WCRP World Climate Research Programme

CliC Climate and Cryosphere

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STATUS BRIEF: Current understanding of global sea-level rise

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This status brief is prepared by the leadership of WCRP's Climate and the Cryosphere Project. It is the first in a new "WCRP Status Brief" series that will synthesise in non-technical language the status of important and emerging topics in climate science and their societal implications for the public and decision makers. This brief outlines the current state and understanding of global sea-level rise science and provides a list key of policy-relevant headline messages (Box 1). It also outlines urgent science priorities that the global community of scientists are addressing to better understand processes and reduce uncertainties, and thus, improve actionable sea-level risk information for society. Insights presented here, are drawn from the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6), WMO State of the Climate reports[1] and important peer-reviewed publications and assessments published since 2021.

[1] https://wmo.int/publication-series/state-of-global-climate-2024
Cover Photo: Stormy seas at Dawlish stock photo. Image source: @Moorefam via iStock (2025).
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Box 1: Key Policy relevant messages

The current rate of sea-level rise (SLR) is **4.7 mm / year** (average of the last 10 years)

1 billion people will be impacted globally by coastal hazards from SLR the end of the century.

0.5 m of global SLR by year 2100 is unavoidable under an emissions pathway consistent with the Paris Climate Agreement target.

2 m of SLR by the year 2100 cannot be ruled out under a high emissions pathway, that accounts for non-linear rapid and irreversible loss of the West Antarctic Ice Sheet.

- Sea-level rise (SLR) is accelerating globally and will continue for centuries under all emission scenarios.
- Decisions made today on mitigation matter and will determine the timing and scale of impacts arising from future SLR.
- Deep reduction in greenhouse gas emissions in line with the Paris Agreement target of 1.5°C can avoid crossing tipping points that would yield rapid and irreversible SLR of several meters for future generations to manage
- Actionable knowledge is crucial to decision-making for climate resilient communities and ecosystems near the coast.
- Minimum estimates of sea-level rise can be made with high confidence and planned for.
- There is deep uncertainty in the maximum levels of sea-level rise that will need to be planned for.
- Sustained engagement between policy-makers and knowledge providers is critical to effectively mitigate and adapt to the threats of sea-level rise, as well as the compounding and cascading factors that can magnify its impacts (natural, social and economic).

A parking lot in Prince Edward Island National Park on the coast which has been eroded away. *Image source: Getty Images via Canva (2025).*

Why does sea-level rise matter?

Sea-level rise (SLR) impacts coastal communities, infrastructure and ecosystems both through permanent inundation of the lowest-lying areas and by increasing the frequency of flooding, and the associated impacts (erosion, groundwater inundation, aquifer and floodplain salinisation) affecting the wider coastal environment. Coastal hazards and their impacts are now occurring worldwide, and their near-term risks are projected to escalate well before 2050. One billion people living on the coast will be impacted by the end of the century.

The ability to anticipate and adapt to sea-level rise and curtail its acceleration beyond 2050 will determine how society copes with increasing coastal risks. This ability depends on access to context-specific risk information and strategies tailored to unique local environmental, cultural and social settings, together with near-term and ongoing commitment to emissions mitigation. There are hard limits to adaptation in the face of progressive sea-level rise, because sea-level rise may become irreversible this century. Coastal inundation already threatens habitability and sovereignty for some small island developing states. Some communities, such as Tuvalu and Fiji, are already implementing relocation or managed retreat from the coast or exploring new visions of a digital community (Rothe et al., 2024).

How much and how fast is sea-level rising?

Global mean sea-level rise depends almost equally on two main contributors, both of which are highly sensitive to ongoing climate change: the expansion of ocean waters as they warm, and meltwater contributions from ice on land - the Antarctic and Greenland ice sheets as well as thousands of smaller mountain glaciers (e.g. Liang et al. 2025). Global sea level is accelerating and increased by 5.9 mm in 2024 relative to a mean annual average rate of 3.4 mm/year between 1993-2024, and 4.7 mm/year between 2014-2023, due to an accelerating rate of land ice loss and recent exceptional rates of recent atmospheric and ocean warming (Hamlington et al. 2025, Liang et al. 2025). Trends based on tide gauge sea-level data from 1970-2023, extrapolated forward to 2050, support mid-range Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report (AR6) projections (IPCC, 2021) of sea-level change by 2050 and highlight the value of observational constraints on model projections (Wang et al. 2025). The likely (17th-83rd percentile) range of global mean SLR for the end of the century for all climate scenarios is between 0.4-1m (Fig. 1).

What are some of the consequences of sea-level rise?

It is estimated that between 4 and 72 million people, with the greatest numbers in Bangladesh, India and Vietnam, but many affected elsewhere, will need to migrate between 2020 and 2100, with a net land loss from 2,800 to 490,000 km^2 (Ballesteros et al. 2025). In Bangladesh alone it is estimated that 15 million will be displaced by 2050 (IPCC, 2019). Across the range of shared socio-economic scenarios (SSPs) considered by IPCC AR6, the greatest estimated migration is under the 'high mid-range' SSP3-7.0 scenario, due to population and economic differences between the scenarios (Ballesteros et al. 2025).

Sea-level will not rise evenly around the world's shorelines. While global average SLR is often quoted, the rate and magnitude of future SLR rise will be different in different regions depending which polar ice sheets melt the fastest and due to influences of mass redistribution on Earth's gravitational field, axis of rotation and the shape of the Earth's surface, as well as regional changes in ocean and atmospheric dynamics (IPCC, 2021). Examples of these regional differences in SLR include: (i) the western equatorial Pacific where rates of SLR are up to 20mm/year due to regional ocean heating, and (ii) the US coastline, which could see up to 20% more SLR than the global average, if West Antarctic Ice Sheet melted dramatically. Moreover, local land subsidence due to tectonics, groundwater and fluid extraction and compaction from the weight of industrialisation (e.g., Ohenhen, 2023) can exacerbate the rate of sea-level rise, meaning adaptation planning decision thresholds, such as those linked to the impacts of coastal flooding and inundation, may be brought forward by decades (Naish et al., 2024).

Some small island and developing states are already near the limits of adaptation. *Source: https://greenstories.co.in/kiribati-slowly-drowning/*.

Is the magnitude and rate of future sea-level rise uncertain?

Despite recent advances in ice-sheet modelling, deep uncertainty remains about the possible impact of accelerating ice mass loss from the Antarctic Ice Sheets on the high-range of sea-level projections, especially beyond AD 2100, due to limitations with understanding and representing physical processes at the ice margins and their physical feedbacks with the climate system (Fricker et al. 2025, Kopp et al. 2023). This includes potential runaway processes such as 'Marine Ice Cliff Instability'. Scientists are still unable to discount some low probability, but potentially catastrophic very high-end sea-level scenarios that go well beyond the upper likely range of the high emissions IPCC scenario (~102 cm global rise) by 2100 (DeConto et al., 2021). For this reason, the IPCC (2021) AR6 Report stated that 2m SLR by the end of the century could not be ruled out. Therefore, further improvements to the models and their forcing datasets (e.g. ocean circulation) together with enhanced observations and an improved understanding of key rate determining processes are urgently needed (Fricker et al. 2025, Williams et al. 2025). Differences between the forcing datasets from different climate models dominate uncertainties in global and regional sea-level projections, at least until around 2070 (Jin et al. 2025). After this time the uncertainty is dependent on emissions mitigation pathway and Antarctic ice sheet melting processes. A recent study indicates that global warming needs to be stabilised well below 1.5°C above pre-industrial, to avoid damaging (multi-metre) levels of sea-level rise over the next few centuries (Stokes et al. 2025). Paleoclimate archives show in response to 1.5°C and 2.5°C of global warming, 125 thousand and 3 million years ago, respectively, sea-levels rose by up to +9m and +20m, occurring over centuries.

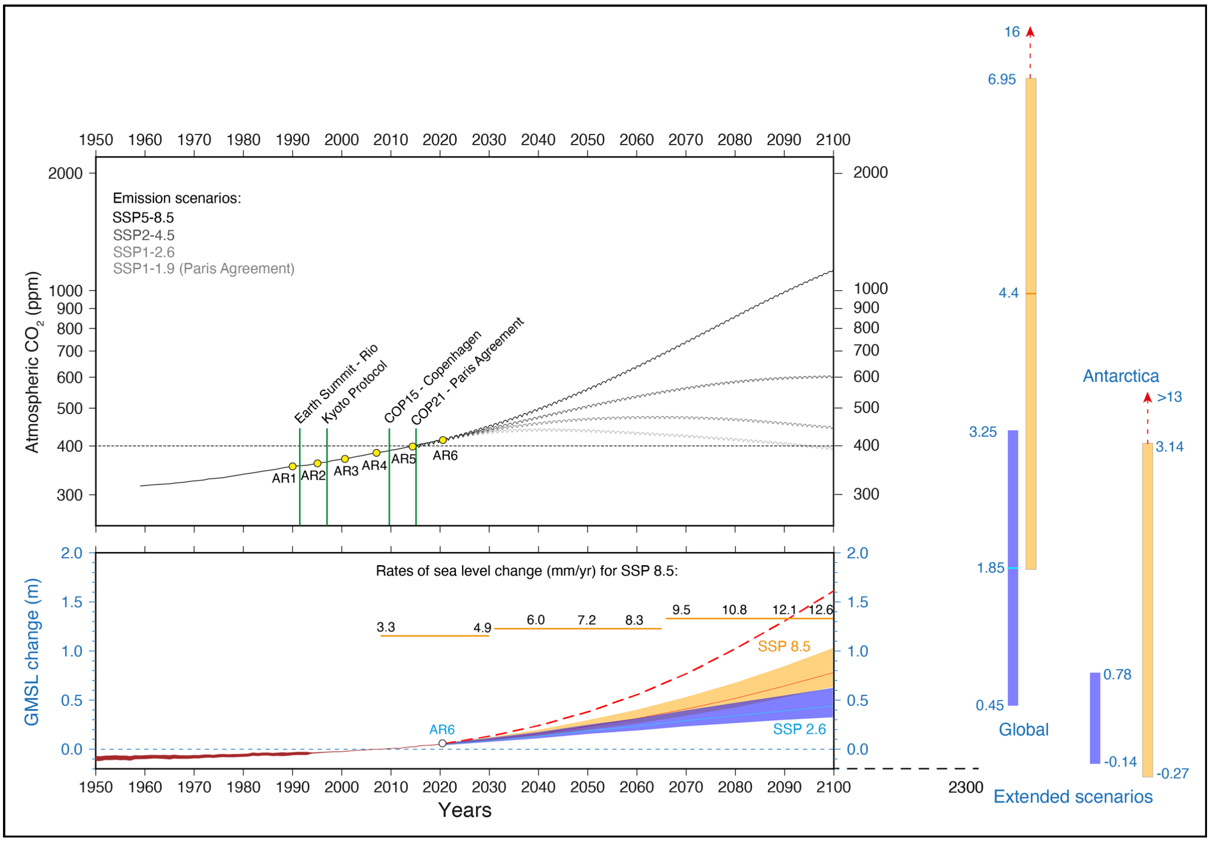

Fig. 1. Atmospheric carbon dioxide (CO_2) concentration (in parts per million, ppm) observed at Mauna Loa Observatory in Hawaii from about 1960 until 2020 (smooth black curve) is shown (top), along with projected CO_2 concentrations (rippled grey curves) for various Shared Socioeconomic Pathways (SSPs) until 2100. Years when key U.N. Framework Convention on Climate Change Conferences of Parties (COPs) were held are shown together with the IPCC Assessment Report publication years. Observed (brown) global mean sea level change (GMSL) from 1950 to 2020 is shown (bottom) relative to the 1994–2015 baseline, along with projected changes for SSP 1–2.6 (blue consistent with the Paris target) and SSP 5–8.5 (orange, unabated emissions) and the low-confidence, high-impact SSP 5–8.5 (dashed red line, which includes rapid Antarctic ice sheet melting). The uncertainties indicated correspond to the 17th and 83rd percentiles for each SSP (known as the "likely range" in IPCC 2021). Rates of sea level change (in millimeters/year) for SSP 8.5 until 2100 are also shown. The projected ranges (17th to 83rd percentiles) of GMSL change and the Antarctic contribution until 2300 CE (extended scenarios) from IPCC AR6 are plotted (right) for SSP 1–2.6 (blue) and SSP 5–8.5 (orange) pathways and for the low-confidence, high-impact scenario SSP 5–8.5 (dashed red arrows, accounting for instability processes in Antarctic ice sheet projections). Modified from Colleoni et al. (2022).

Uncertainties in mean and extreme sea-level projections are further compounded by local factors that affect the rates of vertical land movement (VLM; discussed above), which can be as fast as the rate of global sea-level rise. The direction of VLM can significantly offset or exacerbate the local change in sea-level, known as relative sea level (RSL). These processes driving RSL change are presently poorly represented in models and sea-level projections used for local coastal hazard and risk assessments.

Photo of a flooded coastal village in Malaysia. *Source: Pok Rie: https://www.pexels.com/photo/flood-in-village-14823613/*

Research priorities

Currently, the ice-sheet modelling community is gearing up for a new model intercomparison project called Ice Sheet Model Intercomparison Project 7 (ISMIP7). This is a WCRP CliC-sponsored project that will contribute to the IPCC AR7 cycle and promises to make further advances by spearheading the scientific international science community to improve climate and ice-sheet projections, which in turn will reduce uncertainty regarding future sea-level change. At the same time, practitioners and users of sea-level rise data are asking for a consistency in actionable information to support decision-making and planning for coastal resilience (Hirschfeld et al., 2023). This requires researchers and users working together more effectively in the provision and communication of sea-level rise science and the treatment of uncertainty related to global (Antarctic ice sheet) and local (vertical land movements) drivers of SLR. Recognising the importance of understanding the impacts of our rising seas, WCRP itself is discussing a possible future sea level focused activity to bring together the various aspects of sea-level research and impacts into one focused activity.

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