

Understanding Climate Change & IPCC



Wellington, NZ

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IPCC- Intergovernmental Panel on Climate Change

- Authoritative voice on climate change
 - First assessment report issued 1992
- Best available evidence in Paris Agreement 2015
 - Sixth Synthesis Report issued 2023

IPCC Sixth Assessment Cycle: Reports

<https://www.ipcc.ch/documentation/>

SPECIAL AND METHODOLOGY REPORTS

Methodology Report on Short-lived Climate Forcers

Global Warming of 1.5°C

Climate Change and Land

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

The Ocean and Cryosphere in a Changing Climate

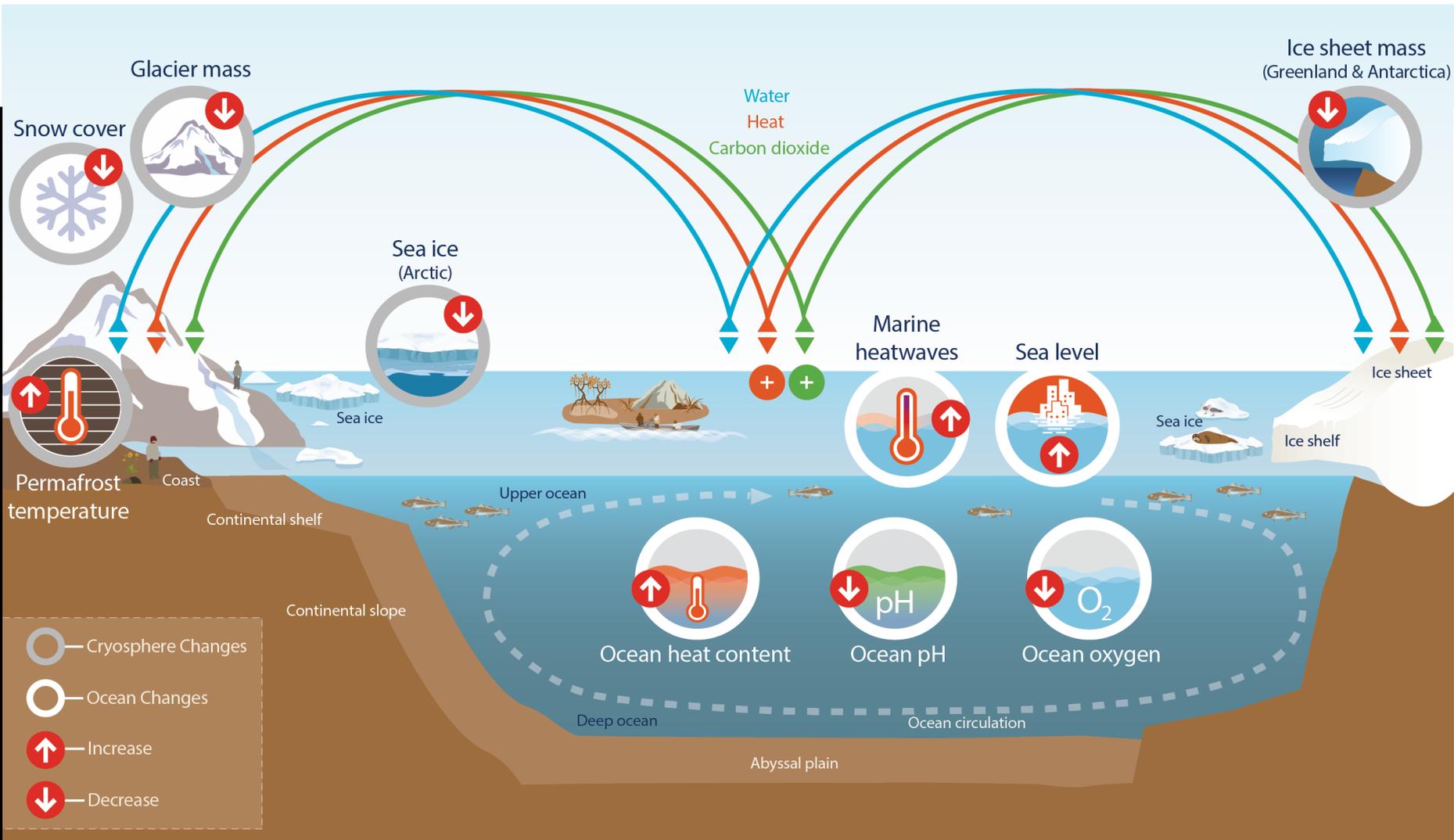
SIXTH ASSESSMENT REPORT

AR6 Synthesis Report: Climate Change 2023

AR6 Climate Change 2022: Impacts, Adaptation and Vulnerability

AR6 Climate Change 2022: Mitigation of Climate Change

AR6 Climate Change 2021: The Physical Science Basis



State of the Ocean

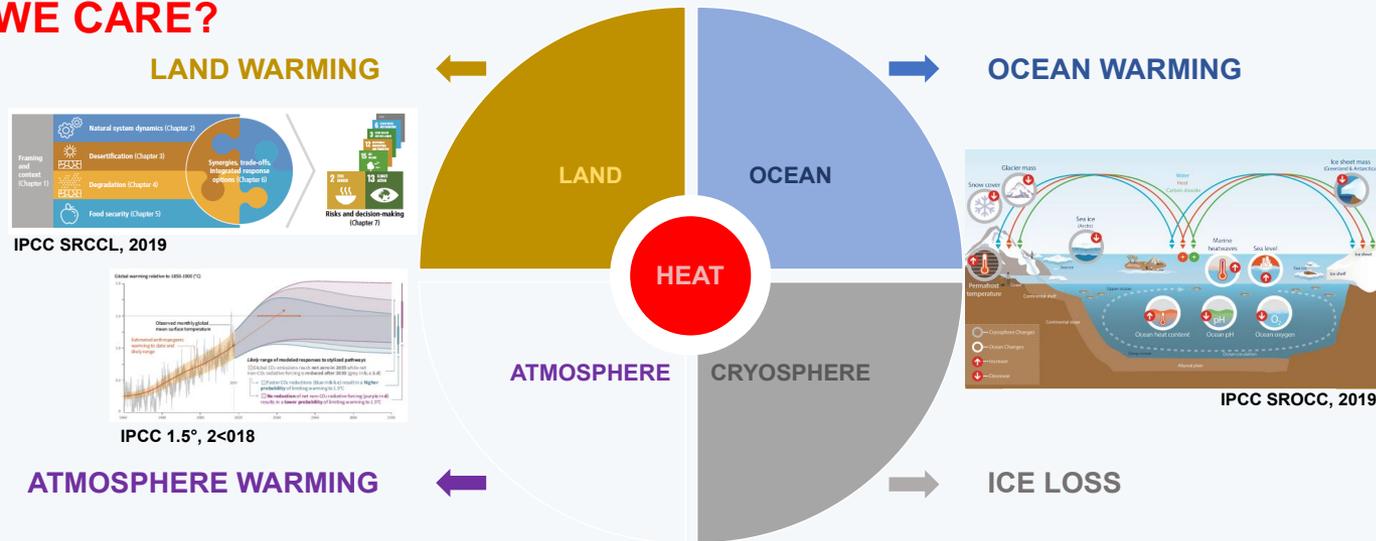
SOCIETY

ECONOMY

ENVIRONMENT

The Earth's Energy Imbalance: Where does the energy go ?

WHY SHOULD WE CARE?



The **various facets and impacts** of observed climate change arise **due to the positive EEI**, which thus represents a **crucial measure of the rate of climate change**.

The EEI is the portion of the forcing that the Earth has not yet responded to

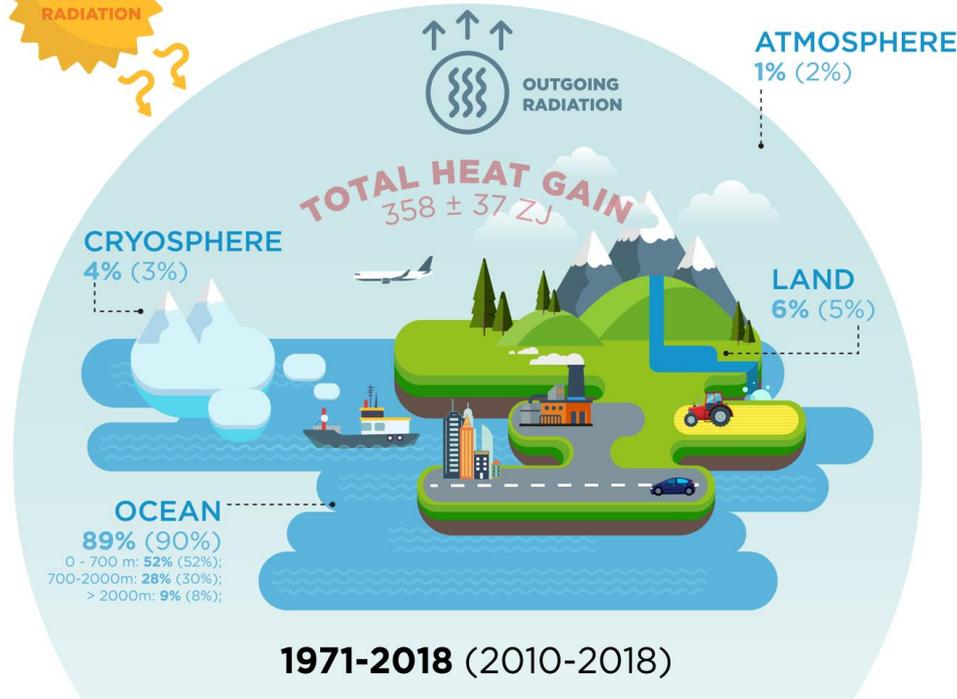
➔ **How much heat is 'in the pipeline' ?**

The EEI is the most critical number defining the prospects for continued global warming and climate change.

The Earth's Energy Imbalance: Where does the energy go ?

EARTH ENERGY IMBALANCE :

-  0.47 ± 0.1 (0.87 ± 0.12) W/m^2
-  Required CO_2 reduction: -57 ± 8 ppm



During 2010-2018, the EEI amounts to 0.87 ± 0.12 W/m^2 .

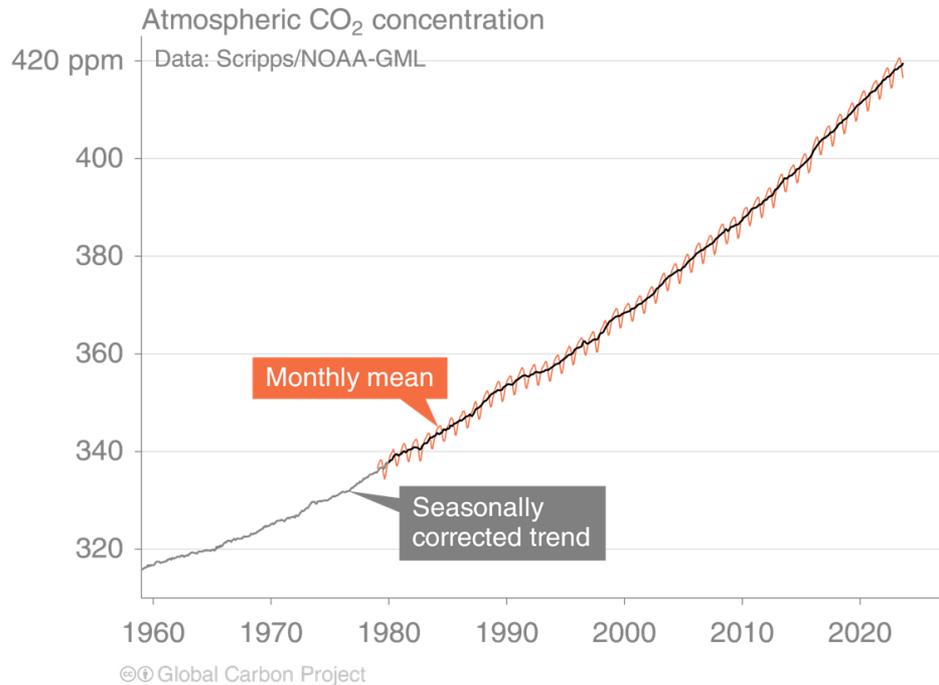
Stabilization of climate, the goal of the universally agreed UNFCCC in 1992 and the Paris agreement in 2015, requires that EEI be reduced to approximately zero to achieve Earth's system quasi-equilibrium.

The amount of CO_2 in the atmosphere would need to be reduced from 410 ppm to 353 ppm to increase heat radiation to space by 0.87 W/m^2 , bringing Earth back towards energy balance.

What is Causing the Warming?

Atmospheric CO₂ concentration

The global CO₂ concentration increased from ~277 ppm in 1750 to 419.3 ppm in 2023 (up 51%)



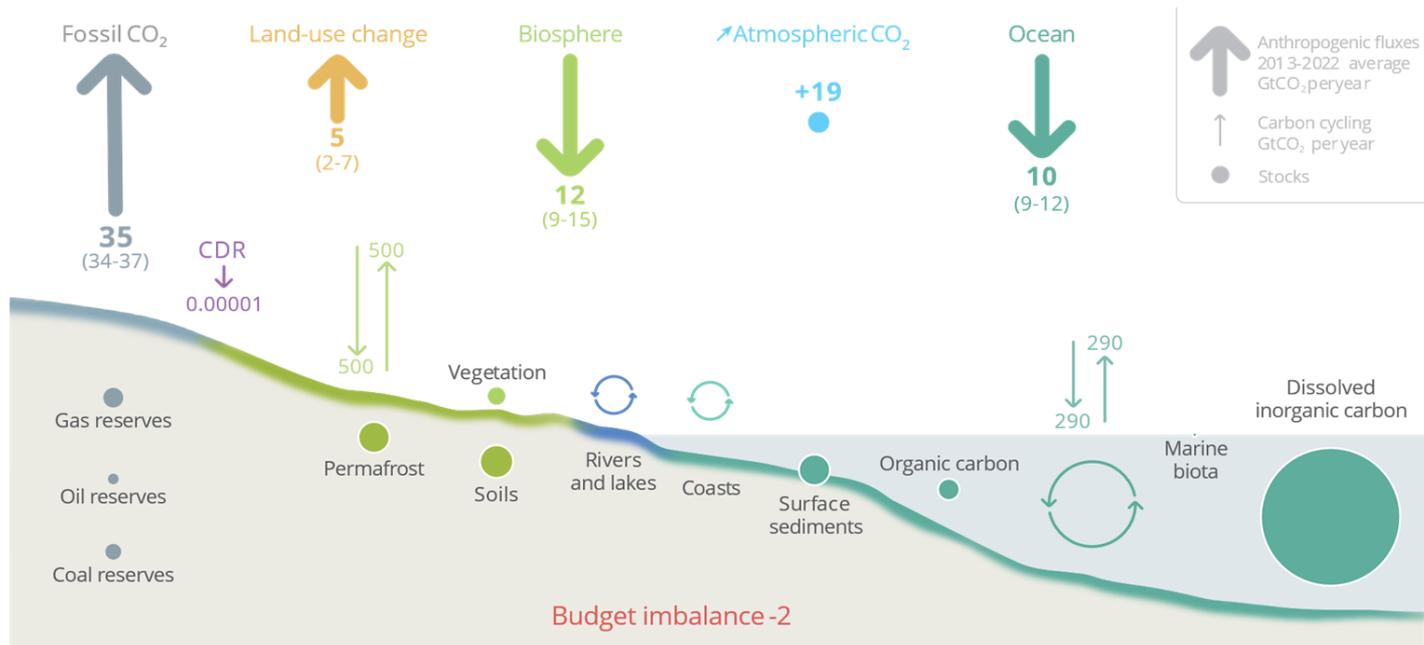
Globally averaged surface atmospheric CO₂ concentration. Data from: NOAA-GML after 1980; the Scripps Institution of Oceanography before 1980

Source: [NOAA-GML](#); [Scripps Institution of Oceanography](#); [Friedlingstein et al 2023](#); [Global Carbon Project 2023](#)

The Carbon Cycle

Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, global annual average for the decade 2013–2022 (GtCO₂/yr)

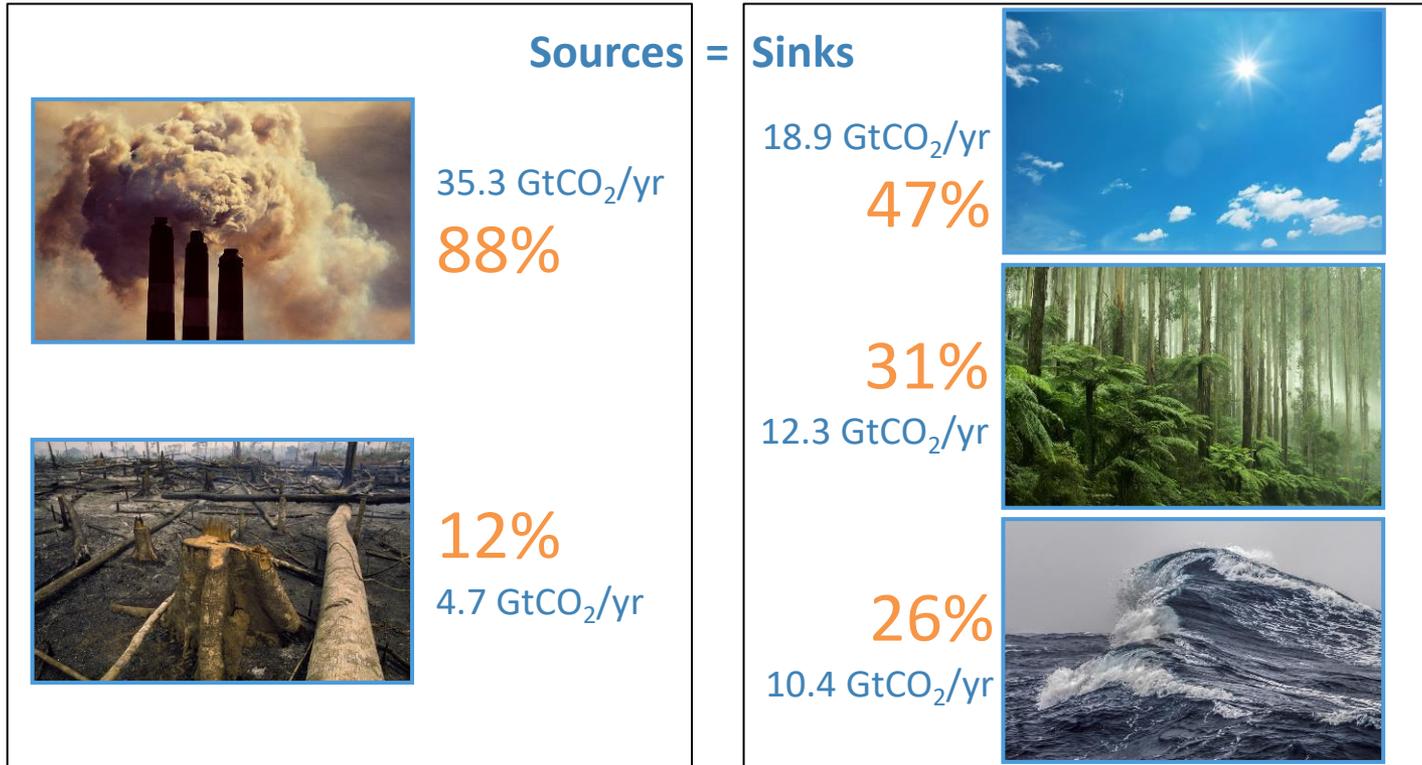


CDR here refers to Carbon Dioxide Removal besides those associated with land-use that are accounted for in the Land-use change estimate. The budget imbalance is the difference between the estimated emissions and sinks.

Source: [NOAA-GML](#); [Friedlingstein et al 2023](#); [Canadell et al 2021 \(IPCC AR6 WG1 Chapter 5\)](#); [Global Carbon Project 2023](#)

Where does the Carbon Dioxide go?

Fate of anthropogenic CO₂ emissions (2013–2022)



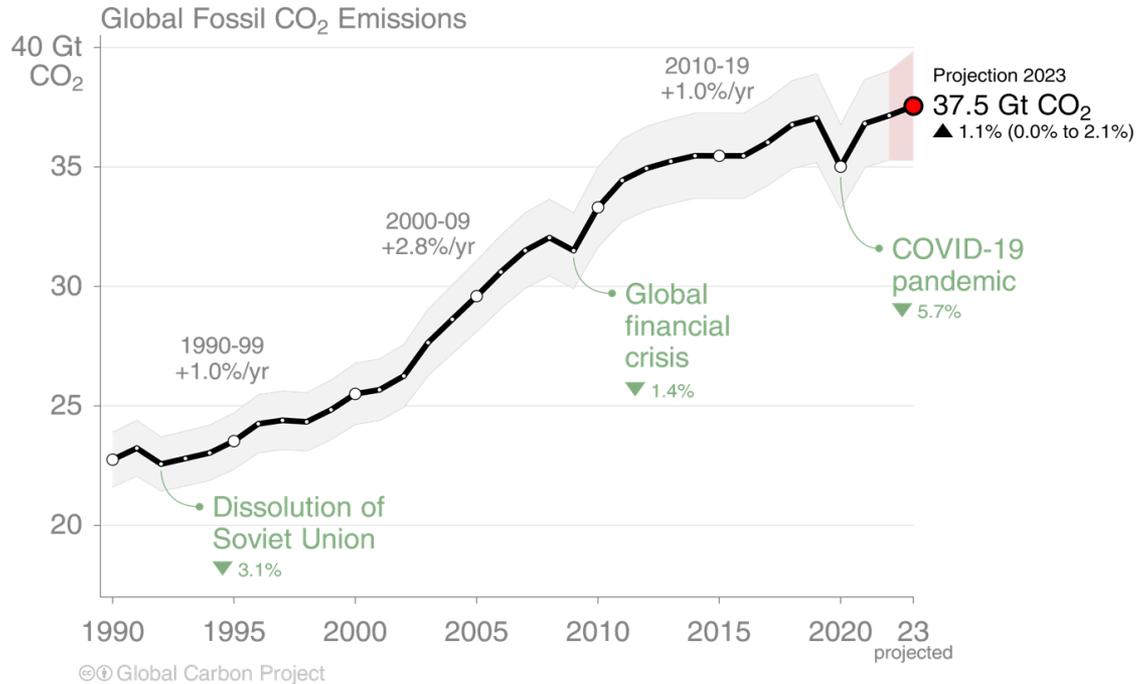
Budget Imbalance: 4%
 (the difference between estimated sources & sinks) -1.6 GtCO₂/yr

Source: [Friedlingstein et al 2023](#); [Global Carbon Project 2023](#)

Global Fossil CO₂ Emissions

Global fossil CO₂ emissions: 37.1 ± 2 GtCO₂ in 2022, 63% over 1990

- Projection for 2023: 37.5 ± 2 GtCO₂, 1.1% [0.0% to +2.1%] higher than 2022



Uncertainty is ±5% for one standard deviation (IPCC “likely” range)

When including cement carbonation, the 2022 and 2023 estimates amount to 36.4 ± 2 GtCO₂ and 36.8 ± 2 GtCO₂ respectively

The 2023 projection is based on preliminary data and modelling.

Source: [Friedlingstein et al 2023](#); [Global Carbon Project 2023](#)

Summary of fossil CO₂ emissions in 2022 and 2023

Region / Country	2022 emissions (billion tonnes/yr)	2022 growth (percent)	2023 projected emissions growth (percent)	2023 projected emissions (billion tonnes/yr)
China	11.4	+0.5%	+4.0%	11.9
USA	5.1	+0.5%	-3.0%	4.9
India	2.8	+5.8%	+8.2%	3.1
EU27	2.8	-1.6%	-7.4%	2.6
International bunkers*	1.0	+15.6%	+11.9%	1.2
All others	15.1	+0.0%	-0.4	14.0
World	37.1	+0.9%	+1.1%	37.5
World (incl. cement carbonation)	36.4	+0.9%	+1.1%	36.8

*Emissions from use of international aviation and maritime shipping bunker fuels are not usually included in national totals. Cement carbonation sink only included in global (World) estimate.

Source: [Friedlingstein et al 2023](#); [Global Carbon Project 2023](#)

IPCC Sixth Assessment Cycle: Scenarios

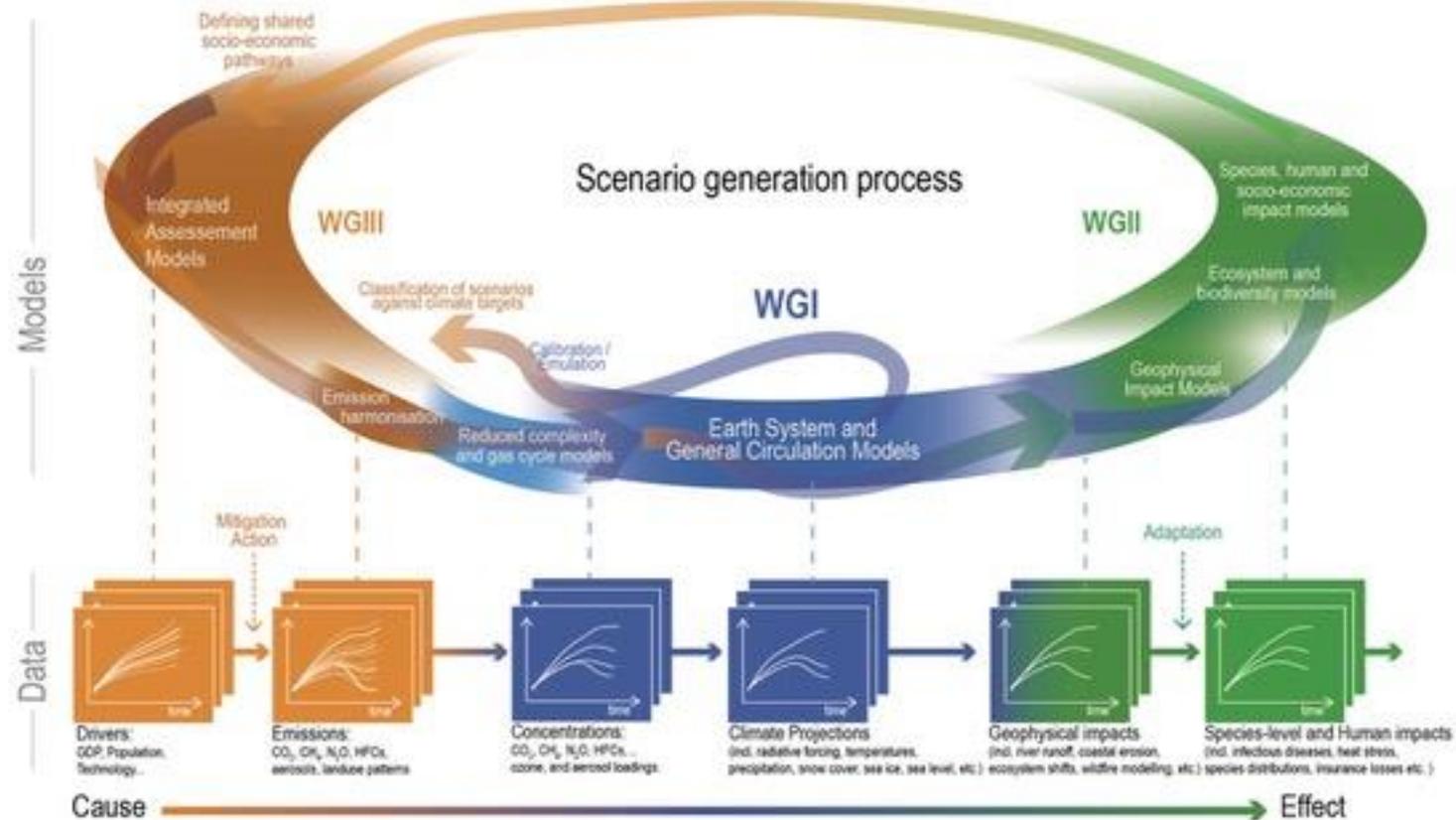
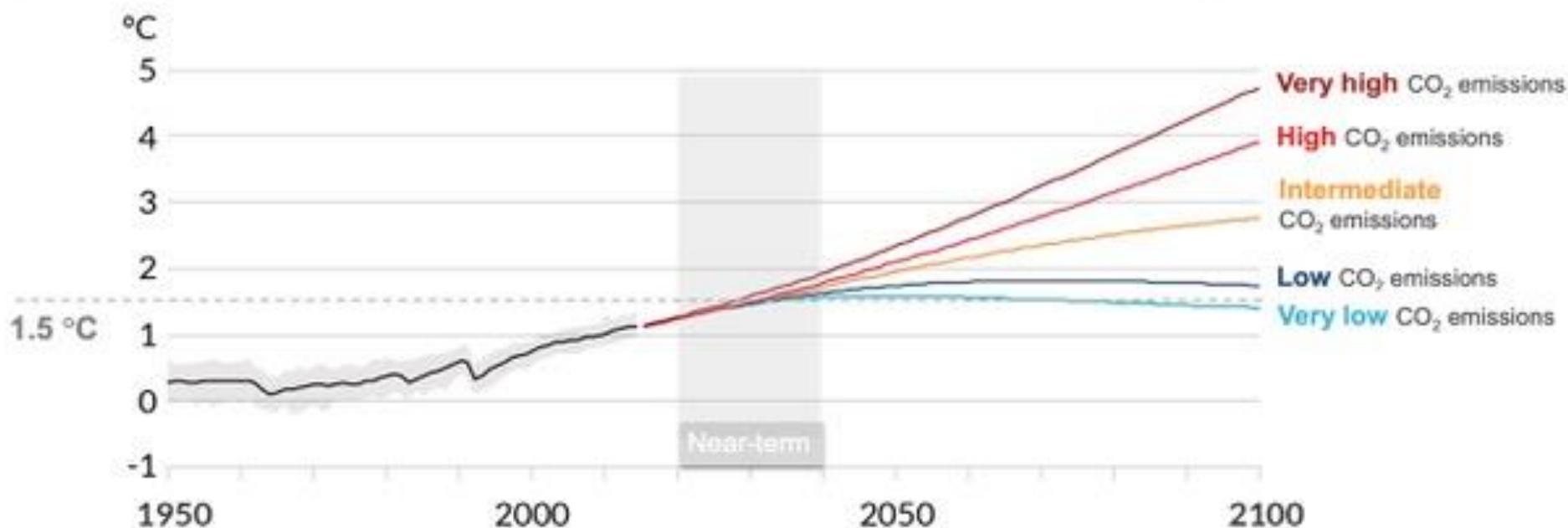


Fig. 1 A simplified illustration of the scenario generation process involving the scientific communities represented in the three IPCC Working Groups. The circular set of arrows at the top indicates the main set of models and workflows used in the scenario generation process, with the lower level indicating the datasets. (Fig. 1.27, in Chen, D., M. Rojas, B.H. Samset, et al., Framing, Context, and Methods. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Masson-Delmotte, V., P. Zhai, A. Pirani, et al. (Eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 147–286. <https://doi.org/10.1017/9781009157896.003> (2021).



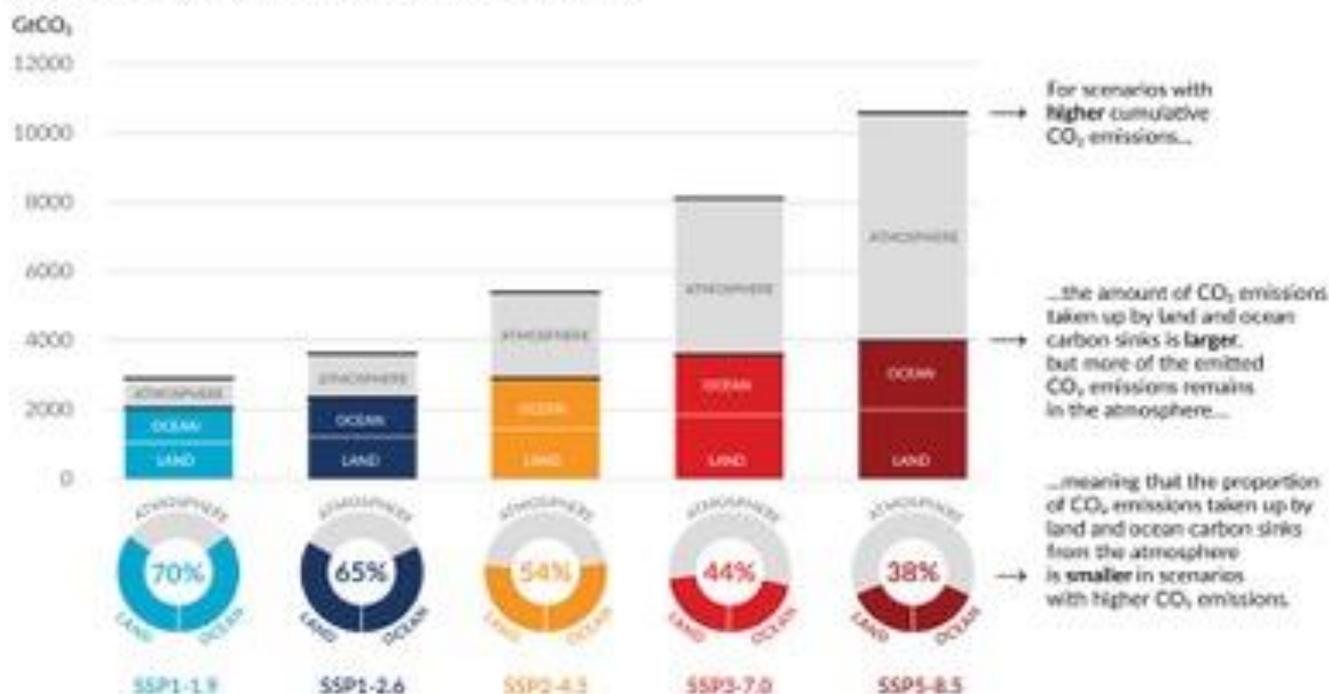
Future emissions cause future additional warming



The proportion of CO₂ emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO₂ emissions

Figure

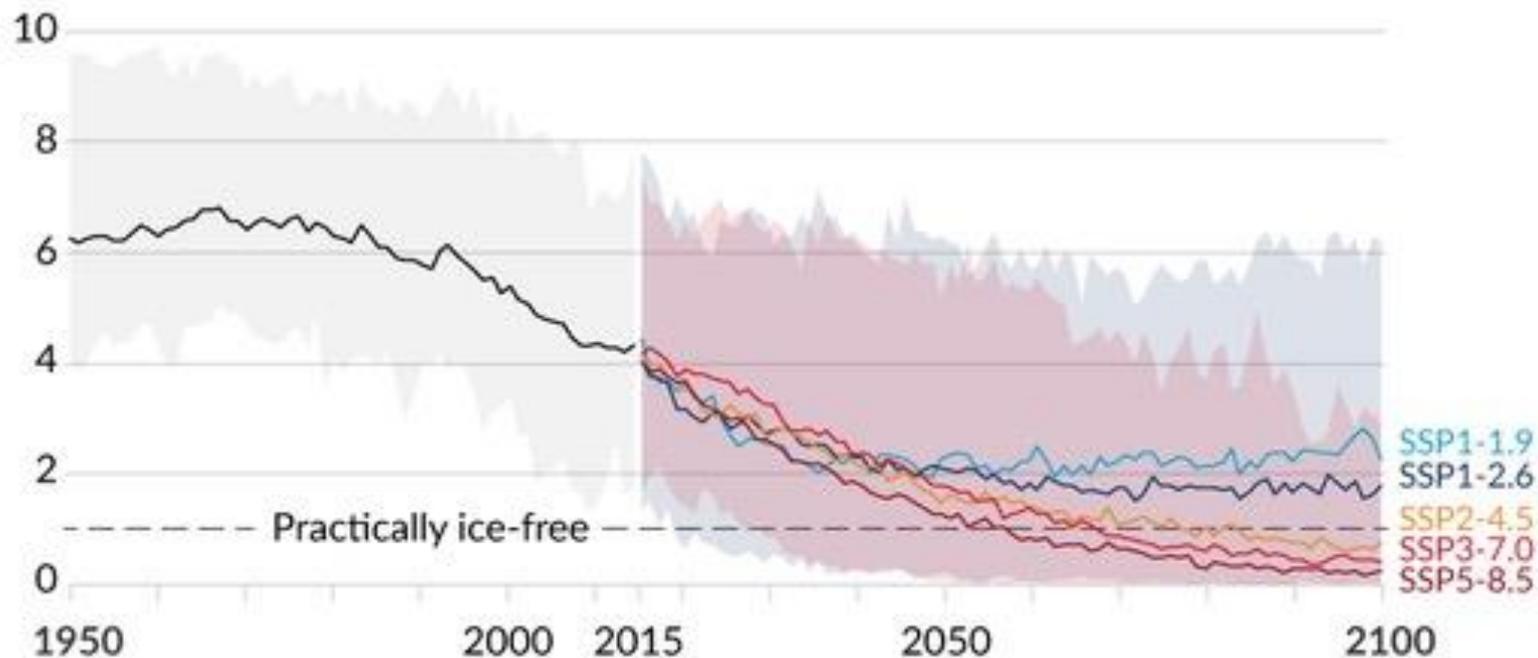
Total cumulative CO₂ emissions taken up by land and oceans (colours) and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100



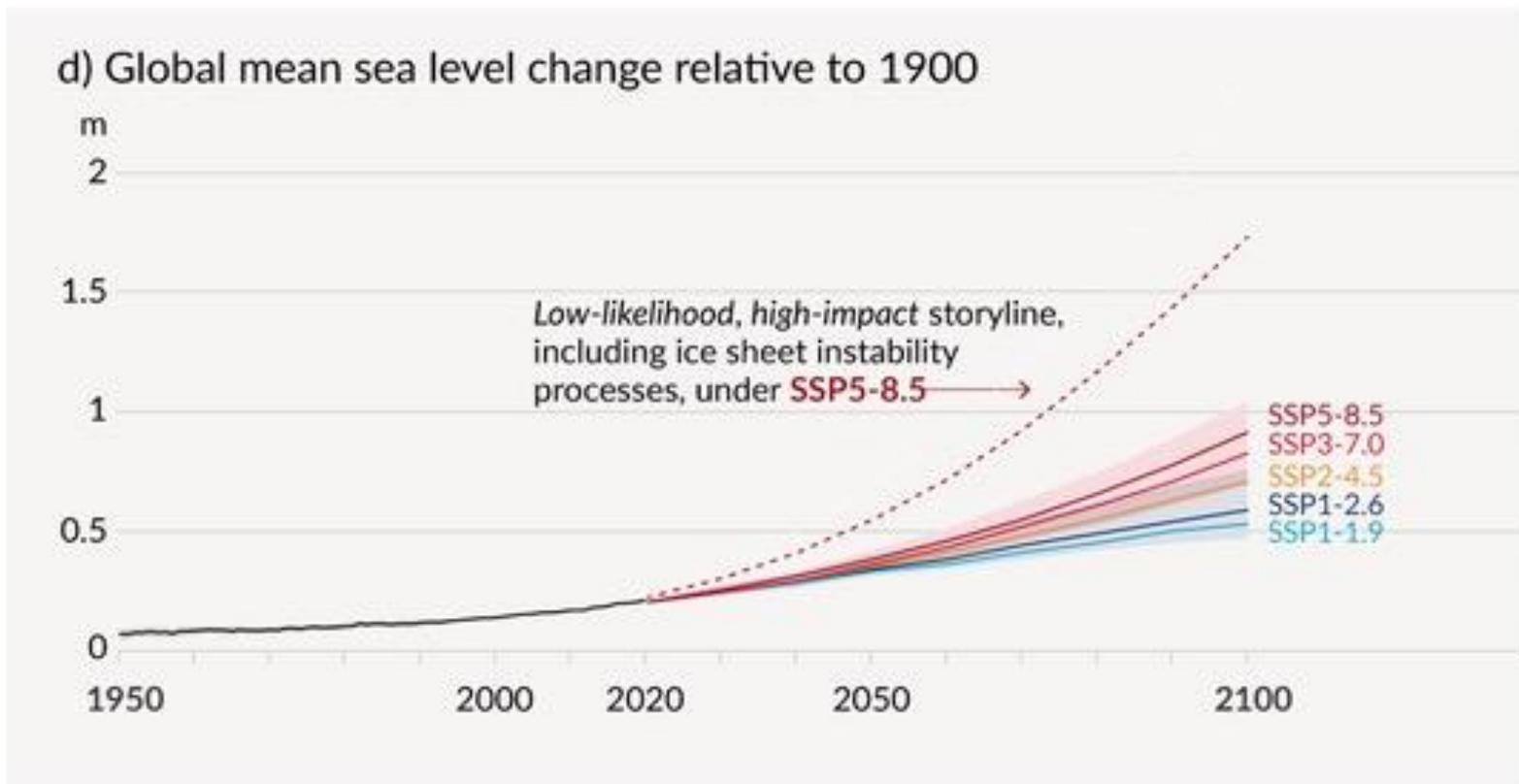
Human activities affect all the major climate system components, with some responding over decades and others over centuries

b) September Arctic sea ice area

10^6 km^2



Human activities affect all the major climate system components, with some responding over decades and others over centuries *Figure*



The Ocean and Cryosphere in a Changing Climate

This Summary for Policymakers was formally approved at the Second Joint Session of Working Groups I and II of the IPCC and accepted by the 51th Session of the IPCC, Principality of Monaco, 24th September 2019

Summary for Policymakers



WG I WG II



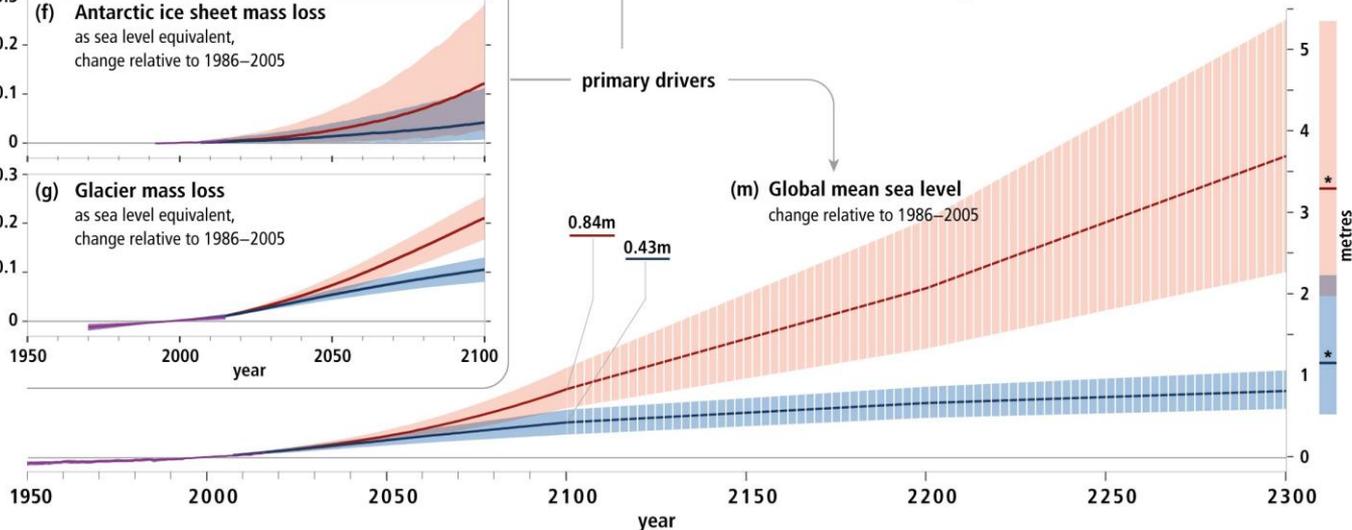
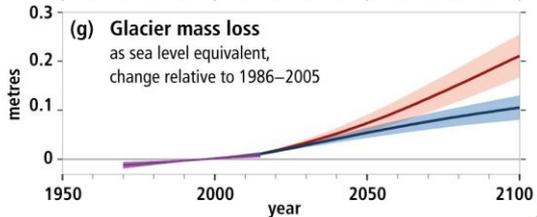
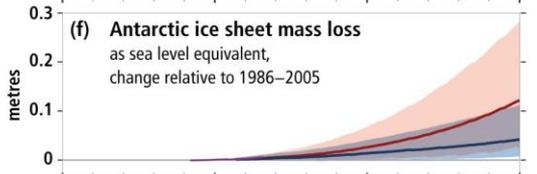
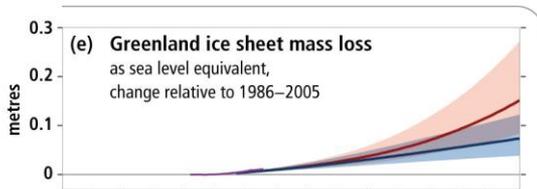
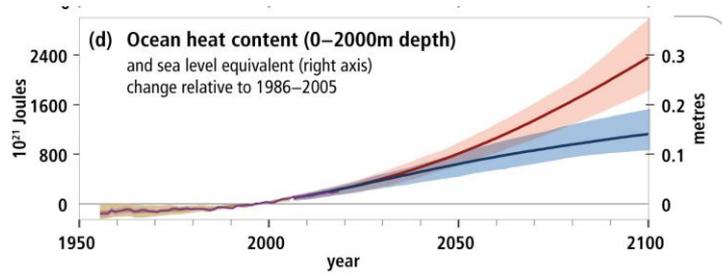
WG I WG II





Photo: Glenn R. Specht

Sea Level
Rise



- Sea level rise will continue beyond 2100.
- Could be limited to around 1m in 2300 under low emissions.
- Up to 5.4m in 2300 for high emissions.
- Adaptation will be necessary, with low emission scenarios giving the best chance of adaptation success.

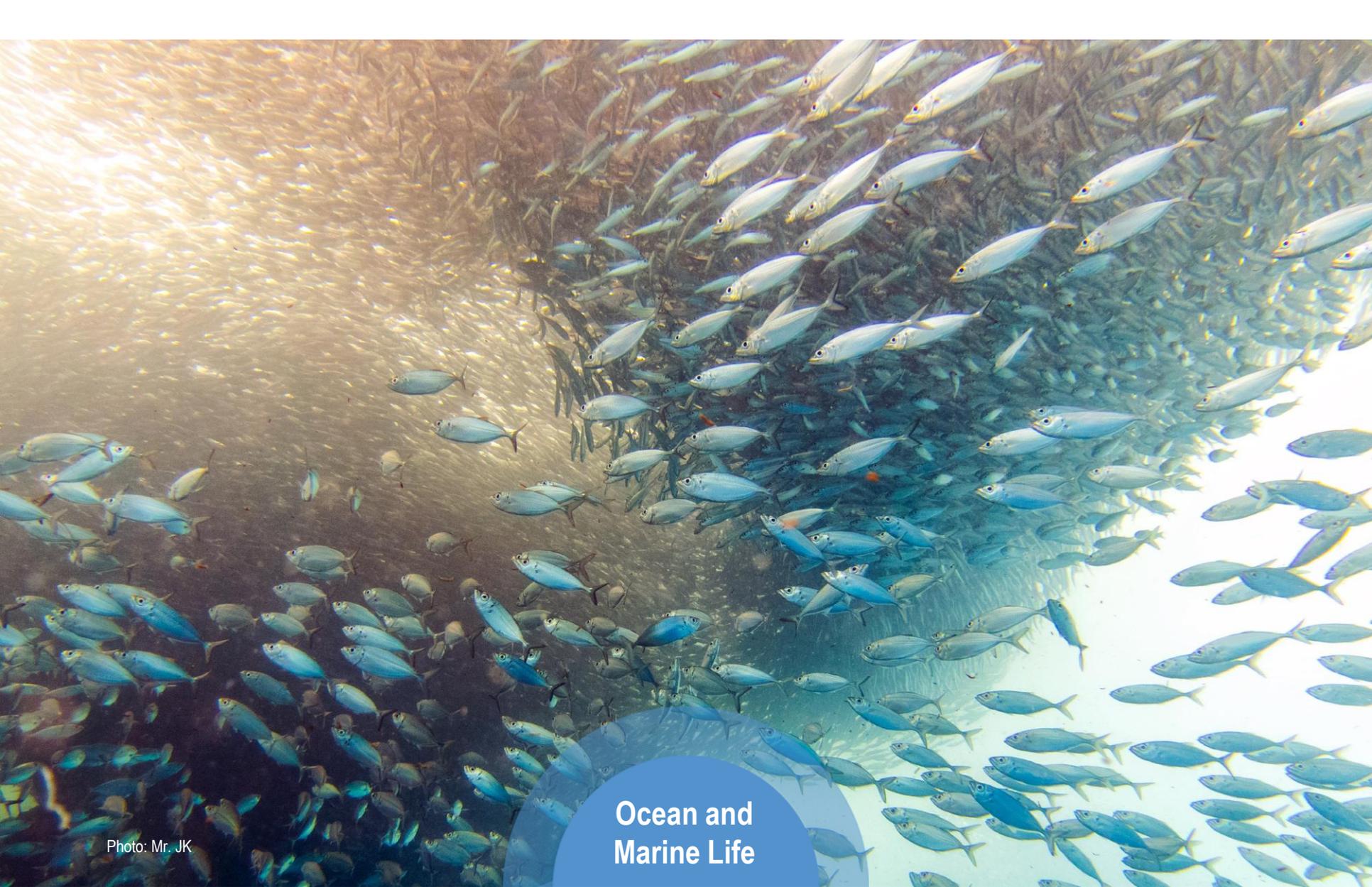


Photo: Mr. JK

Ocean and
Marine Life

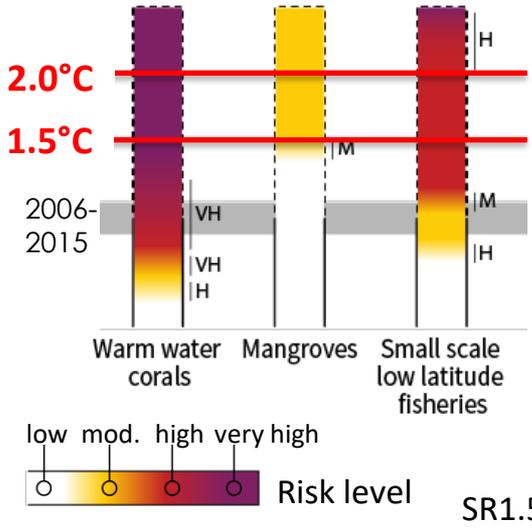
OBSERVATIONS **0.8 to 1.0°C**



Vulnerable Ecosystems identified in AR5, SR1.5, SROCC

Warm water Coral Reefs

Assessing risk of global warming



SR1.5

Even in a 1.5°C warmer world... high risk of losing 70 to 90% of Coral Reefs and associated services for humankind; ... even more at 2°C

Verons 2009

Pacific Messages –

Every island matters.

Every cm (sea level rise) matters.

Every body matters.

Every voice matters

The time for action is now.

ipcc
INTERGOVERNMENTAL PANEL ON climate change

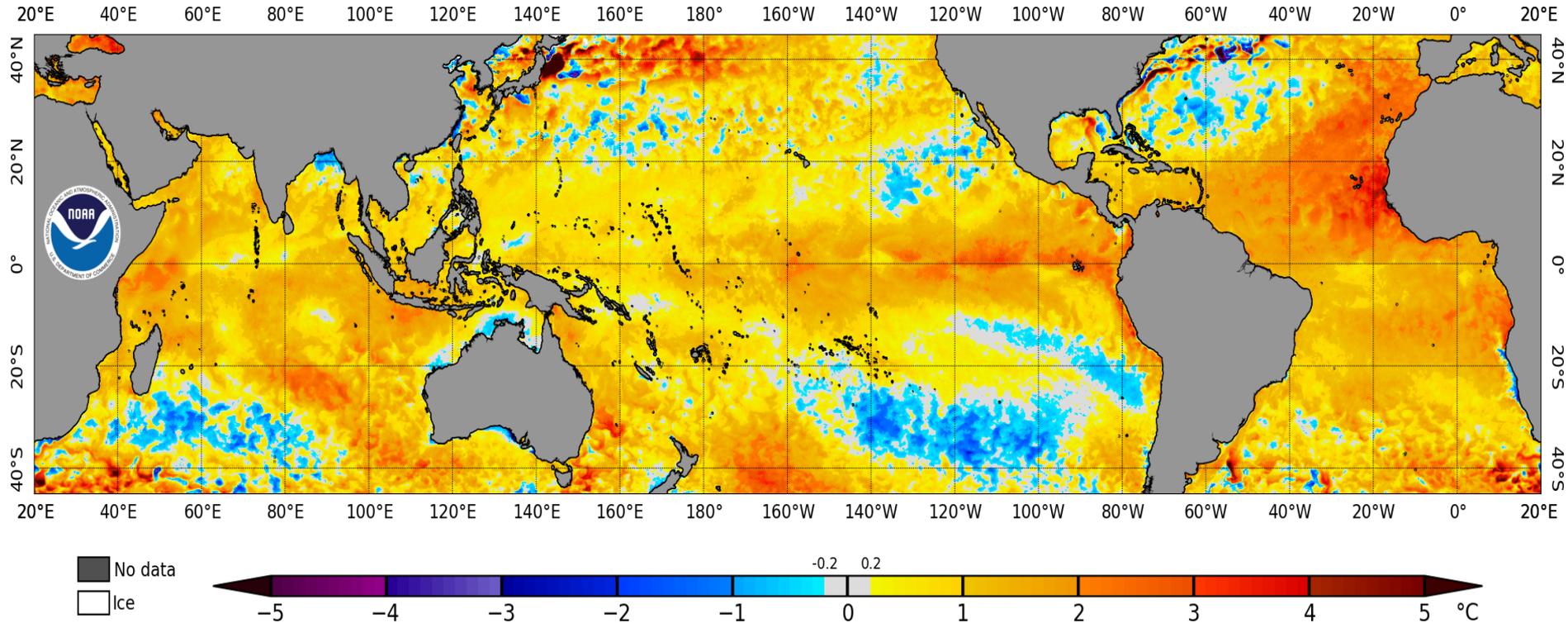


ipcc
INTERGOVERNMENTAL PANEL ON climate change



Now in a strong El Nino:

NOAA Coral Reef Watch Daily 5km SST Anomalies (v3.1) 16 Feb 2024



https://coralreefwatch.noaa.gov/product/5km/index_5km_ssta.php

June exceeded 1.5 °C of warming compared to pre-industrial

“The ocean was given to us by our ancestors to manage so that we could pass it on to our children and future generations. It is our common responsibility and moral obligation for our children”.

Foua Toloa, Minister, Tokelau, Commissioner, Global Ocean Commission

<https://www.change.org/p/ban-ki-moon-help-secure-a-living-ocean-food-and-prosperity-propose-a-new-agreement-for-high-seas-protection-2>



- *Vinaka vakalevu*
- *Fa'afetai tele lava*
- *Malo au'pita*
- *Tank iu*
- *Meral ma Sulang*
- *Ko rab'a*
- *Obrigado*
- *Tank yiu tumas*
- *Tenkyu tru*
- *Fakafetai lasi*
- *Kommol tata*
- *Meitaki Ma'ata*
- *Tubewa*
- *Fakaaue lahi*

Pacific Leaders in Paris

Building on the Suva Declaration, Climate Envoy Tony DeBrum, Republic of the Marshall Islands joined the US and the EU in the High Ambition Coalition with 5 demands:

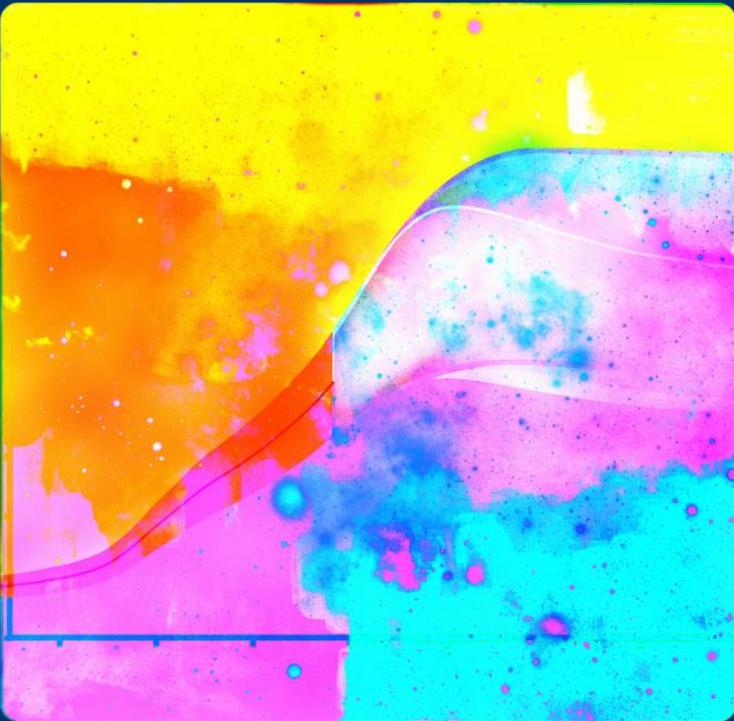
- 1.5 °C global target
- Legally binding
- Increased ambition
- 5 year review
- Loss and Damage



Marshall Islands minister Tony de Brum walks into the final session of talks with US envoy Todd Stern, both wearing a coconut leaf (Photo by IISD/ENB | Kiara Worth)

Messages from the IPCC Special Report on 1.5 °C

- Every Half a Degree matters
 - Every Year Matters
 - Every Choice Matters



IPCC Special Report on Global Warming of 1.5°C

ipcc

INTERGOVERNMENTAL PANEL ON climate change

