding to CO2 that we put into the atmosphere decades ago," and hasn't yet had time to react to more recent emissions, which it will gradually do in coming decades or centuries.
- What will the impact of these irreversible changes ultimately be?
- "Greenhouse gas emissions have more or less committed us to a very long-term sea level rise," she said. "We need to plan for that."

CLIMATE CHANGE IS IRREVERSIBLE

In recent days the emergency due to climate change has been the most important news around the world.

This happened due to the most recent report of the Intergovernmental Panel on Climate Change (IPCC), **in which experts warn about the consequences of climate change that are already considered irreversible.**

The report claims that whatever happens, **the temperature will continue to rise until the middle of this century,** as expected.

The Paris Agreement was unsuccessful and the Sustainable Development Goals will not be met by 2030.

Even if they are met, and must be met, an international **effort must be made to reduce emissions** and do not allow the global temperature to rise more than 2 ° C.

If we do not act immediately **by the end of the century, the global temperature could rise by 4.4 ° C**, which implies an imminent threat to human survival.

The floods that were expected throughout the century will be seen within a few years, even a single year. Coastal cities will disappear in the coming decades.**décadas.**

The **heat waves** that we have seen in different parts of the world will continue to increase.

The arctic layer will be especially influenced, as **during the summer season it will disappear along with hundreds of glaciers.**

The UN ensures that **humanity enters the red code and the main responsible are the greenhouse effect emissions** produced by the burning of fossil fuels and deforestation.

LP

4. OVERALL SITUATION - IRREVERSIBLE AND REVERSIBLE

- That also means coming to terms with the permanence and irreversibility of it, . Land that people have relied on for centuries or more and is tied to their history will disappear.

- "The rate of sea level rise will depend on future emissions,".

- By 2100, sea level will likely rise 0.28 to 0.55 metres if greenhouse gas emissions are cut dramatically. But if emissions remain high, sea level will likely rise 0.98 to 1.88 metres by the end of this century. And in that case a sea level rise of two metres by 2100 and 5 metres by 2150 can't be ruled out, the IPCC report said.

- Similarly, irreversible changes to ice sheets, glaciers, permafrost and the deep ocean will be faster and more extreme with higher emissions-

5. CONCLUSION.

- Mounting evidence indicates that the global climate system has been warming in the 20th century. This evidence is based on a multiplicity of indicators, such as increased surface, ocean and tropospheric temperatures; decreased sea ice, snow cover and glacier extent; and sea level rise.

- This evidence has become so overwhelming that the IPCC-AR4 report defines global warming as "unequivocal". Attribution studles also place high confidence (90-95%) that the warming since the mid-20th century is mainly attributable to the greenhouse effect associated with increasing anthropogenic emissions of carbon dioxide and other greenhouse gases.

- During the same period natural factors, such as changes in solar and volcanic activity, only play a secondary role.

5. CONCLUSION.

- As the emission of greenhousc gases in the atmosphere is expected to continue to increase, global warming and other changes in the climate system are also expected to increase throughout the 20st centurycentury, possibly to levels that might represent a substantial threat to human societies and natural ecosystems.

- The latest set of 21st century climate change projections under different greenhouse gas emission scenarios will then be examined to provide a picture of the climate change signal from the global to the regional scale. The discussion will also focus on the uncertainties underlying these projections and the modeling tools used to produce them.

Thank you for your attention.
Questions and discussion time.